FEED ENZYMES – JUST SOME BASICS

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Robust fungal and bacterial enzyme production continues to improve the efficiency of enzyme manufacturing. In addition, modern-day DNA technology and genetic engineering offer gigantic leaps in physicochemical properties of enzymes. Together, these innovations help steer enzyme application toward poultry and other animal feeds, including that of ruminants.

Feed enzymes have become a routine addition to poultry feeds. Their inclusion cuts feed costs to the tune of $6-10/ton, or more. Phytases and carbohydrases or NSP (nonstarch polysaccharide) enzymes are in most poultry feeds, while proteases are making inroads to legitimately hoist profits (Ward and de Beer, 2012).

Furthermore, only about 65-75% of the energy from a corn/SBM (soybean meal) diet is exploited by poultry. No more than about 85% of the energy in corn and 50-60% of that in SBM is utilized. This is a significant inefficiency and economic loss, largely due to NSP. And there are no NSP enzymes secreted in the intestinal tract of poultry.

What is the Function of Feed Enzymes?

Feed enzymes improve the digestibility and nutritional value of feed ingredients. Based on the higher digestibility, enzyme-derived nutritional “uplifts” are mathematically converted to “matrix values” for nutritionists in least-costing feeds.

This computation is made for the nutritional component it replaces. For phytases, it’s P and Ca. For NSP-enzymes and amylases, more energy becomes available. And for proteases, we get more lysine, sulfur amino acids, threonine, and other amino acids, all from the same feed. Matrix values reflect these contributions.

So, enzymes don’t “bring” added P or energy or amino acids to the feedmill. Instead, they simply increase the amount available in the diet through improved digestibility of the feeds. Based on this, phytase replaces about 16 lbs of phosphate, while NSP enzymes can replace more than 17 lbs fat/ton feed - without losing bird performance.

At today’s costs, this amount of phosphate is worth about $4.00/ton feed. And for NSP-enzymes that replace fat in the diet, the 30 kcal/lb accounts for an additional $3.50-4.00/ton in savings. Add to this the value of amino acids Ca and Na.

Enzyme Categories

Common commercial feed enzymes are listed in Table 1. Today’s phytases can easily replace 0.15-17% P. There’s also mounting evidence that super-dosing levels (6 or more times normal) improve feed conversion and some meat qualities.

Studies have shown that a wide range of NSP enzymes are needed in typical corn/SBM based diets. We separate these according to their effectiveness in cereal grains versus leguminous protein ingredients such as SBM, simply because NSPs in the two ingredient groups differ significantly and require different enzymes.

So, xylanases are important for corn since arabinoxylan (the substrate for xylanases) is the primary substrate in corn (Table 2). But this enzyme brings no value to SBM which has no substrate for xylanase. Cellulases are needed across all plant ingredients, while B-Glucanases are critical to degrade β-glucans in barley, oats, and corn-based diets. And for SBM and other leguminous protein ingredients, pectinases, galactosidases, and mannanases are the primary key enzymes to degrade the NSPs (Bach Knudsen, 2013).

Debranching enzymes assist with xylanases, pectinases, and others by removing structures from NSPs to facilitate degradation (Ward and Kuhnel, 2016). In combination with xylanase, debranching enzymes significantly improve bird efficiency beyond xylanase alone in wheat- and corn-based diets (Ward, 2019).

Choose Your Enzymes Wisely

In a broiler starter diet, 65% of the total NSP comes from SBM, and although about 50% of the NSP in corn is arabinoxylan, it accounts for only about 15% of the total NSP in the diet. This means 85% of the total NSP enzyme needed should be something other than xylanase. And if no debranching enzymes are present, the added xylanase will have little or no value. A mixture of NSP enzymes is essential for any diet. The cereal and leguminous protein ingredients both require different groups of enzymes.

Are We Doing Our Best?

With the abundancy of today’s feed enzyme availability, a more sophisticated approach beyond the single-enzyme method is needed. A strategic battery of enzymes composed of primary carbohydrases and debranching enzymes more effectively dismantles the complicated array of non-starch polysaccharides in corn and other cereals.

Table 1. Common Feed Enzymes and Targeted Substrates and Ingredients

Enzyme	Target Substrate	Ingredient
Phytases	Phytic acid from all plant ingredients	Cereals, plant proteins
Xylanases	Arabinoxylan from cereals	Cereals
Glucanases	Glucans mainly from cereals	Cereals
Pectinases	Pectins from leguminous ingredients	Plant proteins
Galactosidases	Oligosaccharides	Plant proteins
Cellulases	Cellulose in all plant ingredients	Cereals, plant proteins
Proteases	Protein from plant and animal ingredients	Cereals, plant proteins
Amylases	Starch	Cereals
Debranching enzymes	Ancillary components attached to NSPs in plants	Cereals, plant proteins

Table 2. Nonstarch Polysaccharide (NSP) Content on Feed Ingredients

	Arabinoxylan	Cellulose	Pectins	B-glucans	Oligosaccharides	Total NSP
Corn	4.3	2.0	0.9	0.3	0.8	8.3
Soybean meal	-	5.9	9.1	0.7	9.6	25.7
Corn DDGS	11.7	10.7	2.7	-	0.2	25.3
Wheat	7.1	1.8	0.4	0.6	0.1	10.0
Sorghum	3.7	1.1	0.4	0.1	0.2	5.5
Barley	8.1	3.9	0.5	4.3	0.1	16.9
Canola	0.3	6.1	7.1	0.8	3.7	18.0
Wheat DDGS	12.2	3.7	0.9	0.3	0.8	17.0