Practical Applications of Hemicell® Feed Enzyme in Broilers

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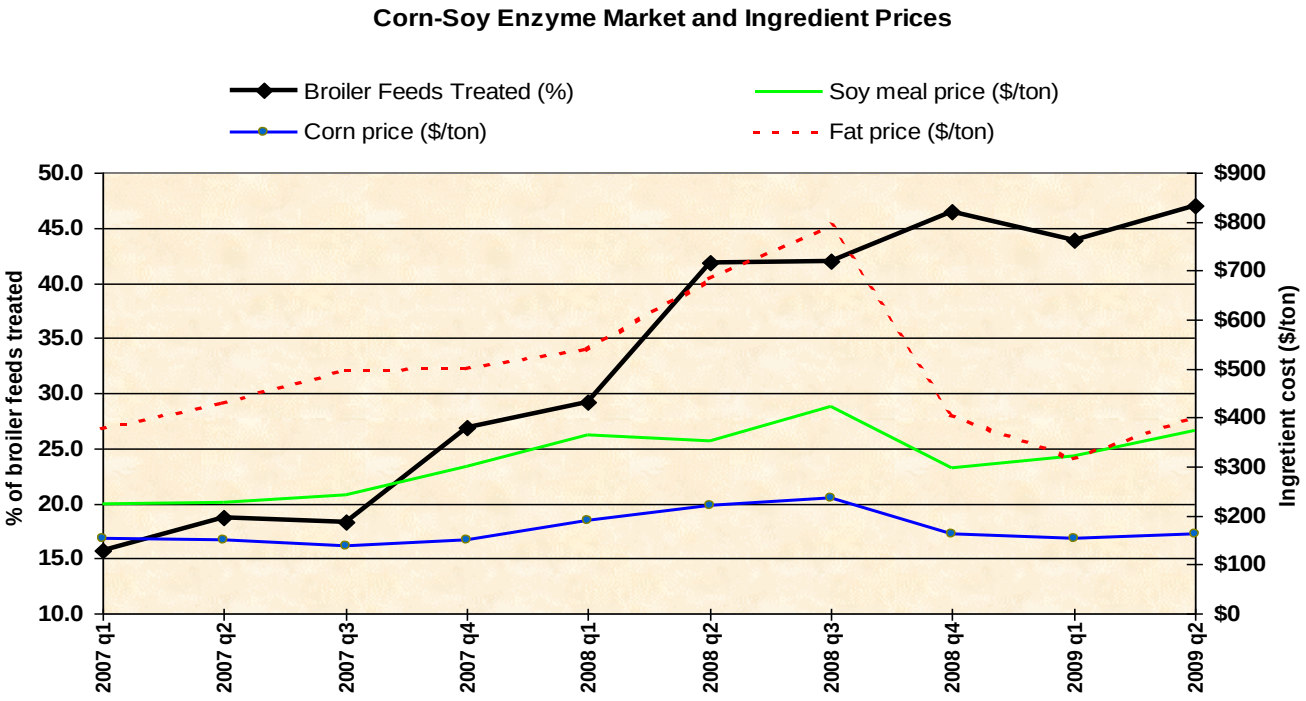
1. Why use Corn/Soy Enzymes?

The broiler industry is facing several challenges, which has increased interest in the potential use of feed enzymes. Ingredient prices have been on a roller coaster in the past 2 years with corn and fat reaching all time highs in August, 2008. Fat and soybean meal prices have been steadily increasing since January, 2009. Broiler nutritionists are striving to find ways to improve the utilization of key nutrients from existing feedstuffs and the use of NSP based enzymes is rapidly being explored and utilized. Approximately 47% of broiler feeds in the USA are currently treated with corn-soybean meal enzymes compared to about 18% in early, 2007 (Figure 1).

Figure 1



Broiler enzyme market penetration: A leading agricultural US database
Ingredient prices: Feedstuff averages.

With the vast increase in ethanol production from corn, a great deal of research has been directed toward determining how best to utilize ethanol by-products such as DDGS. It is well accepted that the quality of DDGS is variable depending on the source and consequently, results have been variable. There is general agreement that the availability of nutrients from DDGS is lower than from corn or soybean meal. Broiler producers have been using DDGS for several years and the availability and usage levels of this by-product continues to grow. It is therefore imperative that a nutritional means to improve the nutrient utilization of DDGS will be increasingly valuable. The use of NSP enzymes as a tool to improve the value of DDGS is of paramount interest to broiler producers.

The use of low levels of antibiotic growth promoters (AGP) has been commonplace in poultry diets for many years as a means to improve flock health and general performance. The use of these enhancers has been called into question by government regulators and consumer groups and AGPs have been banned outright in several countries. Broiler producers continue to search for alternatives to AGPs, particularly in circumstances where domestic market segments and export channels demand their removal. A large number of alternatives including organic acids, oils, spices, prebiotics, probiotics, and enzymes have become available to the marketplace. There is evidence that enzymes designed to improve nutrient utilization may have added benefits of improving health and body-weight uniformity.

Environmental groups and government agencies have been active in pushing to decrease agricultural outputs applied to the soil and subsequent leaching into streams and waterways. The widespread use of phytase enzymes have been highly effective in decreasing phosphorus outputs into the environment and, as an added benefit, decreasing feed costs. The use of NSP enzymes as an additional tool to reduce total fecal outputs has the potential to further decrease negative effects of animal production systems on the environment.

2. Applications of Mannanases

Mannans are common in nature and are part of the hemicellulose fraction of leguminous plant seeds, various types of wood, and beans. Mannanase enzymes have been used in a variety of industrial processes other than as a feed additive for many years. These include the detergent industry, oil drilling operations, coconut oil extraction, coffee production, the textile industry, and the pulp and paper industry. Their main function is to break down mannan fibers and reduce the viscosity of extracts in order to separate out various compounds needed for manufacture.

3. β-Mannans and β-Mannanase

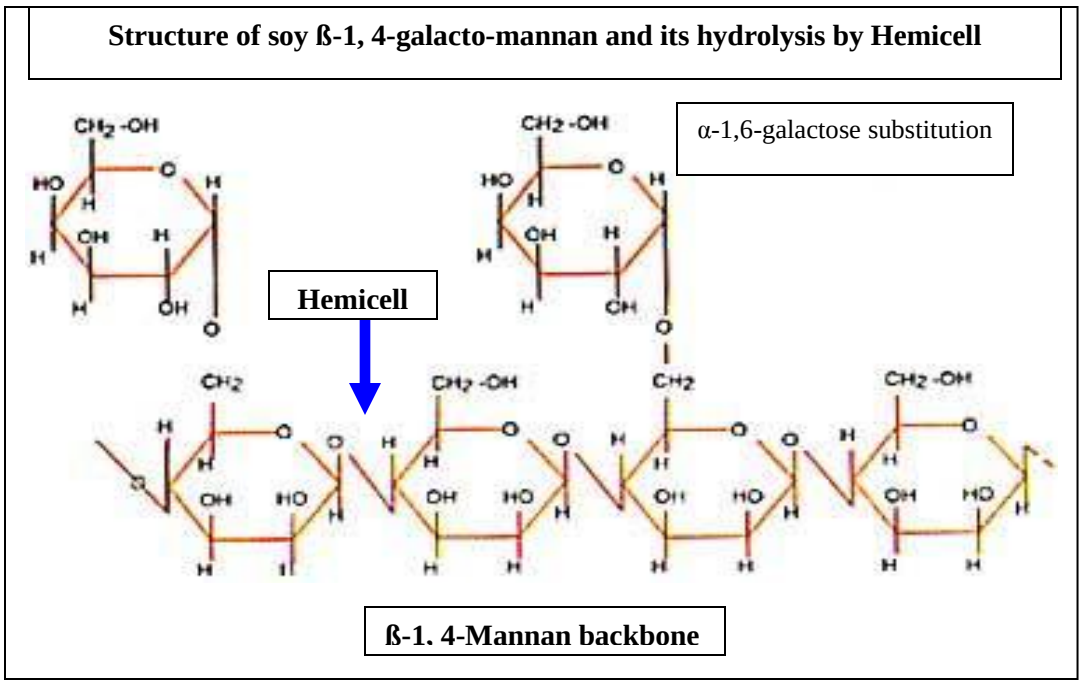
Soybean meal (SBM) contains a number of antinutritional factors. The most widely known of these are the trypsin inhibitors, which are deactivated by heat during the drying/toasting phase of processing. Other antinutritional factors, such as ureases,

goitrogens, antivitamins, phytates, saponins, and estrogens are of little significance in animal feeds. SBM contains approximately 22.7% carbohydrates in the form of non-starch polysaccharides (Chesson, 1987). This includes acidic polysaccharides (8-10%), arabinogalactans (5%), and cellulose (1-2%) (Honing and Rackis, 1979), as well as approximately 1.6 % β-mannans (Hsiao et al, 2006).

β-mannans in SBM are linear polysaccharides composed of repeating β-(1-4) mannose α-(1-6) galactose and/or glucose units attached to the β-mannan backbone. They are highly viscous, water soluble, heat-resistant compounds that survive the drying/toasting phase of processing soybeans (Dale, 1997). Guar gum is a very concentrated form with approximately 70% β-mannan with a galactose to mannose ratio of approximately 1.8 (Horton, 1997). This compares with β-mannans contained in SBM with a galactose to mannose ratio of approximately 1.9 (Whistler and Saarnio, 1957). Experiments using guar gum have demonstrated that ß-mannans are intensely antinutritional in monogastric species. They inhibit postprandial insulin secretion in humans (Morgan et al., 1985) and interfere with glucose metabolism and insulin secretion rates in swine (Leeds et al., 1980). Rainbird et al, 1984 observed a 50% reduction in glucose absorption when a solution of 6.7 g/l of guar gun was perfused through the loop of the jejunum in swine. Sambrook and Rainbird, (1985) reported that the addition of 4% guar gum to swine diets decreased peak postprandial insulin and glucose secretion by up to 49 and 27%, respectively. Addition of guar gum to the diet has been shown to reduce gastric emptying, inhibit insulin secretion, and reduce levels of circulating insulinotrophic peptide (GLP) and insulin-like growth factor (IGF-1) (Nunes and Malmlof, 1992). In broilers, the inclusion rate of 2 to 4% guar gum in feed severely retards growth and decreases feed efficiency (Couch et al., 1967; Ray et al., 1982; Verma and McNab, 1982; Daskiran and Teeter, 2001). A 35% growth depression in broilers was observed with the addition of only 2% guar gum (Vohra and Kratzer, 1964).

Beta-D-mannanase (Hemicell®, EC 3.2.1.78, mannan endo-1, 4-β-mannosidase)[1] is an endohydrolyase enzyme that is a fermentation product of *Bacillus lentus*, which degrades β-mannans. The enzyme cleaves randomly within the 1, 4-β-D-mannan main chain of galactomannan, galactogluco-mannan, and mannan (McCleary, 1988). This is graphically illustrated in Figure 2.

Figure 2



4. Dose Response Studies with Hemicell®

Whereas dose response studies are commonplace amongst studies with amino acids and other key ingredients, little or no research has been reported with corn-soybean meal type enzymes. ChemGen has recommended adding a dose of 100 million units per ton of complete feed (MU) of β-mannanase to poultry diets where 1 MU is defined as the quantity of enzyme capable of producing 0.72 g of mannose per minute under a standard assay conditions. This is based on earlier studies conducted by ChemGen Corp suggesting that the minimal dosage of β-mannanase to elicit a maximum response in poultry was approximately 60-90 MU. An overage was built into the recommendation to offset inaccuracies in product addition and storage conditions. A European experiment (Jackson et al, 2004) supported this recommendation. Results suggested that a dosage of 50 MU elicited a minimal response whereas 80 MU resulted in a response close to a maximum dosage of 110 MU tested.

We have determined in a series of studies that an energy uplift matrix value of 55 kcal/lb is appropriate when 100 MU of enzyme is added and this has been our general recommendation. When balanced in a corn-soybean meal type poultry diet, a 55 kcal/lb uplift is equivalent to a removal of approximately 2.5% added fat with minor adjustments to other key ingredients. The energy levels in most commercial broiler diets have decreased over the past 10 years to a point where 2.5% fat is rarely added.. In response to this reduction in energy levels in broiler feeds, we recently conducted several

experiments to determine as accurately as possible the response which might be expected with an addition of 65-70 MU as compared to our standard recommendation of 100 MU.

Four large broiler pen trials conducted between May, 2008 and April, 2009 compared the responses of 65-70 MU and 100 MU β-mannanase addition rates under precise enzyme addition circumstances. Practical corn-soybean-meal type broiler diets were used and all studies used standard starter-grower-finisher feeding programs to 42 days of age. A summary of the results is given on Table 1. Averaging all 4 studies, a live performance improvement of roughly 3.5% was observed using the 100 MU addition rate. In 3 of the 4 studies, performance as determined by final weights and feed conversion, was poorer when the 65-70 MU addition rate was used.. When averaged across all 4 experiments, the addition rate of 65-70 MU resulted in about 93% of the growth response and 79% of the feed conversion response achieved with the 100 MU addition rate.

Table 1, Effect of reduced levels of Hemicell® on broiler performance

Treatment	May 2008	Aug 2008	Jan 2009	Apr 2009	Avg	% Improvement	% of Hemicell-100
			BW (lbs)				
Control	4.29	4.82	4.83	3.97	4.48	0	
Hemicell 100 MU/t	4.44	5.05	4.96	4.10	4.64	3.54	
Hemicell reduced*	4.40	4.97	5.02	4.10	4.62	3.28	**92.64**
						points	
			FCR			Improvement	
Control	1.854	1.7994	1.815	1.995	1.866	0.00	
Hemicell 100 MU/t	1.794	1.7402	1.785	1.909	1.807	5.88	
Hemicell reduced*	1.806	1.775	1.78	1.916	1.819	4.67	**79.43**
			WAFC				
Control	1.873	1.840	1.832	2.034	1.895	0.00	
Hemicell 100 MU/t	1.789	1.743	1.782	1.927	1.810	8.44	
Hemicell reduced*	1.806	1.790	1.769	1.934	1.825	6.99	**82.90**

* 70 MU/ton in 2008 studies, 65 MU/ton in 2009 studies

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These studies suggest that the use of reduced levels of β-mannanase enzyme result in concomitant reduced improvements in feed conversion and weight gain. The use of a reduced level of β-mannanase, enables a broiler nutritionist to realize its benefit entirely in the form of feed cost savings. However, low-energy broiler diets can make use of 100 MU of β-mannanase. When 100 MU of β-mannanase is added to a low-energy broiler diet, the enzyme's benefit shows up as a feed cost saving combined with improvements in feed conversion and weight gain. It should be noted that improvements in livability and body-weight uniformity, which have been observed when 100 MU of β-mannanase is added to broiler diets, may not be present when the reduced level is used.

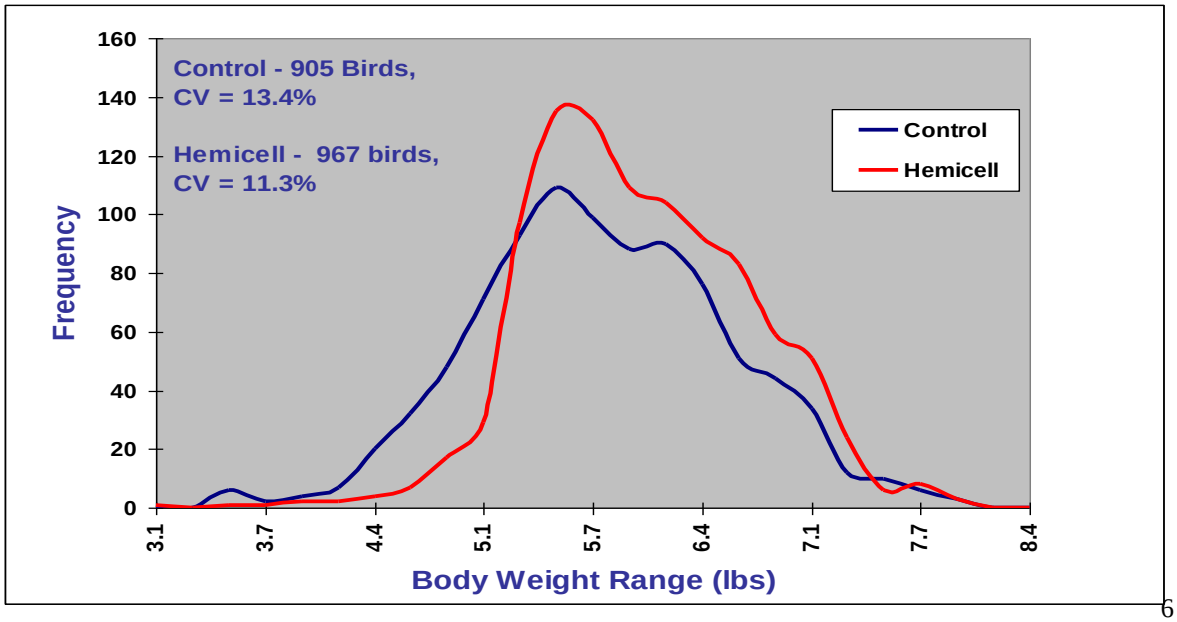
5. Effects of Hemicell® on Broiler Uniformity

Uniformity is a very important criterium affecting the profitability of broiler processing plants. It stands to reason that any improvement in live weight uniformity in broiler grow-out operations will translate to an improvement in the consistency of final products.

Relatively few broiler pen trials have statistically evaluated nutritional effects on the uniformity of live weight. In order to statistically evaluate uniformity, all birds in pens must be individually weighed and the coefficient of variation in all pens must be determined. Several pen trials with Hemicell® with monogastrics, in order to evaluate its effects on live weight uniformity have shown promising results (Anderson et al, 2001). Several years ago, a very large broiler pen trial with 2240 straight-run broilers determined effects of a 100 MU addition of Hemicell® on body weight uniformity at different ages. With 16 replicate pens each containing 70 birds, birds were individually weighed at 21, 35, and 49 days of age. The average body weight Coefficient of Variation (CV) was significantly lower with the Hemicell® pens at 21, 35, and 49 days of age ($P<.05$). The CV of 49-day body weight was 13.31% for the controls and 11.02% for the birds with Hemicell®. The nature of the differences in flock uniformity is graphically represented in Figure 1. It is clear that there were fewer birds in the lower body weight ranges when Hemicell® was provided.

This improvement can be very meaningful at the processing plant. One industry source has estimated that for every 1 point improvement in coefficient of variation, a 0.2 point improvement in WOG yield will result . Based on the above pen trial, this suggests that Hemicell has the capability of improving WOG yield by approximately 0.4 percentage points. The value of this WOG improvement will vary depending on the broiler market and products manufactured by the plant.

Figure 3. Effect of Hemicell® on the body weight uniformity of broilers



Summary

Interest in corn-soybean meal type enzymes has increased dramatically in recent years. This has been propelled by one or more of the following factors: 1. Increasing or unstable feed ingredient prices, 2. Expanding use of ethanol by-products, 3. Political or market pressures for reduced usage of AGP's, and 4. Environmental issues. Corn-soybean type enzyme usage in broiler feed produced has increased from approximately 16% in early 2007 to about 47% today.

Mannanases have been used in a variety of industrial applications where the break down of fibers and a separation of various compounds is needed. Mannans are common in nature and are found in leguminous plant seeds and beans. Soybean meal contains approximately 1.6% β-mannan. β-mannans are very antinutritional in monogastric species and the use of β-mannanase feed enzyme has been shown to improve the performance of broilers in numerous pen trials.

Several broiler experiments have been conducted to determine the response when about 70% of the dose normally applied to feeds is tested. A summary of these trials suggests that using a dose of 65-70 MU/ton of feed results in about 83% of the performance response obtained when 100 MU/ton is provided. The feasibility of using a reduced dosage depends on the economic value of incremental performance responses and the accuracy with which the enzyme can be applied to feeds. It should be noted that improvements in livability and body-weight uniformity, which have been observed when 100 MU of β-mannanase is added to broiler diets, may not be present when the reduced level is used.

Hemicell® has been tested in broiler trials for its effect on body-weight uniformity at an addition rate of 100 MU/ton. All birds in the experimental pens where weighed and the % CV was determined for each pen. Analysis of data revealed that Hemicell® significantly reduced the CV by approximately 2% by reducing the proportion of birds in lightweight categories. The value of this improvement will most likely be realized at the processing plant, but it could improve the WOG yield by approximately 0.4 percentage points.

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