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Practical application of Feed Enzymes to wheat based broiler feeds

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The significant enhancements in digestibility of dietary nutrients attributable to feed enzymes are seldom fully realised in practice. The benefits of feed enzymes are most apparent when a diet which is slightly sub-optimal in terms of nutrient density is returned to requirement levels through the use of an enzyme. In practice, however, feed enzymes are added to the diet 'over the top', i.e. with no nutrient adjustments. Addition of an enzyme to a diet which surpasses the nutrient requirements of the bird can only result in an improvement in FCR if the bird reduces feed intake. This article is intended to demonstrate this effect and suggest strategies for maximising the value of the feed enzymes.

Energy Effects

Feed enzymes designed for barley or wheat based diets are known to enhance the productive performance of birds through improvements in digestibility of nutrients. The debate as to how this is achieved is still ongoing and some still argue that the mechanism is mostly through better digestion of starch and protein present in the endosperm. Most researchers now agree, however, that the bulk of the beneficial effect (probably 50-70 per cent) of feed enzyme use is through reduction in intestinal viscosity which enhances digestibility of all dietary ingredients, not just the cereal grain. The most powerful evidence which supports the viscosity theory is the very large effect enzyme addition has on fat digestion, even in low viscosity (<10 cp) diets. Since most fat (>75 per cent) in a typical broiler diet is added to the diet as a liquid and less than 5 per cent of total fat is located in the wheat endosperm, it is very unlikely that endosperm cell wall destruction is the principal reason for the effect of added enzymes. The choice of mechanism is important when an attempt is made to explain how to use enzymes in practice. Why?

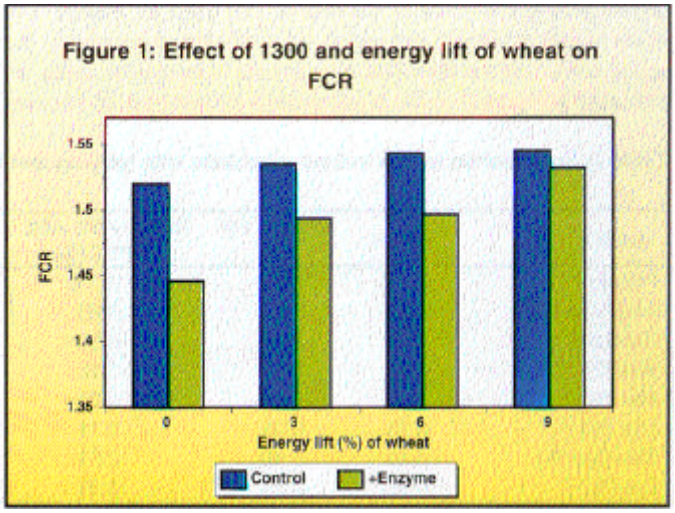
If enzymes are only working on the cereal component of the diet then there should be no effect of other ingredients on the relative extent of performance enhancement provided the diets remain isocaloric and isonitrogenous.

Consider the data presented in Figure *1. Avizyme* 1300 was added to diets which contained wheat valued in the computer at 3080 kcals/ kg, 3172, 3265 or 3357 kcals per kg (representing a 0, 3, 6, or 9 per cent elevation of the energy content of wheat). The effect of enzymes on FCR is most dramatic when the value of wheat in the formulation is 3265 or less. This, despite the fact that the wheat content of the diet increased 58, 60, 61, to 62 per cent when the energy value of the wheat was elevated 0, 3, 6 or 9 per cent respectively. If the enzyme was only having an effect on the wheat component of the diet (i.e. releasing enclosed nutrients from the endosperm), then why is its effect diminished with increasing wheat content. The answer relates to the added fat content of the ration. As the energy value of the wheat is elevated in the computer matrix from 0 through 3, 6 to 9 per cent, the amount of added fat fell from 4.20 through 3.29, 2.03 to 1.33 respectively. The major effect of *Avizyme* is through viscosity reduction, which in turn increases the digestibility of all nutrients, but particularly that of fat. Hence the smaller the quantity of added fat, the smaller (proportionally) the effect of *Avizyme* on elevation of dietary ME.

Since intestinal viscosity is related to the quantity of wheat in the diet (the more wheat, the higher the viscosity), and since the effect *of Avizyme* is principally viscosity reduction, the effect of enzyme on energy digestibility has to be tied to the wheat content of the diet. For example, if there was no wheat in the diet, there would be no effect of *Avizyme 1300* on energy digestion. For these reasons the recommendations for use of *Avizyme 1300* are:

Elevation of AME of wheat by 6 per cent to a maximum of 3250 kcal/kg assuming a minimum of 2 per cent dietary fat added to the ration.

An important consideration is how best to use the enzyme in any given circumstance. It may prove more economic, depending on prices of raw materials and end products (i.e. feed compounder or integrator) to add the enzyme to the existing diet and reap the reward of improved performance as indicated by the '0' diet in Figure 1. It is often more desirable, however, to adjust the energy value of wheat and save on diet costs by reducing the quantity of added fat as is the case in diets 3 and 6, whilst at the same time obtaining performance better than the control diet. If added fat is of uncertain quality there is



a further possible advantage of this approach - that energy supply is moved from fat to starch.

Protein and amino acids

The benefits of energy uplift attributed to *Avizyme* 1300 are not new, they have been recommended since 1991 with the advent of *Avizyme* TX. However, extensive research over the past three years has indicated that by using *Avizyme 1300,* the digestibility of protein and amino acids is also substantially improved. Several ileal digestibility trials have quantified this effect over a range of wheat samples of variable nutritive value. This is vital, since no wheat is average, so recommendations based on one sample of wheat are probably meaningless.

Results from one such series of studies are shown below (Table 1), where birds were fed one of two wheat varieties (at 64 per cent of the ration) in the presence or absence of *Avizyme 1300.* The effect of the enzyme on ileal amino acid digestibilities are summarised below, the values being an average of the effect of enzyme over the two varieties.

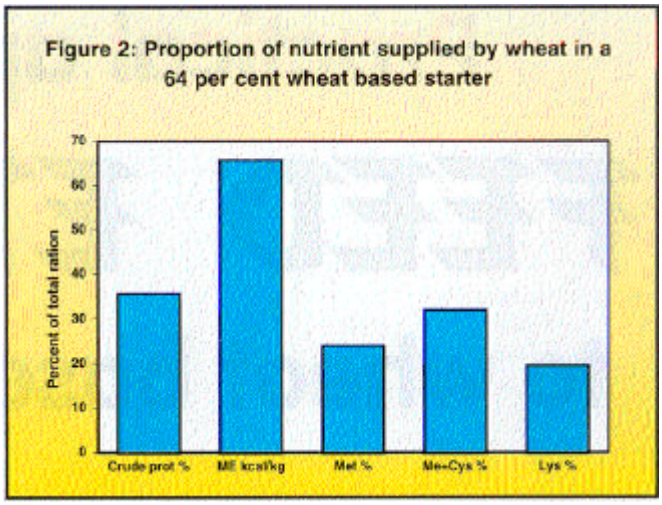


Table 1: Effect of Avizyme 1300 addition on ileal nutrient digestibility (per cent)

Nutrient	*Control*	*+1300*
Energy digestibility	67.4	73.1
Protein digestibility	72.1	77.3
Methionine	76.8	84.3
Cysteine	48.2	65.6
Lysine	80.8	87.1
Threonine	65.8	74.4

All differences between control and Avizyme 1300 were significant (p<0.05)

protein or amino acids in the typical broiler starter and yet supplies over 65 per cent of the energy. But once again, if there was no wheat, there would be no viscosity problem, and hence less response to enzyme addition.

If all the increment in protein, methionine + cysteine or lysine digestibility were to be attributed to the wheat component of the diet, then the following would be true (Table 2).

Theoretically, since methionine and cysteine are the most limiting amino acids, then we ought to be able to increase the amino acid content of wheat by at least 30 per cent in the presence of *Avizyme* 1300. However, since protein is often a constraining factor, particularly in starter rations, the likelihood is that approximately 20

Table 2: Increase in wheat nutrient content needed as a consequence of observed improvements in digestibility of protein and selected amino acids

Nutrient	*Diet content*	*Control diet digestibility (%)*	*1300 diet digestibility (%)*	*1. Digestible amino acid content - control diet (%)*	*2. Digestible amino acid content - 1300 diet (%)*	*3. Increase*	*4. Wheat content in ration (64%)*	*5. Improvement as % of wheat content*
Methionine (%)	0.45	0.77	0.84	0.35	0.38	0.03	0.12	29.3
Cysteine (%)	0.45	0.48	0.66	0.22	0.30	0.08	0.18	43.7
Lysine (%)	0.86	0.81	0.87	0.69	0.75	0.05	0.22	24.2
Protein (%)	24.00	0.72	0.77	17.30	18.55	1.25	8.00	15.6

1. Control diet digestibility x control diet nutrient content
2. 1300 diet digestibility x 1300 diet nutrient content (same as control)
3. 2-1
4. Nutrients coming from 64 per cent wheat
5. Increased nutrient availability as a percent of the nutrients donated by wheat

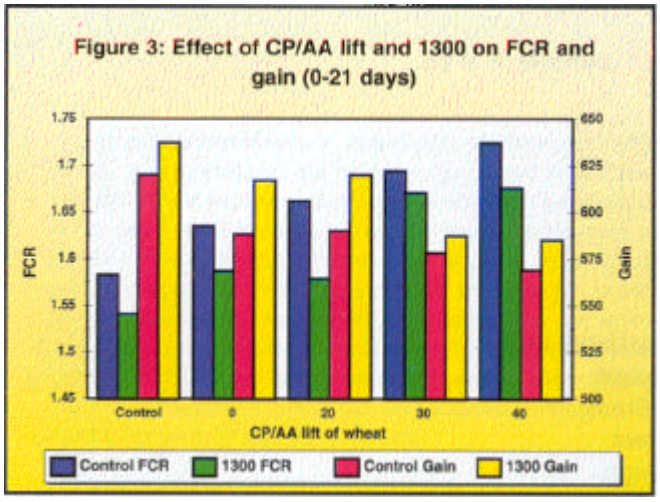
The basic premise with respect to how to utilise such data for protein and amino acids is identical to that used for energy. The effect is tied to wheat, and has to be attributed, therefore, to the wheat content of the diet. This may appear nonsensical, since, as indicated in Figure 2, wheat is responsible for less than 35 per cent of the per cent uplift in wheat protein is all that can be attributed to the enzyme. Therefore, for ease of formulation, it was decided to increase the crude protein and amino acid content (CP/AA) of wheat co-ordinately, starting at 20 per cent and increasing to 40 per cent. An example of such a matrix used in several trials is given in Table 3.

Table 3: Formulation matrix values of wheats with varying levels of AME and CP/AA adjustments

Nutirient	*Wheat*	*Wheat + 6% AME*	*Wheat + 6% AME + 10% CP/AA*	*Wheat + 6% AME + 20% CP/AA*	*Wheat + 6% AME + 30% CP/AA*	*Wheat + 6% AME + 40% CP/AA*
Protein (%)	12.50	12.50	13.75	15.00	16.25	17.50
AME kcal/kg	3080	3265	3265	3265	3265	3265
Calcium (%)	0.05	0.05	0.05	0.05	0.05	0.05
Avail Phos (%)	0.00	0.18	0.18	0.18	0.18	0.18
Met (%)	0.18	0.18	0.20	0.22	0.23	0.25
Cys (%)	0.28	0.28	0.31	0.34	0.36	0.39
Me+Cys (%)	0.46	0.46	0.51	0.55	0.60	0.64
Lys (%)	0.35	0.35	0.39	0.42	0.46	0.49

This article follows on from the article entitled 'Wheat Specific Feed Enzymes' by Andrew Morgan and Mike Bedford, which appeared in the January issue of Feed Compounder

Birds were fed diets based on formulations in which the wheat was entered into the computer as an ingredient described as above. In the case of the wheat + 6 per cent AME + 40 per cent CP/AA, for example, the ingredient in the computer contained 17.5 per cent protein and 3265 kcals of energy. Compared with the diet which contained 'standard wheat', this diet contained far less soybean meal and fat, which reduced formulation costs considerably. The results of this trial are shown in Figure 3.



KEY WORDS
Avizyme 1300, Recommendation for use, Wheat, broiler, xylanase, protease, digesta viscosity, viscosity, uplift, ileal DE, ileal protein, digestibility, amino acid, AME

The control diet was simply formulated as a conventional wheat based diet, with no AME or CP/AA modifications. The diet marked as 'O' actually contained wheat which had been entered in the computer as wheat with a 6 per cent AME lift (i.e. 3265 kcals/kg), whilst those marked 20-40 contained wheats as described in Table 3.

The conclusion from this and several other trials was that the amino acid and protein content of wheat could be raised by approximately 20 per cent and performance would still be equal to the control wheat based diet in which the wheat nutrient matrix had not been manipulated and to which no enzyme had been added. In order to ensure this benefit was always achieved, it was considered prudent to add a substantial 'safety margin' to this recommendation and hence the current recommendations are:

The amino acid and crude protein content of wheat can be increased by a maximum of 10 per cent when wheat is used in conjunction with Avizyme 1300. This is in addition to the energy recommendations made earlier.

Such a recommendation allows the feed formulator savings in high cost ingredients such as protein and fat supplements. Further benefits for the broiler chicken grower such as reduced manure output, fewer litter problems and hock burns and potential carcass gains are yet to be factored in to the true value of enzyme usage.

Conclusion

The feed manufacturer should always look to use enzymes as a means to alter the nutrient worth of the ingredients under consideration, since in many circumstances this is the most profitable method of enzyme use.