

SPESFEED NEWS

Winter Edition

July 2011

General News

The recent excitement regarding dog food contaminated with aflatoxin has given me pause for thought. The fact that the Registrar of Farm Feeds has the power to both withdraw products from the market place and to force the closure of production facilities should serve as a wakeup call for all of us. Selling unregistered products, manufactured in factories that do not comply with Good Manufacturing Practice (GMP) guidelines, is something we all need to be more careful about in the future. In addition, buyers of our products (supermarkets) are demanding that the feed that is used on farms comes from mills that comply with the guidelines.

Courses

The 2011 Poultry Nutrition Course will be held from 12 – 14 September at our usual venue, The Woodmead Golf Course branch of the Country Club. Should you be interested in attending this event, please contact rick@spesfeed.co.za or blosper@afrosoft.biz.

Formulation Objectives

I am back on my soapbox again. Our objective as nutritionists and feed millers is to ensure that our clients maximize profit. This will ensure that their business will grow and that they will be able to pay for their feed. If we were to look at this purely as feed suppliers, it may be acceptable to formulate diets on a least-cost basis alone. Rather, least-cost formulation should be seen as a tool for both balancing the diet and managing our resources. Least-cost formulation as a strategy is a short-sighted, short-term approach as it can ultimately compromise the farmers who use the diets. Sadly, many farmers believe that millers use “least-cost” formulation as a means of cheating them of their due. Nothing could be further from the truth. Least-cost formulation is only the mechanism by which the nutritionist does his/her calculations.

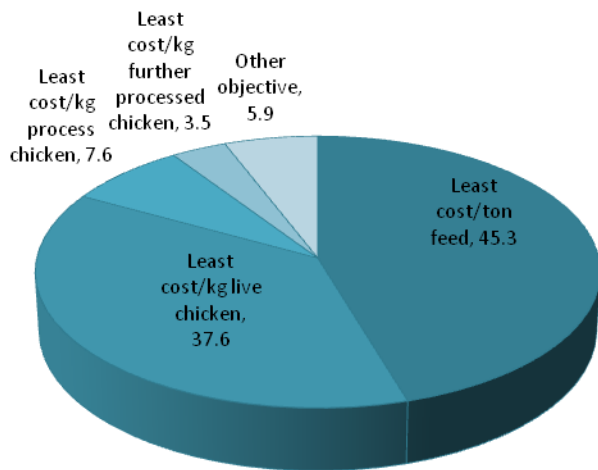
Our true long term objective should always be to maximize returns, either at farm level or across the whole value chain. This is easier to do when dealing with integrated companies; however, the principle applies no matter what diet it is that you are formulating. We always need to ask ourselves, “What level of energy and/or nutrients will result in the maximum return?” Sadly, we are often forced to formulate diets that meet certain price criteria set by the market place.

The June edition of Poultry International carries some of the results of the “WATT Poultry Nutrition and Feeding Survey”. One of the questions that the 224 respondents were asked in the survey was what their formulation objectives were?

It is true that the wording contained in the questionnaire may not have given people enough options, but the fact that more than 90% of respondents thought that the formulation objective had to do with “least-cost” is staggering. As you will remember from the Summer Edition of SPESFEED News, least-cost production is a very different thing to maximizing margin over feed cost. I can’t help but

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wonder what “other” objectives were specified. Did anyone mention the word profit or return?

Books you may want to read

In the past few months I have read three books that are worth bringing to the attention of all of those involved in the food industry. All of these books are available on Amazon, which is where I bought them.

The first of these books is *The Meat Crisis: Developing more sustainable production and consumption* (published by Earthscan). The book consists of chapters written by different authors and has been edited by Joyce D’Silva and Prof John Webster.

In their introduction, the editors ask the question “What meat crisis?” Meat has never been so cheap (relative to disposable income) and it is freely available. The crisis is one of too much rather than too little. High meat consumption represents a health risk to the individual, makes demands on the dwindling global resources of arable land and water and has a negative impact on the environment and on the climate. Lastly, there is too much pressure on animal production systems to allow the animals themselves to live decent lives before we devour them. Prof Webster, who is Professor Emeritus in Animal Science at Bristol University, points out that dairy cows consume up to 5 times their maintenance requirement in order to reach the high production levels that they do, which makes them the most stressed of all farm animals. He believes that at the moment most of them are not getting a fair deal and deserve better.

The book consists of sections on the impact of animal farming on the environment, farming practices and animal welfare, and farming methods for a sustainable future. The various chapters are written by experts in

their fields and the opinions expressed by the various authors are mostly considered and balanced.

Colin Tudge comments that “We cannot put agriculture back on course – not at least on a secure and stable course – unless we create an economy that is sympathetic to sound farming, instead of one that, as now, makes it well-nigh impossible to farm sensibly without going bust”. This sentiment perfectly sums up the dilemma modern farmers face. It is also acknowledged that, whilst the overconsumption of meat represents a problem in the developed world, for the billions of people living in developing economies meat represents the single most important source of protein and other nutrients. Eating meat is something that undernourished people aspire to do.

The chapter entitled “*As Cheap as Chicken*” written by Andy Butterworth, a veterinarian, describes how bio-security issues have led to ‘fortress farming’ which has caused poultry production to become almost invisible, despite its massive size.

I do not intend to go into too much detail about the book here, but I would urge anyone involved in animal agriculture to read it. You may not agree with everything the various authors say, and you may not even enjoy reading it, but it will give you a different perspective on our industry.

In Defence of Food by Michael Pollan (published by Penguin), deals with what he calls the Age of Nutritionism. He says that “Nutritionism is not the same as nutrition. As the –ism suggests, it is not a scientific subject but an ideology. Ideologies are ways of organising large swathes of life and experiences under a set of shared but unexamined assumptions. A reigning ideology is a little like the weather – all pervasive and virtually impossible to escape”. A classic example of nutritionism was the widespread belief that the cholesterol in eggs caused an increase in heart disease – now something we know to be untrue. Another would be the belief that the protein level of a diet or ingredient is its most important attribute, or that its fat content is its least desirable attribute.

Pollan points out that nutritionism tends to foster a great deal of anxiety around the experience of shopping for food and eating it. To do it right, you’ve got to be up on the latest scientific research, study ever-longer and more confusing ingredient labels and sift through increasingly dubious health claims.

Eaters (consumers) don't reap nearly as much benefit from nutritionism as food producers. Sadly, marketing departments often do not understand the difference between nutrition and nutritionism.

This is a well-written and entertaining book. Pollan is pragmatic about food and believes that his book can be encapsulated as follows: 'Eat food. Not too much. Mostly plants.' He gives readers practical advice like "If your Grandmother would not recognise it as food, then it probably isn't" and "stay away from the centre isles of the supermarket – the real food is mostly to be found around the edges."

Lastly, Richard Patton has written a book called *Ruined by Excess, Perfected by Lack; the paradox of pet nutrition* (published by Nottingham University Press). This short volume is probably equally applicable to human nutrition as it is to pet nutrition. Biologically, mammals have inherited (evolved) an exquisite ability to thrive on meagre food intakes during times of shortage, and a woeful ability to deal with the constant excess of soluble carbohydrate contained in the modern diet. Most companion animals are far better able to deal with a lack of energy in the diet than they are able to deal with an excess, which is why many pets are obese.

The book gives a broad overview of nutrition and the paradox in particular. The only thing I found myself a little uncomfortable with is the way in which nutrients are classified and dealt with. They are defined as molecules which are not classic nutrients yet have important biochemical functions. Examples would be Fatty Acids but not fat *per se*, organic acid and the one that really surprised me – phytic acid.

The Internet

As an avid internet user, I can't help but notice how things have changed over the years. The commercial sector has mostly realised that a good website is our window to the world. I for one visit a company's website the moment I have anything to do with it, or the moment I even think about using their products. Very few companies do not have a web presence, and by and large these sites are easy to navigate and contain a lot of fresh, up-to-date information. A huge amount of business is now conducted on the web – think airline tickets or Amazon. In short, the web has come of age for businesses.

The publishing houses that disseminate the majority of the world's scientific journals all have an excellent web presence. For a fee, you can now access just

about any paper ever published. The library has now come to our desktops! The only secret is – knowing what is relevant to you and what is not.

Another new trend has been the proliferation of news services on the net. These are interesting but often only of limited use. If the information contained is commercial then it is adequate, but the minute the subject becomes technical we are only given a teaser. The one exception in our industry would appear in Feedinfo.com.

In stark contrast to the commercial world are academic institutions. The internet started at Universities and for a long time these organisations lead the movement with regard to publishing information on this media. New research, newsletters and discussion forums were all posted on a regular basis. It would appear that all of this has become boring to our academic friends. Many of the faculties have stopped publishing the excellent, interpretative information that they used to. Worse than this, many academic departments don't update their websites. The information they contain is years out of date and most certainly does little to promote the excellence of the institution.

The internet is a most wonderful source of information. However, if everyone tells you not to believe everything you read in the paper – I can assure you that the internet is far worse. Regular readers of the SPESFEED News will be aware that even some peer reviewed papers need to be treated with a fair degree of cynicism. Information contained on the internet is no different – it should be considered critically and if possible verified by another source. Perhaps there is still a role for publications such as SPESFEED News in the information age, as an independent (if somewhat opinionated) view on the world of animal agriculture.

Rick Kleyn

Lessons to be learned from the *E. Coli* outbreak in Germany

The current outbreak of EHEC in Germany is one of the biggest in history, with 36 fatalities to date, over 640 people with chronic kidney problems and more than 3600 recorded cases.

The cases were all related to infection with *E coli*

O104:H4, and mostly occurred in females between the ages of 24 and 50. Several sources were blamed initially, but the latest release from the German authorities is that it could be epidemiologically linked to bean sprouts.

What is EHEC? Enterohaemorrhagic *E. coli* refer to a group of *E. coli*s that leads to haemorrhagic colitis. Most people recover after 10 days but a certain percentage will develop haemolytic uremic syndrome (HUS). HUS is characterized by acute renal failure, haemolytic anaemia and thrombocytopenia. The best-known serotype that caused this syndrome is *E. coli* O157:H7, this organism produces shiga toxins (STX1 and STX2)

What are shiga toxins? As the name indicates, these toxins were first described in *Shigella dysenteriae*. Shiga producing *E. coli*s are relatively new strains, and most probably acquired the ability to produce toxins through the exchange of plasmids. The best-known case of EHEC was the outbreak that occurred after contamination occurred in uncooked hamburger patties in the USA in the late 80s.

How do the current *E. coli* differ from other *E. coli*s? Within days of the outbreak starting, the Beijing Institute for Genomics (BGI) released the complete sequence for the genome of this *E. coli*. This information was released under a Creative Commons 0 (CC0) licence, that means that they waive all copyrights to the information. This had allowed for "crowd sourcing", which means that many people could use and interpret the data and publish their findings outside the normal peer reviewed journals. Below are some of the comments currently available:

- It has aggregative adhesive fimbriae type I (AAF/1), this is normally found in EAEC (enteroaggregative *E. coli*). These fimbria causes the *E. coli*s to adhere to each other and forms a particular pattern on the mucosa of the intestinal tract. EAEC cause diarrhoea that is typically found in children and lasts for about 10 days. It is not associated with haemorrhagic colitis or kidney problems. EAEC is only found in humans, it is not associated with other warm-blooded animals.
- It contains the STX2 gene, this is normally associated with EHEC with has warm-blooded animals (typically ruminants), as a carrier.
- It is highly resistant against many antibiotics.
- It is very similar to strain Ec55989, an

enteroaggregative *E. coli* (EAEC) isolated from children in Africa over a decade ago.

Where did it come from? At this stage, we do not know and one can only speculate. Based on the information above, it is tempting to speculate that an EAEC (from a human) had acquired a plasmid containing the STX gene from another *E. coli*, probably from ruminant origin. Plasmids are DNA pieces that are not part of the bacterial genome and the virulence factors can easily be transmitted with plasmids between bacteria. Therefore, in practical terms, it is possible that a worker with diarrhoea had introduced an *E. coli* to the farm, and this organism had acquired the STX gene from an *E. coli* from e.g. cattle manure.

Does poultry pose a risk? In a study by Parreira (2002) it was shown that of 97 strains of APEC (avian pathogenic *E. coli*) studied, only one strain carried the STX2 gene. It is therefore fair to assume that *E. coli* that infect poultry does not pose a direct risk for humans. Poultry, like ruminants, do not have receptors for the STX2 toxin and are not affected by it. They can, however, act as carriers.

What should we be worried about? In a recent paper from researches of the University of Johannesburg (Omar and Barnard 2010), it was shown that EAEC and EHEC occur in very high percentages of samples taken from wastewater plants in South Africa. This implies that these organisms are already present in the population and improperly treated wastewater poses a major health risk.

What should we do about it? We need to take the control of *E. coli* in food production seriously. The human and financial losses of this outbreak are well known and it will take the European fresh produce market a long time to recover. Bean sprout producers are battling to find a market for their product and the farm implicated as the source of the contamination will most probably never operate again. Twenty-seven restaurants were implicated in the outbreak; several wholesalers must have supplied them, and one should question the role of food safety programs in preventing this from happening.

The following are some steps that we can take to prevent this from happening:

- Basic hygiene standards should be high to prevent contamination of the production chain with pathogenic organisms, particularly from human carriers.
- All water sources should be monitored on a routine basis for *E coli* contamination and an effective method of water sanitizing should be employed.
- Monitoring of food products for *E coli* should not only be based on numbers per gram of product, but should also include screening for virulence factors.
- Pre-harvest pathogen control should be part of the food safety programs.

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The El Minya Broiler Breeder Project in Egypt.

Some 300 km south of Cairo in Egypt, near the city of El Minya, deep in the hostile Sahara desert, there lies the most amazing poultry project that I have ever seen. This is the site of Dakahlia Poultry Company's new broiler breeder operation. This bold move to establish in the desert was initiated in order to isolate the Company's strategic hatching egg production from the dreaded Avian Influenza-plagued Delta region.



A poultry site in the middle of the Sahara! (Photograph to scale!)

The property (it could hardly be called a farm) is some 35 kilometres west of the Nile River and extends over an area of 27 km by 17 km. It is divided into three zones, each zone being separated

by a 5 km bio-security buffer, with all sites being serviced by a central management area. The three zones will ultimately consist of 2 x 5 production sites, and 1 x 5 rearing sites. The production sites house about 80 000 hens in eight houses, while the rearing sites are made up of five pullet houses and two cockerel houses each. The current output from the site is about 1.5 million hatching eggs per week, but this is planned to increase to 2.7 million/week at full capacity which will make it one of the bigger single breeder production operations in the world. The eggs are transported to the Company's hatcheries where they are hatched.

It goes without saying that all houses are fully environmentally controlled and temperature is easily maintained at a steady 24 °C. In addition, they contain all of the latest equipment such as 360° nipples and Genesis feeder pans for rearing. All equipment has been supplied and installed by Chorettime. The general manager, Tom Warren, who is an old friend of many South Africans, explains that having large flocks with many houses allows for the attainment of excellent flock uniformity. The initial grading is carried out at 3-4 weeks of age and the flocks are allocated as specific, uniform weight groups to each of the seven houses at this early age. The controlled environment, together with the excellent uniformity, has meant that some of the first flocks through the site have peaked at over 88% production. Both Hubbard and Cobb birds are used.



A view of some nearly completed rearing houses. Note the size of the wet wall.

In the central area, there is a feed mill, an administration centre, staff housing and an egg handling plant. It takes many resources to house and manage the 500 people who live in this "chicken city".

The logistical support of an operation of this size is both important and difficult. Water is pumped from underground aquifers, so that is not a real problem. Currently though, the whole site runs off big Cat generators as the authorities just cannot seem to get the electrical supply sorted out. Whilst electric poles and cables run to the fence of the central area, they remain unconnected. Some 10 km of the total 100km of the roads on the complex have already been tarred, and it is planned that all major routes will get the same treatment.

My international readers are all asking, "Why put a project of this size in the desert?" The answer is straightforward – Bio-security! Egypt is unfortunate in that the Nile Delta, where most agricultural activity takes place, has become an endemic Avian Influenza area. This probably has to do with the fact that millions of wild birds migrate through the area every October. The solution to the problem was simple – but very bold. Move all of the breeding hens to an area where there are no wild birds, very little poultry and where conditions are so hot and dry that few viruses can survive. The bio-security measures taken are the strictest that I have ever seen, and include a farm lockdown during the period of highest AI risk (staff live on site for the entire period). If you are lucky enough to be invited to visit the farm you will be required to spend 2 nights in the quarantine villa on site before you even see a chicken.

I am one of the lucky ones. I have been to the farm and seeing poultry sites in the middle of the Sahara is almost surreal. I was also fortunate enough to see some of the facilities up close – before construction of a site was completed, (it was still a "dirty" area). Most people will only ever hear about El Minya and never get to see it, yet I predict that it is a model that will be followed by many other companies around the world. This is the boldest and most innovative poultry project I have ever seen, and the performances that are already being achieved would indicate that this would be a hard act follow.

Rick Kleyn

Formulating Diets Using Diets Multiple Enzymes

There is little doubt that the addition of exogenous enzymes to poultry diets represents one of the greatest opportunities that nutritionists have to improve the effectiveness of poultry feeding. They lead to an improvement in the nutrient and energy contents of feed ingredients, a reduction of the environmental impact of animal production and an improvement of intestinal health and gut function. All of these factors make the feeding process more cost effective, lead to improved performance and result in improved welfare of our animals. It is imperative that each of these aspects be manipulated to our advantage. Nutritionists need therefore to understand what classes of enzymes are available, what their mode of action is and how they interact with each other and the other ingredients or additives used in the diet.

There are a wide range of different enzymes marketed into the poultry industry and they fall into two broad categories. There are those products that supply phytase to the diet, and a second group which are products that contain enzymes that aid/enhance in the digestion of the various feed components of the diet that supply protein and energy to our birds. These would include xylanase and glucanase, protease, amylase, mannanase and lipase. Commercially available products may contain single enzymes, a blend of several enzymes or a cocktail of enzymes that contain guaranteed levels of certain enzymes and then a whole range of other enzymes with "side" activities.

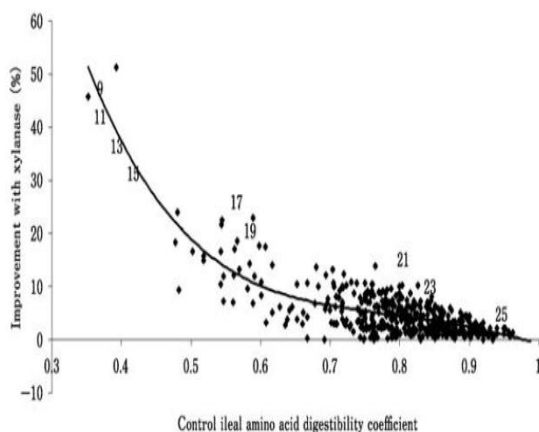
The principal mode of action of enzymes is to enhance the digestibility of dietary components. Some of an enzymes effect in this regard has to do with the fact that they eliminate the encapsulating effect of the cell walls, thereby improving access of the digestive enzymes to the feed components. The digestion of minerals, starch, fat and amino acids is incomplete in the alimentary tract of the chicken. Most of the digestive activity in the chicken gut occurs in the crop, gizzard, proventriculus and ileum, with varying amounts of material passing on undigested into the caecum. This undigested material represents inefficiency to the animal and comprises a nutrient source to both the harmful and beneficial micro-biota in the gastro intestinal tract (a prebiotic effect if you will). Although some digestion

may take place in the caecum, there is very little nutrient uptake from this organ, particularly in the case of young birds such as broilers where the caecum is immature.

Enzymes may also be responsible for the removal of anti-nutrients from the diet. It is understood that phytic acid is an anti-nutrient, the effects of which can largely be overcome by the addition of phytase. It is also reported that proteases will reduce the levels of trypsin inhibitor in soybean meal (Barletta, 2011)

The effect of enzymes (and other feed additives) is substantially lower in diets with a higher digestibility, and there is a distinct law of diminishing return. As a rule of thumb, for each 1% improvement in the digestibility of a feed, there is a 5% decrease in the effectiveness of any enzyme that is offered (Cowieson and Bedford, 2009). This must be considered when formulating diets using different enzyme and/or feed additive combinations. Once an ileal digestibility of 95% is achieved, it is unlikely that enzymes will have any real impact on diet digestibility. The ileal digestibility of the starch in corn-soy diets is 91.2% and that of its protein 80.3% (Zanella *et al.*, 1999).

Figure 1: Correlation between control and ileal amino acid digestibility coefficients and the response to exogenous carbohydrase (19 studies and 538 observations) (Cowieson, 2010).



The use of phytase is now ubiquitous in monogastric diets, and as nutritionists consider that addition of enzyme products to our diets, the question of how we should deal with additional enzymes in terms of formulation arises. An interesting physiological consideration exists. Phytase acts in an acid environment, which means that it is active in the upper digestive tract (mainly the gizzard and proventriculus). Other enzymes require the alkaline

environment of the lower digestive tract to be effective. This means that phytase may well have the first bite at the cherry and should probably be our starting point when considering multiple enzymes!

Enzyme use is made more difficult by a number of compounding factors:

- Even if an enzyme performs as it should, i.e. phytase releases additional P, but if the diet is not limiting in P then there will be no animal response to the addition of the enzyme.
- In vitro measurements of enzyme efficacy are rarely accurate as they only offer a measure of digestibility and take no account of what else happens within the animal. For example, many enzymes play an important role in reducing the loss of endogenous protein and energy, which brings about an improvement in dietary Net Energy, which is difficult to measure.
- Enzymes act differentially in different classes (ages) of animal. They tend to be more effective in younger animals which a poorly developed endogenous enzyme system.
- Many of the “real” effects of enzyme use are not measured or reported. For example, improvements in gut health, will also lead to an improvement in the animal’s immune status.
- To measure small differences (1 or 2% improvements) in a statistically meaningful way is difficult and requires large numbers of replicates. However, the correct interpretation of data is still the best/only means that we have at our disposal for making our decisions. Differences are even more difficult to measure when “farm” data is used.

A fair amount of debate exists around the use of multiple enzymes as to how they work in tandem with each other. There are six possibilities:

- **Additive in their activity** (1+1=2)
- **No improvement at all** (1+1=1)
- **Antagonistic** (1+1=0.75)
- **Less than additive** (1+1=1.75)
- **Synergism** (1+1=3)
- **All of the above simultaneously**

How multiple enzymes will act together is still largely hypothetical, as most research is conducted on

single enzyme products. Clearly if two enzymes act on the same substrate, there is little chance that their activity can be additive. It is also difficult to accept there is no overlap between phytase and protease for example as both have been shown to improve amino acid uptake. Much enzyme activity has to do with the effect that they have on the GIT of the animal, be it an improvement in gut health, a reduction in endogenous loss of nutrients and energy or simply by improving environmental conditions. It is difficult to understand how these effects can be additive.

It needs to be pointed out that when an enzyme cocktail is added to a diet, additivity may well be expressed differently for the different components of the diet. For example, the impact of protease and phytase on the energy “lift” may be of a different magnitude to the improvement in phosphorous uptake.

Anti-biotic growth promoters (AGPs) modify the bacterial composition of the lower gut, in much the same way that enzymes do. Thus, if AGPs are added to feeds that are to be supplemented with enzymes, cognisance of this needs to be taken. Selle *et al.* (2009) published the results of an experiment in which xylanase and/or phytase were added to wheat based diets. Despite the fact that the control diet had 12 MJ/kg as a base energy level, xylanase yielded a 4.8 % increase in energy and phytase a 5.5 % increase. When the two were combined, the energy yield was 8.6%, nearly 20% lower than expected.

Tiwari *et al.* (2010) examined the effect of an enzyme cocktail (Avizyme 1500) and phytase individually or in combination in broilers. They found that a combination of the cocktail and phytase improved performance, but that the enhancement in performance appears to be due mainly to phytase. Both the cocktail and phytase were effective in improving P digestibility and retention of chicks receiving nutritionally marginal (low in P and ME) maize—soybean meal diets. They also showed that the chicks benefited more from the enzyme addition at a younger age and that the contribution of the enzymes to nutrient retention decreased with age in chickens. It is likely that older birds would require different doses of enzymes, because their physiological needs and capacity are different from newly hatched chicks. This finding shows the opposite

effect to what most suppliers of enzymes recommend in practice.

Some interesting Australian work showed that the digestibility of sorghum could be improved by the addition of protease, xylanase and phytase. In terms of protein digestibility, xylanase had no effect, whereas both phytase and protease “lifted” protein digestibility by 3 to 4%. There was no significant difference between the latter two enzymes. When phytase and protease were added together, there was no increase in protein digestibility over the use of either enzyme alone. When examining the impact of the enzymes on energy, all three enzymes significantly improved the AME levels of sorghum, with phytase and protease both being significantly more effective than xylanase.

Combining phytase and protease caused a small numerical lift in the AME, but the combination of the two enzymes only reflected 67% of the lift that full additivity would have given. A combination of all three enzymes resulted in a significant increase in the AME (about 1 MJ/kg DM). If the enzyme activity had been truly additive, this increase would have been 1.59 MJ/kg DM – thus the response represented only 62% of the expected lift. In the case of starch digestibility, xylanase, protease and phytase all improved digestibility significantly, but there was no further improvement observed when any combination of these enzymes were used (Sultan *et al.*, 2010 & 2011).

These results reinforce a number of things. Firstly, phytase does much of the work before any other enzyme is used or added to the diet. Secondly, the choice of protease as the secondary enzyme in the diet would be more effective than the use of xylanase. Lastly, if viewed from the perspective of the energy level of the diet, a combination of enzymes would appear to be justified, although their activity is certainly not additive. It needs to be pointed out that sorghum contains a unique protein, kafirin, which contains numerous sulphide bonds that make it highly indigestible.

Information derived from experiments as described above is crucial if nutritionists are to assess the effectiveness, both biological and financial, of different enzyme on different feed ingredient, or feed mixtures. Bedford (2010) believes that phytase should now be viewed as a permanent ingredient in poultry diets, thus any other enzyme or feed additive in general must have its efficacy assessed in the presence of phytase.

Table 1: Effect of dietary enzymes on AME and apparent ileal protein digestibility of sorghum in broilers (Sultan *et al.*, 2010, Sultan *et al.*, 2011)

	Ileal Protein Digestibility coefficient	AME (MJ/kg DM)	Starch* Digestibility coefficient
Control	.78 ^{bc}	14.07 ^e	.75 ^c
Xylanase	.77 ^c	14.37 ^d	.83 ^b
Phytase	.81 ^{ab}	14.62 ^c	.86 ^{ab}
Protease	.82 ^a	14.81 ^{bc}	.83 ^b
Xylanase+ Phytase	.81 ^{abc}	14.75 ^c	.89 ^{ab}
Xylanase + Protease	.80 ^{abc}	14.66 ^c	.86 ^{ab}
Phytase + Protease	.83 ^a	14.99 ^{ab}	.88 ^a
Xylanase + Protease + Phytase	.81 ^{ab}	15.18 ^a	.87 ^a
SEM	.01	.06	.01

Guidelines for using multiple enzymes: Before considering using a number of enzyme products in the diet, nutritionists need to consider a number of aspects. These could include:

1. Ingredient pricing and availability.
2. What feed specifications are you considering?
The following may apply:
 - If the AvLP and Ca levels used are high (as per the primary breeder recommendation) you may well have more latitude when using phytase.
 - If the diets are high in terms of energy (an indication that they are more digestible) then there may be less opportunity to use carbohydrases.
 - Diets that are high in crude protein offer more opportunity for protease to be effective.
 - If possible assess the quality of the grain that is to be used.
 - Assess the risk associated with the operation. Generally large integrations tend to very cautious (as are many consulting nutritionists). Risk takers are the people selling feed into

markets where no real performance measurements are made. A single client may well be both (averse and a risk taker) in the different markets that he services.

3. How then do you deal with matrix issues (lift values) for each of the enzymes and enzyme combinations? Remembering that much of the research that we require has yet to be carried out, and mostly a conservative approach will be required. See the next point and then the table below.
4. Ensure that the correct feed specifications are being used – particularly with regards AvLP and Ca. Remember too much Ca inhibits phytase activity.
5. Use the correct formulation methodology for the different enzymes used. Use lift values (what DSM call Digestibility Improvement Factors (DIF)) when using carbohydrases enzymes. This allows us to see what the effect of enzyme addition is, but is also a very neat way of dealing with different ingredients effectively. I prefer to see Phytase with a matrix value included – although it is best to include these as part of a premix. How we best use protease will vary from client to client. Reducing specifications has inherent dangers. Using a “matrix” value as one can do for phytase makes it possible to have different values for different ages of broiler.
6. Do not forget the additional benefits of using enzymes – improved gut health and litter condition. These intrinsic benefits of enzyme addition often cannot be quantified.

In table 2 I have given some conservative figures that I think could be used when using multiple enzymes. Remember that most of the research needed has yet to be carried out.

Rick Kleyn

Table 2. Estimated nutrient enhancements that could be used when formulating diets using multiple enzymes.

	Phytase Single Dose	Phytase Double Dose	Carbohyd- rase alone	Protease alone	Phytase + Carbohyd- rase	Phytase + Protease	Phytase + Carbohyd- rase + Proteaset
Phosphorus (%)	1.1 to 1.3	1.3 -1.5	None	None	1.1 to 1.3	1.1 to 1.3	1.1 to 1.3
Calcium (%)	1.3	1.6	None	None	1.3	1.3	1.3
Protein and amino acids (%)	0.5	0.6	2 – 4	3 – 5	3 – 5	4- 6	5-7
ME MJ/kg Maize based diets.	.1 to .2	.15 to .25	Use DIF 0.2-0.4	0.1 to 0.3	Use DIF 0.3 to 0.5	0.2 to 0.4	Use DIF 0.4 to 0.6
ME MJ/kg Wheat based diets.	.1 to .2	.15 to .25	Use DIF 0.5-0.7	0.2 to 0.4	Use DIF 0.6 to 0.8	0.3 to 0.5	Use DIF 0.7 to 0.9

SPESFEED (Pty) Ltd.

Animal Nutrition Consultants

The consultants at **SPESFEED (Pty) Ltd.** publish **SPESFEED NEWS**. The purpose of the newsletter is twofold. It serves both as a source of information for those involved in animal agriculture as well as a means for us to maintain contact with our clients.

SPESFEED provides a professional technical service to the livestock and animal feed industries. Our aim is to ensure that our clients use optimal production and feeding systems in order to maximise the return on investment. The company has no affiliation to any particular product or supplier.

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