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Future Challenges

The Very Important Protein for Dairy Cows

Mycotoxins in Silage

Editorial

Future Challenges

Climatic changes, unpredictable weather conditions, flooding and drought are all hot topics which are widely discussed nowadays that affect agriculture and make sustainable, efficient production of milk and meat a considerable challenge—particularly when milk prices are low. Take feedstuffs. On one hand, protein sources and other components are extensively transported between countries and continents, burning fossil fuels. On the other hand, more emphasis is being given to sustainable and cost-effective production methods that respect the environment. Locally produced silage is one way of using land in a sustainable way that allows cattle to utilize plant fibers effectively. Efficient digestion of nutrients is also key to animal nutrition, making the most out of natural resources and maximizing production.

In this issue of **Science & Solutions**, we talk about microbial protein which is the most natural and local source of protein for dairy cows. We discuss feeding strategies to maximize its production and thereby efficiently utilize the rumen, the cow's engine. We also look at silage management and the occurrence of mycotoxins that can impair animal health and performance. Good quality, hygienic silage is a prerequisite for healthy animals and economic milk production. At BIOMIN, we offer expertise and innovative feed additives to assist you with these future challenges in a natural way.

Lean back, relax and enjoy reading!

Annamaria BOCZONADI
Product Manager Microbials

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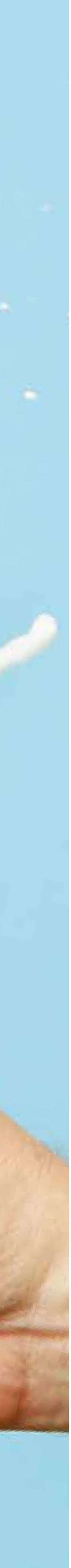
The VIP (Very Important Protein) for Dairy Cows

Between current period of low milk prices, due to global overproduction, and the end of the European milk quota, it is of upmost importance to increase feed efficiency and optimize the biological processes related to milk production. Optimizing rumen function can help maximize metabolizable protein for high producing cows.

By **Luis Cardo**, Ruminant Technical Manager



Feed costs rank first among the variable costs of a dairy farm, although this can vary in relationship to farm forage availability. The most costly nutrients in dairy production are energy and protein. Sources of protein ingredients have experienced particular price pressure recently. Optimizing the use of amino acids and protein in the ration offers a way to improve milk production efficiency. Interestingly, the rumen microbiota produces both the most economical and highest quality source of protein and amino acid balance.

A perfect ecosystem

Ruminants can degrade fiber thanks to the synergistic actions of different microbial populations inside the rumen, including bacteria, fungi, protozoa and methanogens. This ecosystem ferments both fiber and other nutrients, such as sugars and carbohydrates (CHO), into short-chain fatty acids, (SCFAs). These represent the main energy source for the cow for both maintenance and milk production. Fermentation also fuels microbial growth and in-turn the synthesis of protein.

Energy and protein availability

Milk production depends directly on metabolizable energy and protein available to the animal, after the need for growth and maintenance. Modern, dynamic formulation systems such as the Cornell Net Carbohydrate and Protein System (CNCPS) or platforms such as Nutritional Dynamic System (NDS) calculate milk production forecasts based on metabolizable protein and the amino acids profile available at the intestinal level. This approach is becoming more widespread due to their strength in forecasting subsequent production.

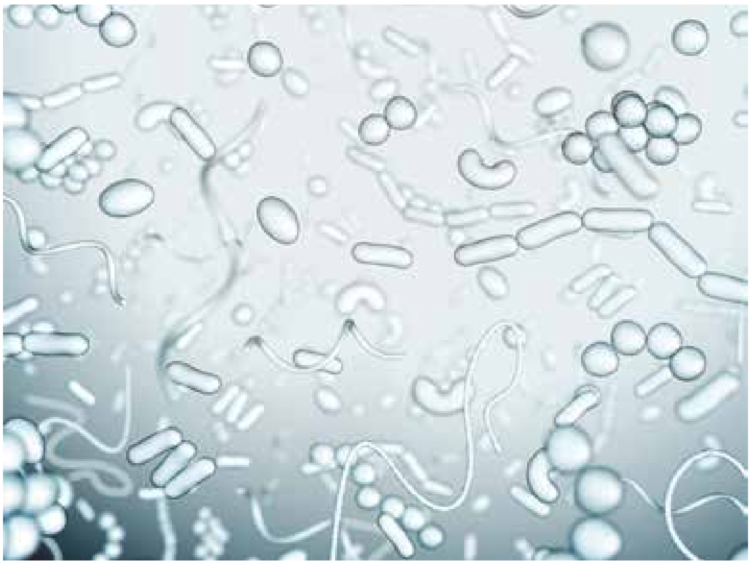


Illustration of rumen microbiota

Photo: dreamerb

A good source of MP

Metabolizable protein (MP) comes from two sources: microbial protein and 'bypass' protein which escaped degradation in the rumen. In high-producing cows, microbial protein can supply more than 50% of total metabolizable protein. In addition, microbial protein provides 60% to 85% of amino acids that reach an animal's intestine. In terms of amino acid profile and

For more on mycotoxins in cows, see
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economic efficiency, microbial protein proves superior to vegetable and other animal protein sources.

From a nutritional standpoint, the amino acid composition of rumen bacteria is the closest to milk (*Table 1*). Increasing bacterial protein synthesis can save on metabolic processes by improving nitrogen utilization and efficiency. Economically, the cost to produce one gram of high quality microbial protein is lower than for any other protein source of either vegetal or animal origin. Consequently, investing in strategies that maximize the output of microbial yields represent a good strategy to optimize economic investments.

Rumen microbial protein production offers additional benefits, including:

- a high rate of digestibility of 75% to 80% (similar to soybean meal)
- a constant and reliable amino acid profile (important for stable milk production and milk protein quality)
- Energy from rumen fermentation through improved fiber digestion.

Optimizing rumen protein production

To the extent that we are able to maximize milk protein production through good rumen function and health, we can optimize the cost of our protein diet.

In this light, producers and nutritionists should pay particular attention to rumen pH, proper cultivation techniques and harvesting time in order to optimize neutral detergent fiber (NDF) digestibility of forages and to the choice of ingredients that best meet a cow's and rumen bacteria's needs.

Economically, the cost to produce of one gram of high quality microbial protein is lower than for any other protein source of either vegetal or animal origin.

Table 1. Amino acid composition of different protein sources.

	Milk	Bacteria	Rape seeds	Fish meal
Arginine	3.4	5.1	5.0	5.7
Histidine	2.6	2.0	2.0	2.0
Isoleucine	5.8	5.7	3.2	2.7
Leucine	8.3	8.1	7.8	7.0
Lysine	7.5	7.9	5.1	7.5
Methionine	2.5	2.6	1.9	3.0
Phenylalanine	4.6	5.1	4.1	3.8
Threonine	4.4	5.8	4.7	4.3
Valine	6.3	6.2	4.0	3.3

Source: Block 2006; (g/100 g of amino acids)

From a formulation perspective, a profitable ration for high producing cows should have at least half of all metabolizable protein coming from rumen bacteria and more than 70% of the starch efficiently fermented in the rumen. Both these parameters are good indicators of proper rumen efficiency.

There are several opportunities for improving microbial protein synthesis, just as there are several bottlenecks that can limit the quantity of microbial protein that rumen microflora create. Some of these are reported in *Tables 2* and *3*.

Tools for the rumen

Rumen microbes require a constant supply of nutrients and stimulating factors to sustain growth. Otherwise, bacterial protein will be depressed, fiber digestion will be sub-optimal and SCFA synthesis variable and provide insufficient energy for dairy cows. Fortunately there are several feed additives to help support dairy performance.

- **Levabon® Rumen E** relies on an advanced, proprietary autolysis technology that uses enzymatic reactions to break down whole yeast cells into fragments, supplying helpful rumen microbiota with needed nutrients

Luis Cardo
Ruminant Technical Manager

In vivo trials have shown Levabon® to increase microbial protein indicators by 46%.

Mycofix® protects against a broad range of mycotoxins that may interrupt animal health or cause reproductive issues.

Table 2. Opportunities for ruminal protein production.

Optimized availability of nitrogen and energy substrates	Bacteria need proper carbohydrate (CHO) and nitrogen source to grow and multiply
Available Nucleotides and prebiotics substances	These nutrients are energetically expensive for bacteria Providing them saves energy for growth
Amino acids (especially branched chain amino acids)	They reduce energy requirements for rumen bacteria to grow
Source of carbohydrates and protein	Availability of N, amino acids and peptides that favor sequential microbial population and fiber digestion
Increased feeding frequency	Improves rumen environment

Source: BIOMIN

Table 3. Bottlenecks for ruminal protein production.

Imbalance between carbohydrates (fiber/starch/sugars)	Poor rumen environment for growth of a more diversified microorganism population
Poorly processed cereals resulting in less carbohydrates available for fermentation	Insufficient fermentation of CHO leads to reduced SCFA production)
SARA (Sub Acute Ruminal Acidoses)	Rumen environment no longer supports proper bacterial growth, particulary fiber digesters
Anti-nutritional factors of the plants	Decrease ruminal protein digestion
Mycotoxins	Decreased rumen bacterial population Decrease bacteria protein flux to the intestine
Lack of sugars	Lack of energy for fast fermenting bacteria
Large feed intake volumes	Increase of passage rate

Source: BIOMIN

among them nucleotides and glucans. *In vivo* trials have shown Levabon to increase the microbial protein indicators by 46%.

- Less well-known mycotoxins seem to play an increasing role in limiting proper rate of fermentation and bacterial growth in the rumen. **Mycofix**® provides protection against a broad range of mycotoxins that may interrupt animal health or cause reproductive issues.

Conclusion

Together with a proper prebiotic stimulating strategy, we need to limit those anti-nutritional factors which have a direct effect on rumen microbial population. A poor amino acid profile in the protein degraded in the rumen and for rumen soluble fraction does not necessarily result in growth limitation of rumen microbes. On the contrary, rumen microbes can convert cheaper sources into microbial protein that has a profile more suitable for the synthesis of milk. An optimal strategy will draw at least half of metabolizable protein from microbial sources. Maintaining rumen microflora that is well-stimulated and well-balanced relies upon a good prebiotic strategy, proper mycotoxins risk management and good feed efficiency.

Identify and Fix Your Mycotoxin-Contaminated Silage

Recent data indicates that corn (maize) silages may present a genuine mycotoxin risk to dairy cows. Given the uneven distribution of fungi and the mycotoxins they produce in a single lot, proper sampling is key to correctly assessing the specific on-farm mycotoxin threat.

This article originally appeared on DairyGlobal.net

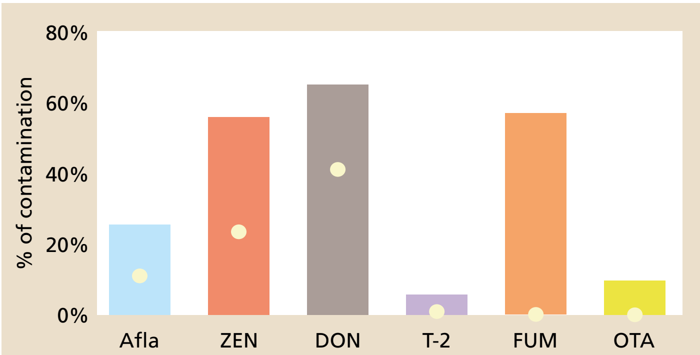
By **Michele Muccio** and **Karin Nährer**, Product Managers, Mycotoxin Risk Management

The variety of ingredients in a ruminant diet, including cereals, protein feed, forages, legumes, sorghum etc., exposes dairy cows to a wide range of contaminants at different dosages and at different times. Mycotoxins—fungal metabolites toxic to animals and humans produced by common molds found in almost all types of grains—can cause significant damage to animal health, performance and productivity. Furthermore, some mycotoxins can be carried over from ingested feed into animals' milk, such as the case with aflatoxins.

The 2015 BIOMIN Mycotoxin Survey covers agricultural commodity samples from over 60 countries to identify the presence and potential risk posed to livestock animal production by mycotoxins worldwide. Corn silage samples were tested for aflatoxins (Afla), zearalenone (ZEN), deoxynivalenol (DON), T-2 toxin (T-2), fumonisins (FUM) and ochratoxin A (OTA). *Figure 1* shows the prevalence of six major mycotoxins in corn silage. More than 40% of samples tested positive for DON at concentrations above the recommended threshold for cows. Nearly one out of four samples had ZEN ppb levels in excess of recommendations. Likewise, Afla exceeded the risk threshold 11% of the time.

Table 1 provides further details on the number of samples, average and maximum concentration levels, and recommended maximum thresholds for dairy cows.

Figure 1. 2015 BIOMIN Mycotoxin Survey results for corn silage. Bars represent percentage of positive samples. Dots display the occurrence of mycotoxins above risk threshold levels (bottom row, *Table 1*).



Source: BIOMIN

Table 1. Corn silage results, 2015 BIOMIN Mycotoxin Survey.

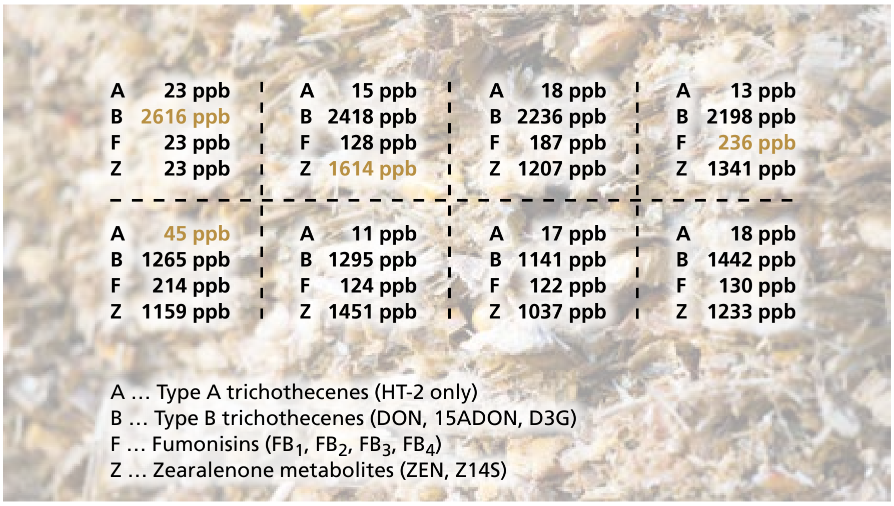
	Afla	ZEN	DON	T-2	FUM	OTA
Number of samples tested	188	247	274	194	191	178
Average of positive (ppb)	8	295	2153	68	201	8
Maximum (ppb)	153	6239	34861	685	1757	32
Recommended max threshold (ppb)	2	100	300	100	2000	80

Source: BIOMIN

Consequences for cows

Aflatoxins, produced by *Aspergillus*, are commonly found at low dosage in forages such as maize silage and hay. It has been shown to carry-over into milk and pose a threat to humans upon ingestion—a key reason for regulatory maximum levels in milk in many jurisdictions. Aflatoxins are associated with impaired rumen function, impaired udder health, increased somatic

***Figure 2**. Variable mycotoxin occurrence in single corn silage lot, 2015.*



Source: BIOMIN

cell count, decreased resistance to environmental and microbial stressors and increased susceptibility to diseases. Even low doses can have serious health implications in the long-term.

Due to its estrogenic proprieties, zearalenone (ZEN) can impair reproduction and have nefarious effects on the reproductive cycle and estrogen hormone regulation in heifers and calves. In the rumen ZEN is converted into two forms: α- and β-zearalenol. The α-form is even more estrogenic, and hence potentially more disruptive to reproduction, than ZEN itself.

Deoxynivalenol (DON) is the most common mycotoxin in forages, occurring worldwide sometimes at high concentrations. It is associated with impaired rumen function, diarrhea, metabolic disorders, mastitis, metritis and lameness.

Invisible threat

Mycotoxins are too small to be visible to the naked eye, so mycotoxin contamination is not accurately detected by sight. The absence of visible mold in silage does not necessarily mean that it is free of mycotoxins. The converse also holds true: heavily infested, visibly moldy silage does not necessarily contain severe levels of mycotoxins. The first step in protecting the herd is to correctly identify the specific mycotoxin challenge on the farm by way of regular testing of feedstuffs and feed prior to feeding.

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Uneven distribution

Mycotoxins and the fungi that produce them are not distributed homogeneously within silage. Since feed is either stored in silos (bunker, trench, etc.), or bales of different shapes, most lots are mainly static and contaminants are not spread equally throughout the lot, but rather accumulate in certain niches, i.e. next to the walls where the humidity can favor fungal growth. *Figure 2* shows uneven mycotoxin distribution in storage silos (single corn silage lot).

Type B trichothecenes include deoxynivalenol, 15-acetyldeoxynivalenol (15ADON) and DON-3-glucoside (D3G), the latter a masked mycotoxin not easily detected by conventional methods often released in the rumen and able to harm animals. The variability between the minimum and maximum ppb levels of mycotoxins in silage can be considerable. As *Figure 3* illustrates, the highest value for zearalenone in this case was 50% higher than the lowest detected value. For type A trichothecenes (HT-2 toxin), there was a staggering 300% difference. Even the lowest variability, that of zearalenone and its metabolite zearalenone-14-sulfate, amounted to a 56% difference.

Michele Muccio & **Karin Nährer**
Product Managers, Mycotoxin Risk Management

Tips for proper sampling

Mycotoxin detection relies on proper sampling to ensure reliable, accurate results that reflect the real mycotoxin challenge on the farm. Here are a few ways to ensure smooth sampling.

Sampling tips

1. Follow a suitable sampling procedure e.g. EU guidelines Regulation (EC) No 401/2006 on "laying down the methods of sampling and analysis for the official control of the levels of mycotoxins in foodstuffs" which sets out the number of incremental samples needed depending on the lot type (solid feed or roughages) and lot size.
2. Use a sampler that reaches every area of the lot rather than sampling from a single spot.
3. Carefully prep samples. Those sent to laboratories should be properly dried, vacuum-packed and refrigerated until shipping.
4. Properly label samples. Attach a label indicating the date of sampling, origin of the lot (country, region, farm name), year of production, size of the lot sampled, short description of sampling procedure, stage of sampling (storage, feed mill).
5. Avoid snail mail. Choose an express mail service and avoid shipping late in the week when packages may sit over the weekend.

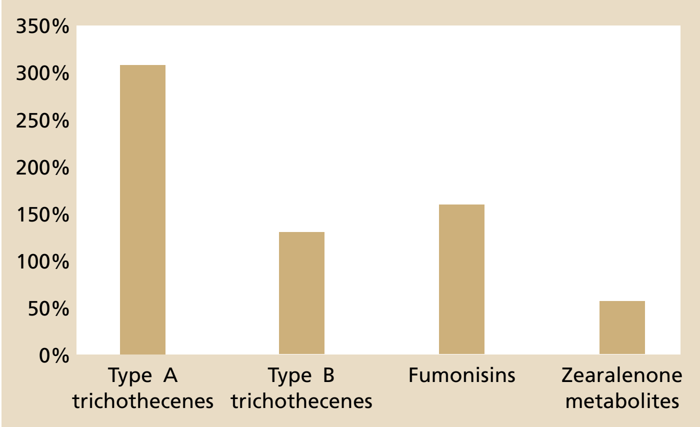
From analysis to action

The mycotoxin analysis report based on submitted samples provides guidance on the specific mycotoxin challenge on the farm. An expert consultation using those results will help farmers in selecting the appropriate mycotoxin deactivator, since different feed additive components have specific modes of action that target the specific mycotoxins and can consequently be tailored to address the identified on-farm threat. It also helps to determine the right inclusion rate.

Multiple innovative strategies

Because groups of mycotoxins differ structurally from one another, several strategies are needed to counter the wide range of mycotoxins found on the field. The three strategies to counteract different mycotoxins are biotransformation, adsorption and bioprotection. Mycofix® contains the only EU authorized feed additives proven to adsorb harmful mycotoxins and to biotransform mycotoxins into nontoxic metabolites. It combines these three modes of action to deliver the most scientifically advanced protection against mycotoxins to date. With proper sampling procedure, sample preparation, regular monitoring and application of a mycotoxin deactivating feed additive, farmers can protect herds from the negative impacts of mycotoxins in order to support continued health and performance.

Figure 3. Percent difference of highest and lowest mycotoxin concentrations in a single corn silage lot.



Source: BIOMIN

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