Silage evaluation
Take stock of your silage this year-end

Planning for success
Enhance silage quality for higher profitability

Dairy cattle intake
Increase production with higher dry matter intake
Make feeds your priority

The quality of primary feeds such as silages influences feed intake, productivity, animal health and fertility. Ensuring good quality feeds is thus the basis for profitable agricultural production. Intensifying farm production is not only in the best interest of the farmer, but also of prime importance on a global scale for feeding a growing world population.

The BIOMIN product range in silage inoculants is based on extensive research on maximising the preservation of silage energy and dry matter. BIOMIN isolated its own bacterial strains, developing them from the lab bench up to large-scale production in the Biomin Research Center based in Tulln, Austria. Many laboratory and field trials have confirmed the effectiveness of our silage inoculants under very different farm conditions, climates and crops.

Our latest innovation is the new EFSA (European Food Safety Authority)-approved heterofermentative silage strain, Lactobacillus kefiri. In August 2013, EFSA confirmed that the silage inoculant has no adverse effects on animal health, human health or the environment. The preparation was also found to improve the aerobic stability of silage by increasing acetic acid production and reducing silage pH. This means that the novel L. kefiri silage inoculant meets all the criteria for stringent safety and efficacy evaluations in the EU feed register. On page 5, Science& Solutions describes the special properties of L. kefiri and its ability to reduce silage pH while improving aerobic stability.

The key to quality silage lies not only in a novel strain but a holistic concept of management. We hope our readers will gain from the tips on silage management and improving dry matter intake in this debut issue of Science& Solutions for the ruminant sector.

Jutta Zwielehner PhD
Product Manager
Planning for silage success

Managing feed in silos and choosing the right silage additives can prolong feed quality. Combining a homofermenter with suitable heterofermentative silage inoculants directly inhibits the growth of yeast and mould while increasing dry matter recovery in feed.

By Mark Nooijen MSc & Jutta Zwielehner PhD

Intake factors in dairy cattle

Maximise the potential for dry matter intake with the right diets and a conducive environment.

By Bryan Miller MSc
Planning for silage success

The year-end is a good time to evaluate the quality of the past year’s silage and plan for achieving even better silage in 2014.

Most crops in the northern hemisphere have been harvested for this season. The quality of stored feed cannot be changed, yet this quality will determine milk production and profitability for the...
coming months. It is thus important to start evaluating in order to plan for improvements in the different parameters of silage quality for 2014.

Some of the most common mistakes are inappropriate bunker silo measurements, non-airtight closing of the silo and insufficient compacting. These often result in the growth of yeast and mould. Mould growth could lead to the production of mycotoxins while yeast growth results in increased silage temperature, decreased amounts of dry matter, ethanol formation and a lower energy content.

Research also shows that feed intake is dramatically reduced when animals are fed with heated up silage.

Hygiene
Planning for high quality silage is important and several factors should therefore be considered. Empty silos should be cleaned and any wastes removed. Feed left-overs could contaminate incoming silage with spoilage organisms. Mice and rats also like to feed on left-overs.

Silos should be regularly checked for holes in the plastic foils. Rodent control strategies should be implemented if there are rats or mice.

Management
Do the bunker silos have the right measurements? Good bunker silos are designed so that silage can be well compacted. Walls help in achieving good compactation. The silos should be designed for a feed-out rate of 3 meters per week during the summer and 1.5 meters per week during the winter.

Ensure that high quality foils are available during harvest. Foil should be used on the walls of the silo and the top foil should fit the entire bunker silo. Important technical parameters for the choice of foil are UV-resistance, oxygen permeability and elasticity.

Self-propelled forage harvesters are becoming bigger while the capacity for compacting does not often increase to the same extent. To allow sufficient time for good compacting, a minimum 1 tonne compacting capacity is required for every tonne of dry matter harvested per hour. For a forage harvester with a capacity of 15 tonnes dry matter per hour, either a 15-tonne loader or two 7.5-tonne tractors may be used.

Silage additives
Select the right silage additive. Different bacterial strains are available to maintain the feed quality.

Homofermentative bacteria strains like Lactobacillus plantarum are added to improve fermentation by a rapid production of lactic acid. This gives spoilage organisms a shorter time-frame for growth, resulting in

Evaluate your silage quality

- What were the results of the silage analysis?
- What was the content of butyric acid, ammonia and ethanol in the silage?
- Did the silage or TMR heat up during the summer?
- How was feed intake and animal performance?

Figure 1. Cross-section of a bunker silo with correct filling shape and closing.
Maize and whole-crop cereal silages are notoriously unstable once the silo has been opened. Heterofermentative silage inoculants are useful for reducing aerobic spoilage and for increasing the "shelf-life" of the silage. The problem of aerobic spoilage is particularly serious when the rate of feed-out is slow because the silo is too big, and when silage is being removed from the silo in hot and/or humid weather.

A new Biomin® BioStabil strain, Lactobacillus kefiri, achieved EFSA registration as a silage additive on 12 August, 2013. The improved Biomin® BioStabil Plus, planned for re-launch in 2014, will include the EFSA-approved L. kefiri strain. The combined use of this novel strain with the L. brevis heterofermenter and L. plantarum homofermenter has shown excellent results in improved fermentation and aerobic stability.

L. kefiri improves the aerobic stability of silage by increasing the production of acetic acid and reducing silage pH from easy and moderately difficult-to-ensile materials. The combination of the heterofermenters L. kefiri and L. brevis has also been shown to improve fermentation quality and further extend aerobic stability in such materials.

Data from recent field trials in Austria during the summer of 2013 have shown that the well-balanced combination of homo- and heterofermentative silage strains in BioStabil Plus can achieve a gain in net energy of lactation (NEL) of about 5-7% (Table 1). The increase in NEL was a result of reduced spoilage activity, which led to lower concentrations of ammonium and acetic acid. Even though the dry matter percentage was slightly higher with BioStabil Plus due to field trial variations, there was an increase in lactic acid content which resulted in a lower pH. BioStabil Plus was also found to increase digestible protein despite the lower levels of raw protein due to field variations. The increases in both NEL and digestible protein have a great impact on animal production.

Table 1. Field trial in alfalfa with the novel Biomin® BioStabil Plus that includes the heterofermenter L. kefiri

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Control</th>
<th>Biomin® BioStabil Plus</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (DM)</td>
<td>g/kg</td>
<td>344</td>
<td>384</td>
<td>1.6%</td>
</tr>
<tr>
<td>Raw protein</td>
<td>g/kg DM</td>
<td>181</td>
<td>178</td>
<td>-1.7%</td>
</tr>
<tr>
<td>Digestible protein</td>
<td>g/kg DM</td>
<td>120</td>
<td>124</td>
<td>+3.3%</td>
</tr>
<tr>
<td>Raw fat</td>
<td>g/kg DM</td>
<td>34</td>
<td>33</td>
<td>-2.9%</td>
</tr>
<tr>
<td>Raw fibre</td>
<td>g/kg DM</td>
<td>288</td>
<td>280</td>
<td>-2.8%</td>
</tr>
<tr>
<td>Raw ash</td>
<td>g/kg DM</td>
<td>104</td>
<td>103</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Digestible organic matter</td>
<td>%</td>
<td>59.6</td>
<td>63</td>
<td>+5.7%</td>
</tr>
<tr>
<td>Metabolisable energy (ME)</td>
<td>MJ/kg DM</td>
<td>8.46</td>
<td>8.9</td>
<td>+5.2%</td>
</tr>
<tr>
<td>Net energy lactation (NEL)</td>
<td>MJ/kg DM</td>
<td>4.85</td>
<td>5.16</td>
<td>+6.4%</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>4.7</td>
<td>4.5</td>
<td>-4.3%</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>g/kg DM</td>
<td>33.2</td>
<td>35.7</td>
<td>+7.5%</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>g/kg DM</td>
<td>27.9</td>
<td>14.9</td>
<td>-46.6%</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>g/kg DM</td>
<td>0.9</td>
<td>0.8</td>
<td>-11.1%</td>
</tr>
<tr>
<td>Ammonia (NH3)</td>
<td>NH3-N (%)</td>
<td>4.6</td>
<td>2.8</td>
<td>-39.1%</td>
</tr>
</tbody>
</table>

Source: Biomin, using data from an independent commercial farm in Austria

The improved Biomin® BioStabil Plus, planned for re-launch in 2014, will include the EFSA-approved L. kefiri strain. The combined use of this novel strain with the L. brevis heterofermenter and L. plantarum homofermenter has shown excellent results in improved fermentation and aerobic stability.
Maize silages are the least problematic to ensile because they have a relatively high sugar and starch content, low protein content and therefore low buffering capacity. Furthermore, harvested maize usually contains over 300g/kg dry matter. These factors taken together explain why inoculants with a high proportion of heterofermentative silage bacteria give the best results in maize silage.

For grass and legume silages, it is important to achieve a low and stable pH as quickly as possible through lactic acid production. Homofermentative silage inoculants (e.g. *Lactobacillus plantarum*) can direct the speed and the pattern of fermentation.

Lactic acid, the main metabolite of homofermentative strains is one of very few microbial metabolites which improve feed palatability. Unfortunately, high levels of lactic acid make silages more susceptible to aerobic spoilage. A good balance must be achieved between lactic acid and acetic acid for excellent palatability as well as aerobic stability (or shelf-life). Therefore, it is recommended to combine the use of inoculants of homo- and heterofermentative strains.

But which heterofermentative bacteria is the most suitable for different types of silage?

### Heterofermentative silage inoculants: Which to choose?

Maize silages are the least problematic to ensile because they have a relatively high sugar and starch content, low protein content and therefore low buffering capacity. Furthermore, harvested maize usually contains over 300g/kg dry matter. These factors taken together explain why inoculants with a high proportion of heterofermentative silage bacteria give the best results in maize silage. For grass and legume silages, it is important to achieve a low and stable pH as quickly as possible through lactic acid production. Homofermentative silage inoculants (e.g. *Lactobacillus plantarum*) can direct the speed and the pattern of fermentation.

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### Prepare a top layer treatment

Moulds occur most frequently in the top layer of the silo. Their occurrence depends on the mould contamination level at harvesting and the amount of available air in the silage. Moulds need oxygen to grow, so the visible occurrence of moulds means that oxygen has been present in this part of the feed. Oxygen can enter the silo when compaction is insufficient or due to non-airtight closing of the silo. Furthermore, the oxygen permeability of the plastic foils can play a role.

A good way to protect the top layer of the silo from mould growth is the use of Biomin*® CleanGrain* liquid. CleanGrain liquid is designed to be highly effective against yeast and mould while being at the same time safe to use as it is non-corrosive. The recommended dosage is 3-5 L/tonne for the entire silo or top layer. Alternatively, 0.5-1L/m² can be applied as surface treatment to the outer top layer with a watering can.

Silage matters and the right decisions are crucial as animals feed on the silage you have in stock. Good silage pays itself off through higher meat and milk production.
Table 2: Comparison of heterofermentative silage

<table>
<thead>
<tr>
<th></th>
<th>L. brevis &amp; L. kefiri</th>
<th>L. buchneri</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidifies corn and grass silages with lactic and acetic acid</td>
<td>Does not acidify silage, because acetic acid dominates</td>
<td></td>
</tr>
<tr>
<td>Extends aerobic stability. L. kefiri inhibits yeast growth</td>
<td>Extends aerobic stability and inhibits yeast growth</td>
<td></td>
</tr>
<tr>
<td>Suitable for all silages – corn as well as grass and legume</td>
<td>Suitable for corn silage, less suitable for grass silage</td>
<td></td>
</tr>
<tr>
<td>Preserves dry matter in all silages</td>
<td>Causes dry matter loss</td>
<td></td>
</tr>
</tbody>
</table>

Acidifying grass silage

L. kefiri and L. brevis are able to acidify grass silage compared to the untreated control.

Figure 2. Change in grass silage pH (single-strain laboratory silage fermentations)

Dry matter preservation

L. brevis and L. kefiri are the only heterofermentative silage inoculants suitable for both maize and grass silage.

Table 3. Average dry matter (DM) recovery in silage inoculated with only one silage bacterium.

<table>
<thead>
<tr>
<th>Treatment with single strain</th>
<th>DM recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maize silage</td>
</tr>
<tr>
<td>L. brevis</td>
<td>98.5</td>
</tr>
<tr>
<td>Control L. brevis</td>
<td>98.2</td>
</tr>
<tr>
<td>L. kefiri</td>
<td>97.5</td>
</tr>
<tr>
<td>Control L. kefiri</td>
<td>98.1</td>
</tr>
<tr>
<td>L. buchneri</td>
<td>94.1</td>
</tr>
<tr>
<td>Control L. buchneri</td>
<td>95.5</td>
</tr>
</tbody>
</table>

Aerobic stability

L. brevis supports fermentation and DM recovery in all silages and supports aerobic stability. Because of considerable amounts of acetic acid, L. kefiri is a good choice for improved aerobic stability.

Figure 3. Comparison of the aerobic stability of silages treated with either L. kefiri or L. brevis (single-strain laboratory silage fermentations)

Dry matter preservation

L. brevis and L. kefiri are the only heterofermentative silage inoculants suitable for both maize and grass silage.

Palatability

The Biomin® BioStabil strains L. brevis, L. kefiri and L. plantarum were selected as silage inoculants owing to their excellent palatability properties. All three strains were not found to produce 1-propanole, a metabolite which greatly diminishes feed palatability.
Although the concept of feed intake is relatively simple, the factors affecting it can vary dramatically. These factors may include animal characteristics such as genetic selection or propensity to eat, and neurologic and hormonal feedbacks pertaining to satiety, metabolic conditions, and diseases.

The feed itself can affect intake from a variety of characteristics, including, moisture, taste, fat content and fibre content. Because ruminants rely on fermentation to provide nutrients from volatile fatty acids to microbial protein, they risk being affected by disturbances from feed changes and factors affecting microbial growth.

As ruminants, dairy cattle are essentially consuming feed at all times. As such, some of the satiety controls and monitors found in monogastric animals may not be effective to the same levels as in dairy cattle.

**Rumen and gut effects**

Does rumen fill cause satiety? In evaluating rumen fill researchers have used inflated balloons in the rumen to simulate fill, resulting in decreased voluntary intake. However, at physiological levels this feedback mechanism is unlikely to be the sole or major reason for decreased intake.

Research on sheep has demonstrated that the duodenum has receptors affected by titratable acidity but not glucose or osmolality. Moreover, it has also been demonstrated that the infusion of propionate to the liver results in decreased in-
take with feedback to the brain via nerve transmissions. This is interesting when one considers that propionate is the primary gluconeogenic volatile fatty acid (VFA).

Circulating ketones such as β-hydroxy butyrate can reduce feed intake in both monogastrics and ruminants. Produced during negative energy balance and a lack of glucose, ketones can lead to a continuous spiraling down in dry matter intake (DMI).

Feed management

Feed formulation is the area in which management can most greatly affect DMI. Within common diets, DMI can be fairly well predicted based upon the energy content of the diet and the level of milk production. They do not predict potential intake and subsequent production. Fats and high simple carbohydrate diets can certainly increase caloric density. However, issues of absorption and acidosis can limit their use. Today's dairy cattle intake is often restricted by the physical constraints of moving enough feed through the system. Toward this end, it is important to maximise the digestible fiber portion of the diet.

Neutral detergent fiber, as a measure of forage quality, is important in predicting forage DMI. However the digestibility and rate of digestibility are also important in predicting intake. Enzyme, chemical treatments and genetic selection for more digestible NDF portions have resulted in increased digestibility and subsequent intake. For cattle to consume new or continue eating new feed, the previously consumed feed contents must disappear through a combination of digestion and passage. Feed fiber utilization is maximised through good fermentative characteristics in the rumen which include both proper pH and available nitrogen for bacterial growth.

Weather effects

Dairy cattle have a fairly wide thermal neutral zone from 5 to 20°C and are generally more tolerant of cooler temperatures. It is the combination of temperature and humidity which affect the “comfort” of the cattle. The combination of heat and humidity can decrease feed intake by 10-25%, and in extreme conditions up to 55% (Table 1).

Management tools to deal with heat and humidity include the use of misters, fans, reduced crowding and dietary changes to include more fats and less fiber.

Improved intake

DMI is a result of the innate ability of dairy cow to consume feed based upon genetics which affect gut volume, sensory and hormonal controls. Dairy producers need to maximise this potential for DMI through dietary selection and the provision of an environment conducive to maximal feed intake.

### Table 1. Temperature and humidity levels that can negatively affect milk production.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>29</td>
<td>84</td>
</tr>
<tr>
<td>26</td>
<td>80</td>
</tr>
<tr>
<td>25</td>
<td>77</td>
</tr>
<tr>
<td>24</td>
<td>75</td>
</tr>
<tr>
<td>22</td>
<td>72</td>
</tr>
</tbody>
</table>

Source: Chase, Cornell University

Feed intake can also be reduced by the presence of mycotoxins, especially trichotecenes such as deoxynivalenol (DON or vomitoxin) and T-2 toxin (T-2) in the feed. Fescue pastures or hay containing alkaloids lower heat tolerance and subsequently reduce dry matter intake.

Moisture content

Diets containing over 50% moisture have generally been associated with decreased intake. This reduced feed intake is related to the fermented products of such diets rather than the water content per se.
Biomin® BioStabil

Preserve the energy in your silage!

Blend of homo- and heterofermentative bacteria
• Better fermentation
• Longer aerobic stability
• Reduced dry matter and energy losses
• Higher productivity and profitability