Practical hints and tips on what makes a good silage inoculant

Silage inoculants are based on live bacteria which contribute to improving silage acidification and/or aerobic stability depending on the bacteria activities. The inoculant market is growing, with many different products on offer, claiming many benefits and various price ranges. This article offers hints and practical tips on how you can make an enlightened choice.

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There are two main types of bacteria used in an inoculant formulation, depending on the desired outcome:

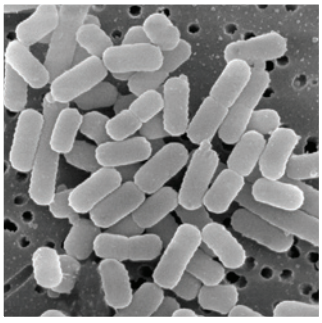
- Homofermentative lactic acid bacteria (LAB), which convert soluble sugars from the forage into lactic acid, for example, Lactobacillus plantarum or Pediococcus acidilactici. These bacteria are used to speed-up the initial fermentation, helping to quickly reach a safer pH.
- Heterofermentative bacteria such as Lactobacillus buchneri, which convert soluble plants sugars into lactic and other acids which have a documented antifungal activity (acetic acid or propionic acid). They are effective to improve silage aerobic stability and hence reduce the risks of aerobic spoilage after silo opening.

According to Professor Limin Kung, PhD, University of Delaware, "Of the heterolactic acid bacteria, only Lactobacillus buchneri has proven itself (with multiple research publications) to be an effective silage inoculant."

However, in the same bacteria species (for example L. buchneri), each strain has its own genetic identity and commercial strains are registered with unique strain numbers (for example L. buchneri NCIMB 40788 from Lallemand Animal Nutrition). In Europe, unique strains are authorised as silage additives and all documentation is linked to a particular-strain number. This means that, for example, what has been published for one L. buchneri strain cannot apply to another.

Always check the strain reference on the European Union register of feed additives before choosing an inoculant.

All inoculant formulations are specific. Inoculants can be based on a single strain or associate different strains with complementary activities. For example, homofermentative and heterofermentative bacteria can be combined to improve both acidification and aerobic stability of low sugar, high DM and high-nutrient content forages such as alfalfa.



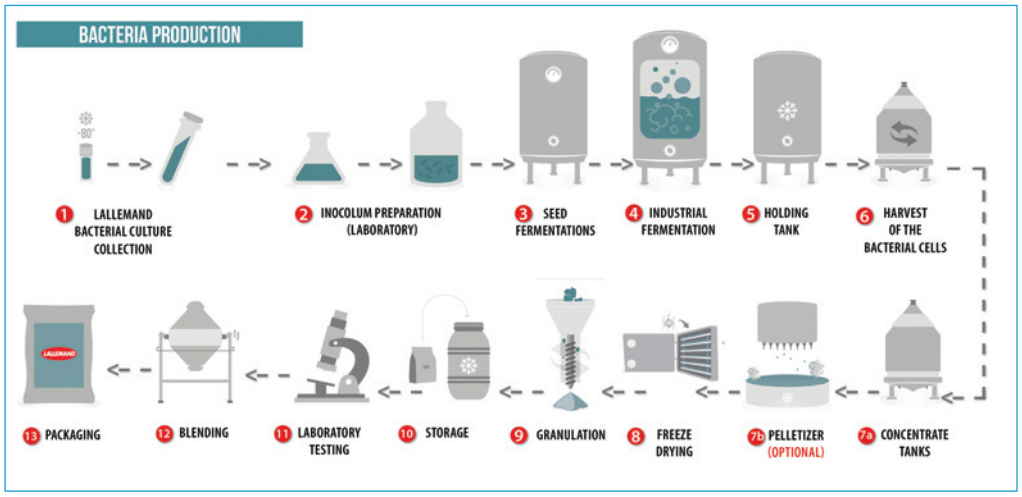
Lactobacillus buchneri (Electron micrograph courtesy of D. S. Smith, Dept. of Food Science, University of Guelph, Canada).

There is no rule as to what is the best combination, but the formulation should respond to specific issues related to each type of crop. For example, maize is prone to aerobic instability due to its high sugar and dry matter content. The best option for preservation is to use a proper strain of L. buchneri authorised to improve aerobic stability. On the contrary, grass silages and alfalfa have a lower sugar and dry matter content.

In this case, acidifying bacteria is necessary to achieve an ideal acidification. Some inoculants even associate these bacteria with enzymes that raise the fibre digestibility and release soluble sugars to enhance the lactic acid and antifungal bacteria metabolism.

Inoculant formulation should be specifically adapted to the target crop and ensiling challenge in order to ensure best silage preservation.

Fig. 1. From a few bacteria cells to tons of finished products, bacteria production is a succession of upscaling steps and tight quality controls, necessary at every step to ensure purity and quality of the final product. (Lallemand Animal Nutrition)



Research is key

Professor L. Kung wrote, "An effective silage inoculant will have independent, statistically analysed, and published data supporting its use. Of course, the more supporting

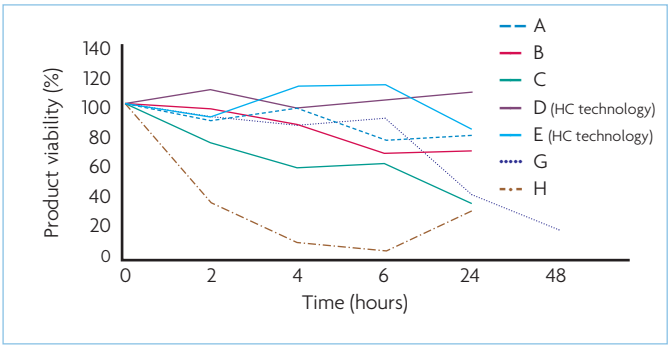


Fig. 2. Inoculant viability (%) over time in suspension in water: comparison of seven commercial products (Lallemand internal data, 2017).

On-farm services, such as Lallemand's silo audits can be a very important management tool.

data there is, the more credibility a product has. I will take an educated guess and say that no more than 10-15% of the silage inoculants in the marketplace have more than five publications showing that they work."

It is important to check that there is independent published research related to the inoculant formulation and/or strain(s). Not all companies invest in continuous research and development to document their products. Professor Kung explains, "Lactobacillus buchneri NCIMB 40788 has become the gold standard to improve aerobic stability, showing consistent results."

Always check that the scientific and technical references provided with a product refer to the specific strain.

Production is essential

An inoculant's efficacy relies on the biological activity of live bacteria. Thus, efficacy of the final product relies on the survival of the bacteria, from the plant all the way through to the silo.

Bacteria viability depends on the strain (its intrinsic quality), as well as the quality of the production process, formulation, and finally, storage conditions including packaging. The production of live bacteria requires expertise and stringent quality controls throughout the process.

Only a few companies possess the capability to produce bacteria and deliver pure, live, stable, and consistent blend of specific bacteria.

Companies that produce their own bacteria and control the whole chain from bacteria fermentation to final product packaging ensure optimal quality and traceability of the product (Fig. 1).

When choosing an inoculant, it is important to check the reputation of the primary producer, the product shelf life and the storage conditions.

Importance of formulation and dosage

Not only is the bacteria composition important, but also the dosage and product formulation technology. One can select the best possible bacteria strains, but if the farmer does not end up with the right number of live and active bacteria in the silo, it is useless for them.

Hence, the number and the viability of the bacteria, as well as solubility and ease of application at the harvester, are very important, too.

Once the product's scientific documentation and technology has been checked, it is important to check the dose.

All published data are related to a recommended dose of use, which is expressed as CFU (Colony Forming Units) per gram of fresh forage treated or per gram of product.

The CFU represents the number of live and active bacteria. When comparing two products, it is important to compare the final bacteria count, as sometimes this can help explain the price difference.

For example, L. buchneri is effective at 300,000 CFU/g of fresh forage. Certain products could be misleading as giving the overall bacterial count. It is important to check the number of each individual bacteria to make sure the optimal dose is used.

Always compare dose according to final bacteria count in forage.

Dead bacteria are useless

Number of bacteria or CFU in the sachet is one thing, but the number of live bacteria reaching each part of the silo is another. Lallemand's inoculants are stored as hydrodispersible powder in an aluminium foil sachet.

The bacteria are preserved in a freeze-dried form. When considering liquid applications, the bacteria are revived when mixed in water, surviving only a few hours in water outside the silo. For this reason, the remaining product should be discarded from the tank at the end of the working day or silo, within 24 hours.

However, bacteria viability after dilution is also dependent on the formulation and technology associated. For example, the High Concentration (HC) technology has been developed by Lallemand Animal Nutrition specifically for low volume applicators with three major features:

- High concentration of the product.
- Low sedimentation for homogenous application throughout the silo.
- High stability.

Fig. 2 shows the viability of bacteria in suspension in water over time, or stability, for different products available on the market. It shows that some products lose more than 25% viability during only the first two hours after dilution, and that at the end of six hours the viability had fallen to 60%.

The product using the HC technology offers up to 24 hours bacteria survival in suspension.

Formulation technology helps ensure viability over time.

Does the product remain in suspension?

Inoculants are very concentrated; billions of bacteria are present in every drop of diluted product. To be effective, it is essential that their application is homogenous during ensiling.

One can have the best bacteria, but if it settles in the bottom of the tank, it is useless. As shown in Fig. 3, depending on the formulation,

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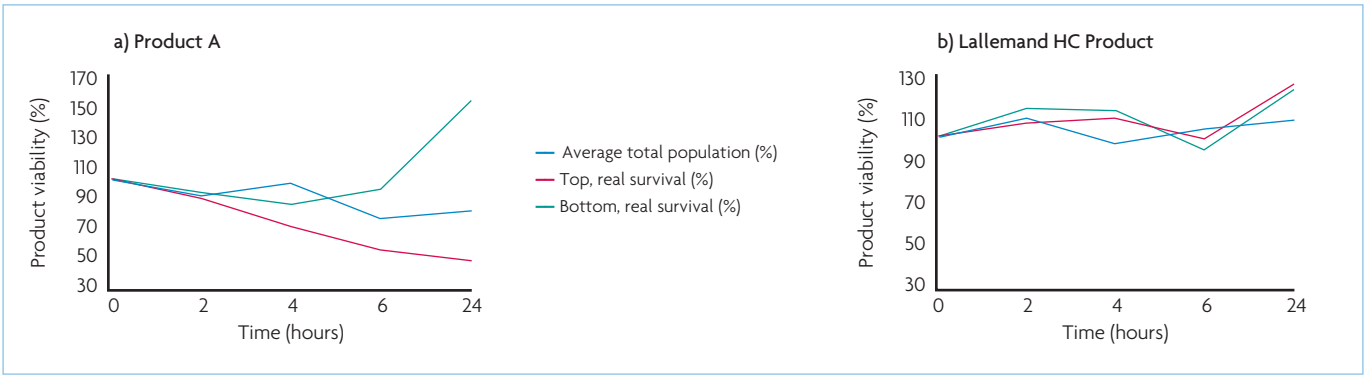
Fig. 3. Sedimentation of a) commercial product (without HC technology) and b) Lallemand HC product in suspension over time (Lallemand internal data, 2017).



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certain inoculants remain in suspension for hours, which ensures homogenous application within all the silo, while in other formulations, the bacteria, once mixed with water, tend to sink to the bottom of the tank after only a few hours.

As a result, the application can be far from optimal. Producers can risk overdosing the silage at the bottom of the silo while under-dosing the top part.

Silage at the top of the silo is where the aerobic challenge is often greater due to its higher porosity and where inoculant is most needed. With the HC technology, bacteria remain in suspension for up to 24 hours.

Product speed of sedimentation is important technical criteria.

Technical support

Successful silage making can meet many challenges and requires technical knowledge.

Silage inoculants are not commodity products and to make sure the investment pays-off, ideal practices should be implemented. Providers should accompany their users with strong technical support.

Professor L. Kung wrote on this matter, "Although technical service is not directly related to the effectiveness of a silage inoculant, this should be factored into your decision-making process. Certainly, companies that are willing to assist you in times of need should be highly considered."

On-farm services, such as the silo audits developed by Lallemand Animal Nutrition are very useful to achieve precise, objective and rapid assessment of the silage quality on-farm and represent invaluable tools to optimise the silage management at this level.

Check that your provider offers expert technical services on-farm.

Conclusion

There are many silage inoculants on the market with different claims and specifications. A better understanding of the makeup of a silage inoculant, its modes of action and specificities, help make the right decision.

The checklist shown in Table 1 (right) can help guide you to the right decision or at least address the preferred questions when choosing a product. ■

References are available from the author on request

Is the company reputable?	Yes	No
Do they manufacture their own products to international quality standards?	Yes	No
Is the product packaged properly to maintain product viability?	Yes	No
Is the product shipped in a way to maintain product viability?	Yes	No
Does the company have data to support the shelf-life of their product?	Yes	No
What do I need from my inoculant?		
Improve front-end fermentation and DM recovery	Yes	No
Improve stability at feedout and prevent spoilage	Yes	No
Does the company have third-party data to show the product can meet my needs?	Yes	No
What additional features and benefits would I like?		
Easy to use	Yes	No
Increased milk production	Yes	No
Other (write in)	Yes	No
Does the company have third-party data to show the product can deliver those extras?	Yes	No
Does the company offer help with sourcing applicators?	Yes	No
Does the product formulation include stabilisers to keep the product stable in the applicator tank?	Yes	No
Does the local rep provide additional services (for example, silage sampling and testing)?	Yes	No
Does the company have technical support services staff for any necessary follow-up?	Yes	No