ADDCON

Silaging

KOFASIL® LIFE




Bacterial preparation for improving the fermentation quality of silage made from grass, leguminous plants and whole cereal plants

Problem

For profitable dairy and beef production, it is absolutely essential to obtain high yields from the basic feed. Besides energy and special nutrients, the properties of the silage that encourage consumption play an important role in achieving this. Poorly fermented silage, which is usually caused by intensive bacterial nutrient breakdown, will not be eaten so readily (Table 1), and the harmful microbes in it (e.g. clostridia and Listeria) can furthermore endanger the animals' health.

Table 1:
Effect of the fermentation quality on the consumption of silage by dairy cows

Energy concentration Fermentation quality	high good	low good	high poor
Grass silage intake (kg DM/animal and day)	11,2	9,8	8,9

Gill et al, 1988 FAL Braunschweig

With many types of feed, wilting the forage crop is the most important measure in controlling butyric fermentation in silage preparation. But practice has shown that good fermentation quality cannot always be achieved with wilting alone. Recent trials by the Weser-Ems Chamber of Agriculture, for example, which were performed in 2004 on 507 silage samples, prove that even with an average dry matter content of 35%, fermentation quality was unsatisfactory and many grass silages were classified as being in need of improvement. On average the silages contained 1.47% butyric acid in the dry matter and had an ammonia-N content of 12.5% of the total N. The DLG evaluation scheme for silage quality sets the target values for these two parameters at < 0.3% butyric acid/DM and < 10% ammonia-N of the total N.

Where butyric fermentation occurs in a forage crop that has a sufficiently high DM level according to previous standards, this is usually caused by acidification taking place too slowly in the silo. This can be caused by insufficient numbers of powerful lactic acid bacteria on the forage crop that are suitable for the ambient conditions concerned. Intensive lactic acid fermentation is essential to reduce the pH value to below the lowest level at which the elements that cause butyric fermentation can grow (critical pH value). For example, it has been shown that butyric acid occurs in the silage particularly when the green crop has a lactic acid bacteria count of less than 100,000 per gram (Table 2). The natural lactic acid bacteria count is usually much lower than that.

Table 2:
Influence of the number of lactic acid bacteria (LAB) on the occurrence of butyric acid in silage

Silage crop	Number of silages (n)		Proportion of silage containing butyric acid (%)
	total	containing butyric acid	
All batches of forage crop	244	98	40
of which:			
< 106 LAB/g	49	2	4
105 to 106 LAB/g	43	2	5
< 105 LAB/g	153	94	61

FAL Braunschweig

It is also known that only a very small and highly fluctuating fraction of the epiphytic lactic acid bacteria occurring naturally on the green crop (about 10% on average) is osmotolerant, i.e. can survive with little water. Most epiphytic lactic acid bacteria are therefore completely incapable of multiplying in silage made of strongly wilted forage crop, which is why lactic acid fermentation and pH reduction usually get going slowly in wilted silage.

Another negative factor is that the intensity of nitrogen fertilisation has been reduced in recent years. As a result, grass often only contains extremely low levels of nitrate nowadays, and some nitrate is needed to ensure the success of wilted silage without additives. Any nitrate present is converted into nitrite during the first few hours of fermentation. This nitrite and its gaseous decomposition products suppress the elements that cause butyric fermentation during the initial fermentation phases, as long as the critical pH value has not been reached. This protective effect is absent in forage crops that lack nitrate, so it is particularly important to accelerate lactic acid fermentation in wilted silage made of low-nitrate forage crops in order to counteract butyric fermentation.

Faster lactic acid fermentation and pH reduction are also generally beneficial, since early elimination of elements that negatively affect fermentation restricts the nutrient breakdown they cause and reduces fermentation losses. This makes it possible to gradually improve the quality of the silage even in situations in which butyric fermentation is unlikely.

Concept

To produce the best possible silage, it is important to take all possible technical measures to create the optimum conditions for the desired fermentation process.

These include:

- sufficiently strong wilting,
- not leaving the mown forage crop in the field too long,
- careful, clean retrieval of the silage crop,
- adequate chopping with a short chopping or cutting length,
- good compaction of the feed in the silo,
- short, uninterrupted silo filling times, and
- covering the feed stack immediately and carefully.

Any remaining risk of butyric fermentation can then be limited by adding lactic acid bacteria to accelerate lactic acid fermentation.

Because neither the nitrate content nor the presence of lactic acid bacteria in the forage crop can be predicted, wilting should generally be combined with the addition of bacterial preparations. Inoculation with powerful, osmotolerant lactic acid bacteria as a permanent part of the silaging process ensures that the desired fermentation is achieved regardless of the amount of bacteria naturally present in the forage crop.

For this measure to succeed, however, it is important that the silage crop is able to ferment adequately. Whether this is the case depends on the sugar content, the buffer capacity and the dry matter content of the forage crop. Controlling the fermentation process with bacterial preparations is only possible with silage crops that are easy or moderately hard to ferment. Wilting improves the forage crop's ability to ferment, so it only makes sense to use bacterial preparations when the crop is sufficiently strongly wilted, the degree of wilting necessary depending on the type of crop.

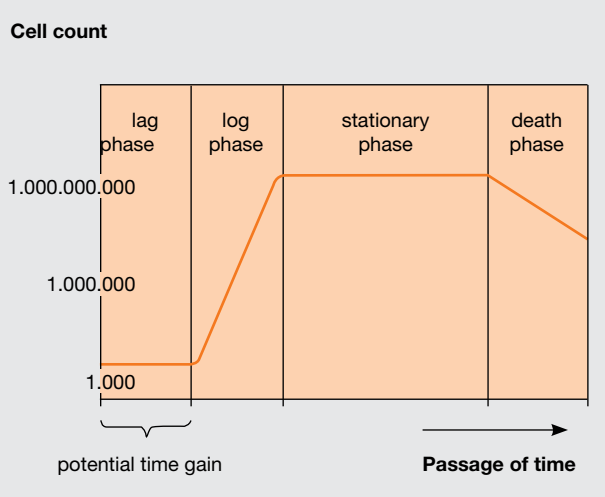
The main reason for improving the fermentation process by inoculating the crop with lactic acid bacteria is to reduce its pH value as quickly as possible. This accelerated reduction in the pH value can be achieved by adding large numbers of homofermentative lactic acid bacteria to the silage crop. Lactic acid bacteria with this type of metabolism are able to convert vegetable sugar into lactic acid with low levels of loss and bring about rapid acidification, as they form virtually no by-products apart from lactic acid.

To compensate for the lack of powerful lactic acid bacteria, the practice in the past has been to use freeze-dried bacterial preparations either in dried granular form or by dissolving a dry concentrate in water. However, in both forms of application the lactic acid bacteria take several hours to achieve their full metabolic activity in the silage and to start propagating.

To ensure that the lactic acid bacteria start producing lactic acid as soon as they are introduced into the silage and reduce the pH value as rapidly as possible, it is therefore beneficial to add them in the form of living cells, i.e. in metabolically active form.

Every lactic acid bacteria culture introduced into a new environment generally undergoes four phases of development, which are illustrated in the diagram opposite. In the lag phase the bacteria adapt to the ambient conditions before starting to multiply. This is also the time when which freeze-dried bacteria cultures need to become revitalised after the metabolically inactive stage.

The time the lactic acid bacteria added to the silage takes to become effective can therefore be significantly shortened, thus also increasing the inoculation effect, if a freshly prepared culture consisting of metabolically active cells that are ready to divide is used instead of a dried preparation. An active culture of this kind can be very easily prepared on the farm using suitable media.



Development phases of a bacteria culture

Product

KOFASIL® LIFE is a preparation for on-farm bacteria cultivation. **KOFASIL® LIFE** comes in canisters and aluminium refill pouches which contain both the lactic acid and propionic acid bacteria and a dry powder culture medium. The medium is activated by adding hand-hot water and leaving at room temperature for 48 hours, during which time the bacteria start to multiply extremely rapidly. The culture is ready to use when the colour of the culture liquid changes from violet to dark yellow in line with the change in the pH value.

The product **KOFASIL® LIFE** contains the two extremely robust and powerful strains of *Lactobacillus plantarum* (DSM 3676 and DSM 3677) that are also used in the bacterial preparation **KOFASIL® LIFE**, and which have proved their worth many times over in agricultural practice. These strains stand out not only for their strong acidification effect and high osmotolerance (ability to grow in highly wilted silage crops), but also because they complement each other's activities perfectly at different temperatures. They are therefore effective across a wide range of wilting levels and ambient temperatures that may occur in agricultural practice.

KOFASIL® LIFE also contains two strains of propionic acid bacteria (DSM 9676 and DSM 9677) which form metabolites that reduce any potentially detrimental effects homofermentative lactic acid bacteria may have on the storage life of the silage when exposed to air.

Use and dosage

KOFASIL® LIFE is ideal for silages made of

- grass crops consisting mainly of rye grass species with 25-40% DM
- all other field and meadow grass crops with 30-40% DM
- clover and clover grass crops with 30-40% DM
- whole cereal plants with 30-50% DM

When made up in accordance with the instructions for use, 1 litre of **KOFASIL® LIFE** cultivation solution is sufficient to treat 15 tonnes of forage crop. This guarantees an inoculation density of at least 400,000 bacteria per gram of silage crop.

The solution is diluted with water in accordance with the intended application rate immediately before use. It is applied using any generally available dosing equipment for liquid preparations. We recommend the dosing equipment supplied by SILA GmbH, Bitterfeld (marketed under the brand name SILASPRAY®). The homogeneous blending of bacteria with the silage crop that is necessary for optimum effectiveness is best achieved with an application rate of 1 - 2 litres of bacterial solution per tonne of silage crop.

Results of tests of different forms of application

To test what effect different forms of application of the *Lactobacillus plantarum* strains used in **KOFASIL® LIFE** have on the pH reduction rate and on enterobacteria levels in the early fermentation phase, a series of silaging tests was performed at FAL Braunschweig. Tables 3 and 4 show some examples of the results of a test with clover grass (42% DM).

The use of **KOFASIL® LIFE** inoculation strains as an active culture produced more rapid enrichment of lactic acid (Table 3) and therefore a more rapid reduction in the pH value (Table 4) than the other variants. The ideal low pH value of 4.5 (the green range in the table) was achieved after as little as 3 days with the active culture, only after 4 days with the bacterial concentrate applied in liquid form, and after as much as 5 days with the dry application.

Table 3:
Effect of the form of application of KOFASIL® LIFE inoculation strains on the formation of lactic acid

Fermentation time (days)	Lactic acid content (% DM)			
	without additive	Form of application		
		dry	liquid	active culture
1	0,3	0,3	0,3	0,6
2	0,5	0,8	1,8	3,1
3	0,7	2,4	3,7	4,3
4	1,1	3,3	4,8	5,7
5	1,2	5,3	5,3	6,2
7	1,7	7,2	7,1	7,5
14	1,9	7,5	7,1	7,3
28	2,5	7,7	7,3	7,6
56	3,8	8,2	7,3	7,9

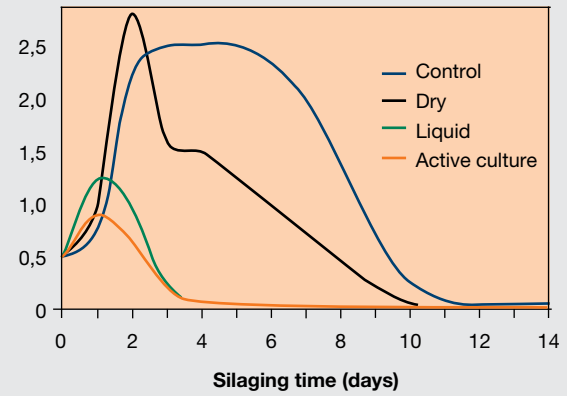
FAL Braunschweig

Table 4:
Effect of the form of application of KOFASIL® LIFE inoculation strains on the reduction of the pH value

Fermentation time (days)	pH value			
	without additive	Form of application		
		dry	liquid	active culture
1	6,4	6,3	6,4	6,3
2	6,4	6,1	5,4	4,9
3	6,2	5,1	4,7	4,5
4	6,2	4,7	4,5	4,3
5	6,1	4,5	4,4	4,3
7	5,9	4,4	4,3	4,3
14	5,7	4,3	4,3	4,2
28	5,2	4,3	4,3	4,2
56	4,9	4,2	4,2	4,2

FAL Braunschweig

Because of the more rapid acidification, the use of **KOFASIL® LIFE** inoculation strains results in a slower increase in the level of enterobacteria and earlier elimination of these negative elements from the silage. This is illustrated in the graph opposite (FAL Braunschweig). Therefore, the use of this active culture also has advantages over the other forms of application tested in terms of eliminating these undesirable harmful bacteria.



Results of fermentation quality tests

The tests to ascertain the benefits of the active culture form of application were followed by a phase of intensive laboratory scale studies at different research establishments which looked at the improvement in the fermentation process brought about by **KOFASIL® LIFE**.

The use of **KOFASIL® LIFE** has been shown to have a significant impact on fermentation quality even after the silage has been stored for a long period of time. As a result of the greater production of lactic acid, acetic acid and butyric acid levels were reduced compared with untreated silaging crops (Table 5).

Suppression of harmful bacterial organisms also clearly reduces protein and amino acid breakdown, as shown by the significantly lower ammonia fraction in the total nitrogen. It was also shown that the individual amino acids in the silage prepared with the active culture were subject to breakdown to a much smaller extent.

Dry matter losses during silaging were also reduced with the targeted control of the fermentation process brought about by the use of **KOFASIL® LIFE** (Table 6).

Table 5:
Effect of KOFASIL® LIFE on fermentation quality

Parameters	Clover (24% DM)		Clover grass (33% DM)	
	without additive	**KOFASIL® LIFE**	without additive	**KOFASIL® LIFE**
pH value	5,2	4,7	4,6	4,0
Fermentation products (% DM)				
Lactic acid	5,8	8,6	4,2	7,2
Acetic acid	3,5	2,2	2,9	1,3
Butyric acid	1,3	0,3	7,3	0,3
NH_3-N (% total N)	13,3	9,2	10,6	3,6

Nitra Research Institute for Animal Production, Slovak Republic

Table 6:
Effect of KOFASIL® LIFE on fermentation losses during silaging

Trial	Dry matter losses (%)	
	without additive	**KOFASIL® LIFE**
Clover, 24% DM [1)]	10,2	2,4
Grass, 45% DM [2)]	4,6	4,1
Grass, 42% DM [2)]	4,4	4,1
Grass, 44% DM [2)]	5,0	4,4

[1)] Nitra Research Institute for Animal Production, Slovak Republic
[2)] FAL Braunschweig

Results of feed intake and animal performance tests

In a silaging trial after which the silage was fed to growing cattle, the addition of **KOFASIL® LIFE** to grass resulted in an improvement in the fermentation quality even under control practical conditions. As a result, the energy content and silage consumption levels increased significantly (Table 7).

Table 7:
Effect of KOFASIL® LIFE on fermentation quality, energy concentration and feed intake in cattle

Parameters	Variant	
	without additive	**KOFASIL® LIFE**
DM (%)	44,1	46,7
pH value	5,1	4,8
NH_3-N (% total N)	6,7	5,5
Fermentation products (% DM)		
Lactic acid	3,0	4,0
Acetic acid	1,3	1,1
Butyric acid	0,0	0,0
Convertible energy (MJ NEL/kg DM)	10,2	10,5
Silage consumption (kg DM/animal and day)	6,66	7,12

Swedish Agricultural University, Uppsala

KOFASIL® LIFE

In other studies too, treating forage crops with **KOFASIL® LIFE** also brought about an increase in digestibility, energy content and silage consumption, indicating that adding such additives to the basic feed is likely to result in better animal performance.

Various tests on male and female cattle in different growth stages substantiate this decisively.
In the studies shown in Table 8, the addition of **KOFASIL® LIFE** brought about an average daily increase in live mass of 14.8%.

Table 8:
Effect of KOFASIL® LIFE on live mass increase in growing cattle

Trial	Live mass increase (kg/animal and day)		
	without additive	**KOFASIL® LIFE**	Effect of silage additive
Grass[1)]	840	972	+ 15,7 %
Grass[2)]	445	524	+ 17,8 %
Clover grass[2)]	1308	1450	+ 10,9 %

[1)] Technische Universität Munich; [2)] Swedish Agricultural University, Uppsala

DLG seal of approval

The bacterial strains used in **KOFASIL® LIFE** are selected from nature and have not been genetically modified. The quality of the components of the dry culture medium corresponds to that of food raw materials.

Following effectiveness trials by independent institutions, the Deutsche Landwirtschaftsgesellschaft has awarded **KOFASIL® LIFE** the DLG seal of approval

- **for improving the fermentation process**
  - Mode of action 1b (moderately hard and easy to ferment feed in the lower DM range)
  - Mode of action 1c (moderately hard and easy to ferment feed in the upper DM range)
  - Wirkungsrichtung 1c (mittelschwer und leicht vergärbares Futter im oberen TM-Bereich)
- **for improving nutritional value and performance**
  - Mode of action 4a (improvement of feed intake)
  - Mode of action 4b (improvement of digestibility)
  - Mode of action 4c fattening (improvement of animal performance).

KOFASIL® LIFE is therefore a highly effective, comprehensively tested bacterial preparation for improving the fermentation quality of silage made from grass, leguminous plants and whole cereal plants.

The particular benefit of **KOFASIL® LIFE** compared with lactic acid bacteria applied in other forms is that they are mixed in with the silage crop as metabolically active living cells that are ready to divide.

For the user, **KOFASIL® LIFE** also has the benefit that, unlike with other bacterial preparations, it is possible to observe the colour change of the culture liquid and be certain that the culture is actually active.

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