ADDCON

Silaging

KOFASIL® LIQUID




Silaging additive to ensure the fermentation quality of silage from grass, leguminous plants and whole cereal plants

Problem

Reliably generating high-quality silage from protein-rich forage crops is decisive for cattle farmers' competitiveness. In spite of major advances in silage technology, the silage quality is often unsatisfactory. Approximately one third of all grass silage still suffers from butyric fermentation which decreases the nutritional value of the silage, the feed intake by the animals and, as a result, the efficiency of the basic feed. As a rule, such silage has a high butyric acid content. The butyric acid is produced by butyric acid bacteria (clostridia) which multiply in the silage and form spores. A large clostridia spore count in the silage negatively affects milk quality. In addition, just like other harmful bacteria (enterobacteria, Listeria), clostridia poses a danger for the animals' health.

Since wilting the forage crop reduces the risk of butyric fermentation and the release of environmentally harmful silage effluent, this should be done wherever possible. The richer in protein the forage crop, the longer it should wilt. However, practice has shown that wilting in itself is not enough. The forage crop does not wilt fast enough in all kinds of weather, but lengthening the wilting time will often do more harm than good. A harvested crop should not be left out in the field for more than one night (table 1).

Table 1:
Field losses when preparing wilted silage from grass

Harvest conditions	Bringing in after…nights	Field losses from harvesting to the silo	
		Dry matter loss (%)	Nutritional value decrease (NEL MJ kg/DM)
very good	0	2	0.05
good	1	4	0.1
mediocre	2	8	0.3
poor	3 - 5	12	0.5

Valuable nutrients are lost when the crop is left out in the field too long. The nutritional value of the harvested feed is affected, its sugar content decreases and harmful microbes will already have multiplied before the feed has entered the silo. And in addition, a longer wilting time will often also increase the risk of the material to be silaged becoming polluted.

If the crop is only slightly polluted with earth during harvesting, this may already result in high clostridia spore counts in the silage material. And even if this crop has wilted sufficiently and no butyric fermentation can be demonstrated, the resulting silage fodder will not enable high-quality milk to be produced and might cause cows to fall ill.

Concept

To help solve these problems, the concept of light wilting for a short period combined with an additive developed specifically for this purpose was born. This has resulted in the strategy of no longer limiting the use of silage additives to problem situations, but to use them as a standard element in the preservation procedure.

The main objective of this strategy is to ensure optimum silage quality. The following requirements have to be set on a suitable silage additive, i.e. a real „safety additive“:

- The working method of the additive must be compatible with the wilting method. Both measures must work in synergy and complement each other.
- The additive must not only prevent butyric fermentation and the propagation of clostridia in the silo, but it must also neutralise the clostridia spores which already exist in the silage.
- A perfectly even distribution of the additive is a precondition for ensuring its effect. In principle, this requirement can only be fulfilled by a liquid preparation.

The best perspectives for the success of such a strategy are offered by the principle of controlled fermentation, i.e. neither chemical preservation (for example with formic acid) nor relying only on spontaneously occurring, accidental biological processes. The natural fermentation process is still at the heart of the strategy, but is now controlled by carefully selected, sparsely dosed and harmless active ingredients. The lactic acid bacteria which are always present in forage crops are stimulated by administering active ingredients to suppress their competitors. This is mainly applied in situations where nature does not provide sufficient guarantees for the result being pursued.

Product

This objective can be achieved with a highly effective combination of active ingredients, found after years of research, resulting in the development of an optimised liquid preparation, called **KOFASIL® LIQUID**

KOFASIL® LIQUID is a silage additive containing

- sodium nitrite and
- hexamethylentetramine.

Dosage

KOFASIL® LIQUID is used for silaging:

- meadow and mowing field grass,
- forage grasses,
- green rye and green oats,
- whole cereal plants
- clover/grass and alfalfa/grass mixtures,
- pure red clover and alfalfa crops.

The dosing amount is

2 to 3 litres of KOFASIL® LIQUID per ton of lightly wilted forage crop. In a normal situation (where insufficient wilting or a slight contamination with earth cannot be ruled out) 3 litres per ton should be dosed to ensure an optimum effect. If the crop has wilted more and is clean, 2 litres of **KOFASIL® LIQUID** per ton will be sufficient. Contrary to formic acid and other acid-based additives, **KOFASIL® LIQUID** is neither caustic nor corrosive, giving it excellent handling qualities. It is applied using common dosing equipment for liquid preparations. We recommend the dosing equipment supplied by SILA GmbH/Bitterfeld (marketed under the brand name: SILASPRAY®).

Testing

KOFASIL® LIQUID was tested in extensive laboratory, pilot and practical trials. Nowadays it is one of the most carefully tested silage additives. It has been proven to have a convincingly good effect and to work at least as well as formic acid and much better than any currently available organic preparation. Insufficient wilting and poor starting conditions for the fermentation process which may be due to the silage crop being polluted during harvesting are reliably compensated by adding **KOFASIL® LIQUID** (table 2).

Table 2:
Effect of KOFASIL® LIQUID (3 l/t) when silaging grass

Attempt (dry matter, g/kg)	Treatment	pH-value	Acid content (% FM)			Fermentation loss (% DM)	Fermentation quality
			lactic-acid	acetic-säure	butyric-acid		
A (160)	without additive	5.1	0	0.8	**1.8**	12.7	very poor
	KOFASIL® LIQUID	4.3	**1.8**	0.6	0	3.6	**very good**
B (190)	without additive	5.3	0	0.8	**2.0**	11.4	very poor
	KOFASIL® LIQUID	4.5	**1.1**	1.5	0	5.5	**good**
C (260) pollution-degree	without additive	5.5	0	0.8	**2.3**	14.3	very poor
	KOFASIL® LIQUID	4.3	**2.2**	0.4	0	5.2	**very good**
D (420) pollution-degree	without additive	5.3	0	1.7	**2.1**	11.3	very poor
	KOFASIL® LIQUID	4.2	**3.3**	0.7	0	3.0	**very good**

Oskar-Kellner-Institut für Tierernährung, Rostock

The results in table 3 show that a combination of wilting and adding KOFASIL® LIQUID makes it easily possible to generate good silages, even from hard to ferment forage crops like alfalfa.

Table 3:
Effect of KOFASIL® LIQUID (3 l/t) when silaging alfalfa

Attempt (dry matter, g/kg)	Treatment	pH-value	Acid content (% FM)			Fermentation loss (% DM)	Fermentation quality
			lactic-acid	acetic-acid	butyric-acid		
A (160)	without additive	5.7	0	1.3	**2.8**	12.0	very poor
	KOFASIL® LIQUID	4.2	**2.9**	0.7	0	3.5	**very good**
B (190)	without additive	5.3	0	1.8	**2.6**	12.3	very poor
	KOFASIL® LIQUID	4.3	**3.3**	0.9	0	3.3	**very good**
C (260) pollution-degree	without additive	5.6	0	1.8	**2.7**	11.6	very poor
	KOFASIL® LIQUID	4.7	**2.8**	1.4	0	4.3	**good**

Oskar-Kellner-Institut für Tierernährung, Rostock

The effect of **KOFASIL® LIQUID** equals the dry matter (DM) content being increased by wilting by at least 100 g/kg. If this silage additive is added to a hard to ferment forage crop which would require a dry matter content of at least 400 g/kg for silaging without the risk of butyric fermentation, the crop can already be silaged without any risks from a dry matter content of 300 g/kg. Forage crops which are moderately difficult to ferment require only light wilting plus an additive. Easy to silage forage crops, such as the first yield of grass crops with a high share of ryegrasses, can be silaged immediately, without wilting if necessary, provided that **KOFASIL® LIQUID** is added.

The dry matter content of the wilted silage crop put into a silo always varies. The more the crop has wilted, the greater the variations will be. Even if wilting generally appears to have been sufficient, some batches of feed which are too wet will often end up in the silo. Unfortunately, butyric fermentation always spreads from such wet feed fractions in the silo.
The combination of wilting and adding **KOFASIL® LIQUID** can reliably eliminate this problem.

A further risk to a good fermentation process results from the fact that, due to a more economical use of N fertilizer than in the past, grass from extensive cultivation often hardly contains any nitrate. However, a certain minimum nitrate content has always been a precondition for producing wilted silage without additives. A very comprehensive series of trials shows that the lack of nitrate can now be compensated very effectively by adding **KOFASIL® LIQUID** (table 4).

Table 4:
Effect of silage additives on the butyric acid content in silage of low-nitrate forage crops (average values)

Fermentation coefficient of the silage crop (fc)	butyric acid content (% DM)		
	without additive	bacterial preparation	**KOFASIL® LIQUID**
low (fc < 35)	2.0	1.3	0.1
medium (fc 35 - 45)	2.2	1.4	0.1
high (fc > 45)	1.5	0.9	0.2

Humboldt University Berlin

Application strategy

This concept, using these silage additives, enables grass silage to be prepared virtually independently of the weather and much more reliably than before.

The basic principles are:

- harvesting in time, at the optimum cutting time, virtually independent of the weather conditions,
- using all technical possibilities for quick wilting, but limiting the wilting time to 1 or 2 days at the most,
- silaging the feed after this time while continuing to add **KOFASIL® LIQUID** in doses that match the degree of wilting achieved.

The objective of harvest management when preparing the wilted silage must be to keep the dry matter of the silage crop within an optimum range by adjusting both the way work is organised and the use of machines to suit the current weather conditions. The bottom limit of this optimum range is determined by the need to prevent butyric acid fermentation (minimum dry matter content = DM_{min}). To minimize crumbling losses in the field (alfalfa and clover) and to compact the feed stack in the silo properly, the upper limit of this range must not exceed the limit of 450 g of DM/kg (maximum DM content = DM_{max}).
Table 5 shows the variation bandwidth of the DM content of the silage crop when preparing the wilted silage in the horizontal silo in order to prevent butyric fermentation and compaction problems.

Table 5:
Target DM variation bandwidth when preparing wilted silage (in g/kg)

Type of feed crop	DMmin … DMmax	Bandwidth of optimum range
Crops where ryegrass is predominant		
without silage additive	300 … 450	150
with **KOFASIL® LIQUID**	**200 … 450**	**250**
other grass crops and red clover		
without silage additive	350 … 450	100
with **KOFASIL® LIQUID**	**250 … 450**	**200**
Luzerne		
without silage additive	400 … 450	50
with **KOFASIL® LIQUID**	**300 … 450**	**150**

It is a well known fact that the less sugar and the more protein the forage crop contains, the more wilting is necessary to prevent butyric fermentation. A distinction can be made here between three categories of feed types, based on their ability to ferment. As shown, the minimum DM content is always 100 g/kg less when using **KOFASIL® LIQUID**.

This allows silaging to be started much sooner after harvesting than if no silage additive were used. And if sufficient wilting is made impossible by a change of weather, this can also be compensated for much more easily by using the silage additive.

Field experience

The advantage of this application strategy has been demonstrated in numerous production experiments and has proven its worth in agricultural practice. Tables 6 and 7 list the results of a large-scale trial with a relatively low-sugar grass, which had to be harvested under unfavourable weather conditions to comply with the optimum cutting time. Wilting was stopped two days after mowing, and the grass with an average DM content of 250 g/kg was silaged, with **KOFASIL® LIQUID** being added. To enable a comparison to be made, some grass was also silaged without adding the silaging additive.

The silage prepared without **KOFASIL® LIQUID** proved not to be stable, was subject to butyric fermentation and was completely spoilt after prolonged storage in the silo. Butyric fermentation caused valuable nutrients to be lost, causing the concentration of energy to fall by over 0.4 MJ NEL/kg DM. The use of **KOFASIL® LIQUID** reliably impeded this spoilage process and, in spite of the crop being silaged in adverse weather conditions, stable silage of a good fermentation quality and with a significantly lower loss of energy was achieved (table 6).

Table 6:
Effect of KOFASIL® LIQUID on the fermentation quality and energy concentration of grass silage

Parameter	Storage duration (months)					
	3	6	9 - 12	3	6	9 - 12
	without additive			**KOFASIL® LIQUID** (3 l / t)		
DM g / kg	243.0	237.0	234.0	250.0	248.0	255.0
pH	4.5	4.7	4.8	4.3	4.4	4.2
NH3-N (% total N)	13.6	17.1	21.5	12.7	13.3	14.5
fermentation acids (% DM)						
lactic acid	10.0	8.8	7.0	11.7	11.5	11.2
acetic acid	3.6	3.7	4.4	2.7	3.2	3.1
butyric acid	0.5	2.0	2.8	0.1	0.1	0.3
Fermentation quality (according to DLG)						
Points	69	34	21	88	84	84
Mark	III	IV	V	II	II	II
Energy (MJ NEL/kg DM)	6.21	6.16	6.14	6.41	6.38	6.33

Silage crop: DM = 252 g/kg, energy content = 6.57 MJ NEL/kg DM; FAL Braunschweig

Bei der Verfütterung der beiden Silagen an Milchkühe als jeweils alleiniges Grundfutter ergab sich, dass die Tiere von der mit **KOFASIL® LIQUID** hergestellten Silage 1,3 kg TM je Tag mehr verzehrten. Aus der Verbesserung der Futteraufnahme und der Energiekonzentration errechnet sich für die mit dem Siliermittel behandelte Silage, ein um rund 3 kg Milch je Tag erhöhtes Milchproduktionspotenzial (Tabelle 7).

Table 7:
Effect of KOFASIL® LIQUID on the feed intake and milk production potential of grass silage

Parameters	varieties		
	without additive	**KOFASIL® LIQUID** (3 l / t)	effect of silage additive
DM intake from silage (kg DM/day)	10.7	12.0	**+ 1.3**
energy content (MJ NEL/kg DM)	6.14	6.33	**+ 0.19**
energy intake from silage (MJ NEL/day)	65.7	76.0	**+ 10.3**
Milk production potential (kg FCM/day)	8.5	11.6	**+ 3.1**

FAL Braunschweig

The higher output potential of grass silages produced by adding **KOFASIL® LIQUID** was also confirmed by extensive feeding trials carried out with young bulls at the Oskar-Kellner-Institut für Tierernährung (institution for animal nutrition) in Rostock, Germany. The animals‘ energy intake was increased by an average of 7.4 % in all these trials after treating the silage with this silage additive.

Feed hygiene

Not only is the higher energy and nutrient content of silage from forage crops rich in protein becoming increasingly important, but its hygienic quality as well. Silage with a high content of harmful bacteria can cause livestock to become ill.
High-yield dairy cows are more sensitive to this than cows with a lower milk output. In addition, the harmful bacteria from poor silage can end up in the milk and, as a result, in the human food chain. They may cause production failures in milk processing operations and are a potential hygiene hazard for users.

KOFASIL® LIQUID is one of the few silage additives which enables such risks to be eliminated in a targeted manner. It prevents butyric acid fermentation and the associated increase of the clostridia spore count in the silage. And it eliminates any clostridia spores already present in the harvested crop, due, for example, to pollution with earth. The trial results presented in tables 8 and 9 testify to this.

Table 8:
The effect of KOFASIL® LIQUID on the clostridia spore count in grass silage

	clostridia spores (MPN/g FM)
Grass (base material)	2,200
Grass silage	
without additive	2.400,000
KOFASIL® LIQUID	430

Oskar-Kellner-Institut für Tierernährung, Rostock

The positive effect of the silage additive on the hygienic status of the silage was also demonstrated by a significantly reduced clostridia spore count in the faeces of cattle which had been fed this silage (table 9).

Table 9:
Clostridia spore count in wilted silage of polluted grass and in cattle faeces after feeding on the silage

Variety	Clostridia spores (MPN/g)	
	silage (n = 8)	faeces (n = 24)
without additive		
average value	18,700	47,600
variation bandwidth	40 … 90,000	1,600 … 370,000
KOFASIL® LIQUID		
average value	< 10	< 40
variation bandwidth	< 1 … 15	< 1 … 300

Oskar-Kellner-Institut für Tierernährung, Rostock

Research in several countries, including the UK, has demonstrated that adding **KOFASIL® LIQUID** also enables pathogenic Listeria bacteria, occurring in silage polluted with earth, to be reliably eliminated (table 10).

Table 10:
Listeria count in grass silage contaminated with earth with different degrees of contamination

Variety	Listeria (KBE/g silage) silage of	
	clean grass	contaminated grass
without additive	122	230,000
KOFASIL® LIQUID	6	9

Greenmount College, Northern Ireland

DLG approval seal

KOFASIL® LIQUID is a patented product (DD 289 408) which is used successfully in numerous European countries and in some countries outside Europe. Repeated testing of the harmlessness of its constituents and the reliability of the action of the silage additive was a precondition for obtaining approval to be able to market the product in the various countries.

Extensive studies produced proof that the active chemicals in **KOFASIL® LIQUID** decompose very quickly during fermentation in the silo without posing any risk to animal health. A waiting time of 4 weeks has to be observed before feeding the silage to animals. The silage effluent can be removed like slurry from the first day of being generated. Any danger to users from the two active chemicals or their possible decomposition products has been ruled out to a high degree of certainty.

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

- **for improving the fermentation process**
  Mode of action 1a
  (hard to ferment forage crops)
  Mode of action 1b
  (easy to moderately difficult to ferment ‘feed in the lower DM range)

- **for improving nutritional value and performance**
  Mode of action 4a
  (improving nutrient intake)

- **for additional effects**
  Mode of action 5a
  (preventing the propagation of clostridia)

This provides all the relevant proof of the product’s quality that really matters. Other seals of approval, such as for modes of action 4b and 4c, have not been applied for. They concern silage qualities inherent to the use of a silage additive to produce this effect, given the drastic improvement of the fermentation process. As regards reducing the clostridia spore count in silage, **KOFASIL® LIQUID** is one of very few silage additives which have this important effect on improving feed hygiene.

KOFASIL® LIQUID




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