Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

Producing Quality Silage for Maximum Energy Utilization

Vesna Jenkins, PhD

Naturally ahead

Biomin

Outlines

- Principles of ensiling process
- Clostridia Challenge
- Aerobic stability
- Role of Silage inoculants
- BIOMIN solutions

Naturally ahead

Biomin

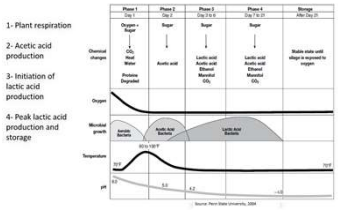
What does excellent silage quality mean?

- Maintain good animal health
- Sustain milk production
- Ensure good fertility

High Energy	⇒	Less energy to purchase
High Protein	⇒	Less protein to purchase
Good Palatability	⇒	Good feed intake
Hygienic	⇒	Less pathogen/mycotoxin risk

Two key factors for excellent silage quality

From the Start → Achieve rapid acidification



At Feed Out → Achieve aerobic stability

Fermentation Phases

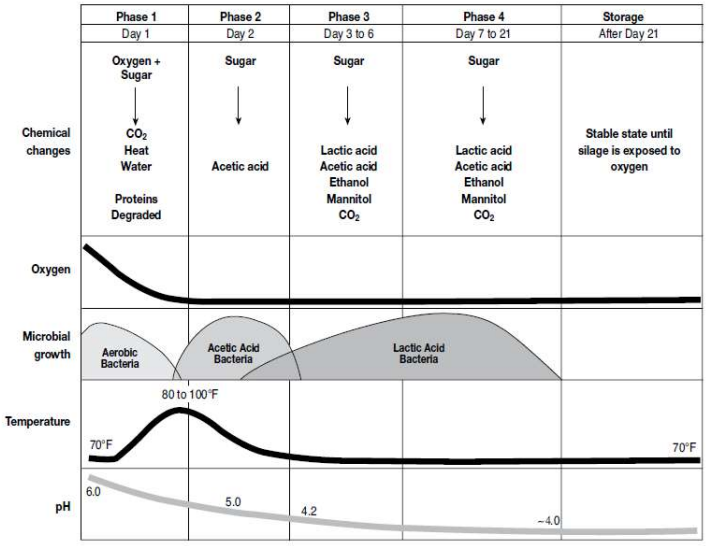
1- Plant respiration

2- Acetic acid production

3- Initiation of lactic acid production

4- Peak lactic acid production

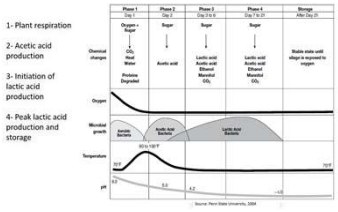
Storage



Biomin

Two key factors for excellent silage quality?

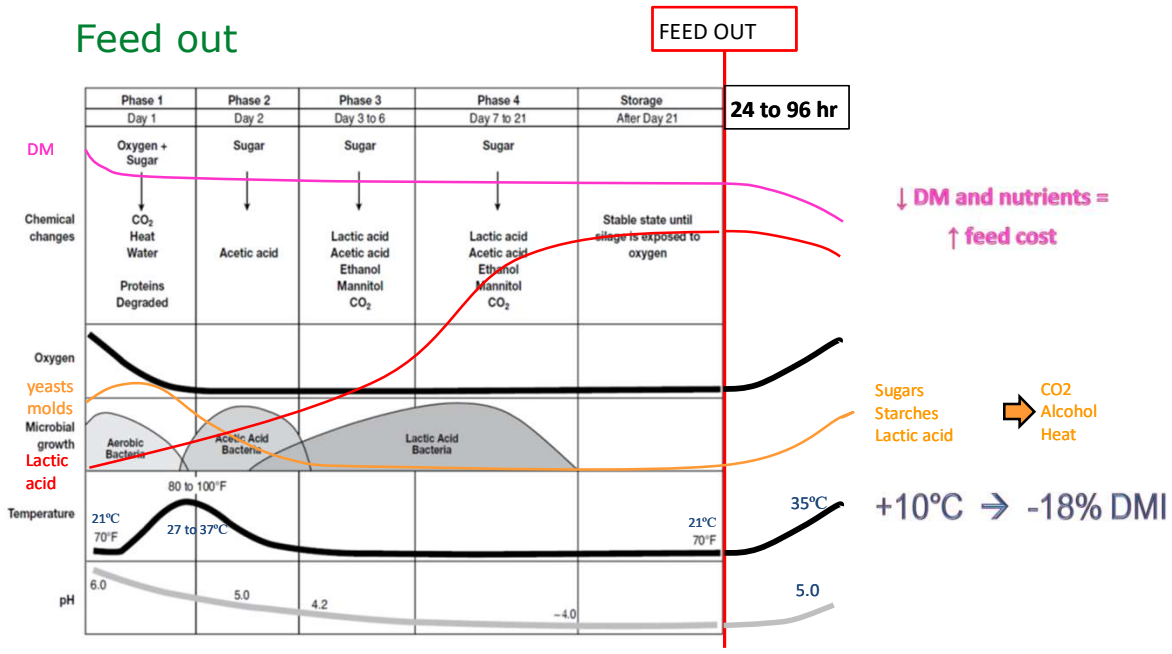
Storage → Achieve rapid acidification



At Feed Out → Achieve aerobic stability

Biomin

Feed out



Good silage managament from harvest to feed out

- Optimal maturity at harvest
  (high nutrients, good compaction, low fungal infestation)
- Optimal DM content at ensiling
  (according to used technology)
- Chopping & kernel cracker

Compaction!!!

- Proper sealing
  →Plastic on walls, top
  →Prevent bird/rodent damage
  →Regularly check for holes
- Weight used to compress the plastic down
- Appropriate removal rate

- **Use an Inoculant**

Competition for Fermentation Substrate

- Good microbes
  Lactic acid bacteria

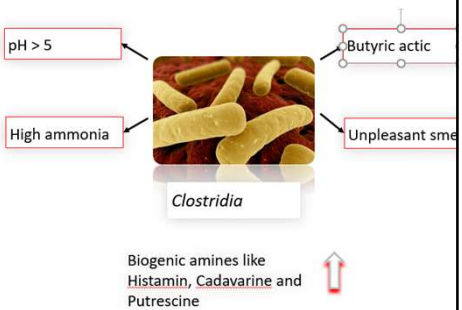
homofermentative heterofermentative

- Bad microbes

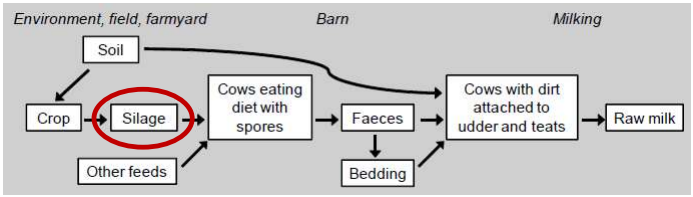
- Yeast
- Mold
- Clostridia
- Enterobacteria

Silage making and Clostridia challenge

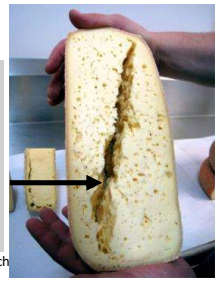
- A key challenge to silage quality is Clostridia bacteria, which can negatively impact animal health, performance and profitability
- Grass and legume silages with < 30-35% DM or sub-optimal management of either harvest or ensiling increases the Clostridia risk
- Clostridia bacteria consume carbohydrates, proteins and lactic acid as their energy source and produce butyric acid and toxins



Clostridia in milk?



Frank Driehuis, NIZO food research



Consequences when clostridial silage is feed to animals:

- Low DMI and loss of milk production in dairy cows and potential milk taint
- Late blowing defect in cheese
- Increased risk of ketosis or other metabolic disorders in dairy cows

Naturally ahead

Biomin

Clostridia challenge in silage

How to recognize clostridial fermentation in silage:

- high concentration of butyric acid
- poor nutritive value
- high concentration of ammonia (NH_3)
- high level of biogenic amines
- slimy, olive green appearance
- stinky, unpalatable silage

Naturally ahead

Biomin

Silage Management and Clostridia




Silage Management Steps to prevent Clostridia proliferation in silage:

- Harvest at optimum DM level (30-35%)
- Minimize contamination of forage from soil and manure at harvest
- Fast silo filling
- Proper packing density (> 240kg DM/m^3)
- High quality plastic cover to seal bunker preventing moisture seepage and oxygen ingress
- Use research-proven silage inoculant

Factors Contributing to Aerobic Instability

- Initial yeast and bacterial population
- Packing density
- Face management
- Feed-out rate
- No silage additives application


❖ "*Aerobic deterioration of silage during feed-out phase is a **significant problem for farm profitability and feed quality worldwide***" (Borreani and Tabacco, 2010)

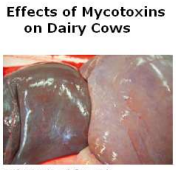
Risks of Aerobically Unstable Silage

When oxygen is introduced to silage:

- ❖ yeast and mould begin to grow
- ❖ They consume sugar and ferment acid
- ❖ This raises the temperature and pH
- ❖ Leading to…
- lower nutritive value
- reduced palatability
- risk of negative effects on animal performance and health
- increased mycotoxin risk

Photo 17a. Mastitis (trichothecenes)

17b. Lameness (trichothecenes, ergot alkaloids)

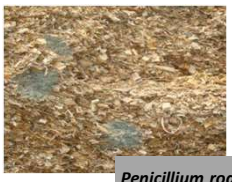


Effects of Mycotoxins on Dairy Cows

17d. Fatty liver (aflatoxins)

17e. Acidosis (trichothecenes)

Monascus ruber
e.g. citrinin

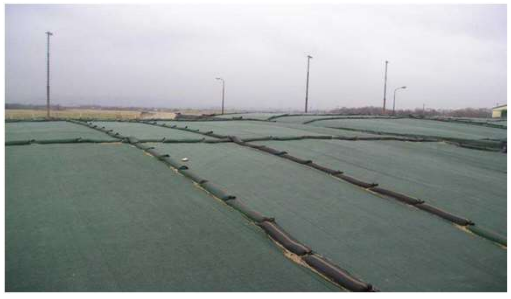


Penicillium roqueforti
e.g. Roquefortine C

How to prevent aerobic spoilage?

At Harvest

- Harvest at Optimal DM content at ensiling (between 30 to 35%)
- Harvest when fungal infestation is still low
- Chop length: <20 mm & use of corn cracker



In Silo

- Sufficient compaction!!!
- Airtight sealing with plastic
- Weight to compress the plastic down
- Regularly check for holes

and… Use a Proven Silage Inoculant

Types of silage additives

- Fermentation inhibitors (organic acids and their salts)
- Fermentation stimulants (bacteria inoculants)

Pick your feed additives

If you had to choose one or two feed additives, which would you consider to be the most important?

CALIFORNIA D. S.

I am going to list five, in my order of importance: monensin, silage inoculants, organic trace minerals, yeast product, and rumen buffer. Essential oils may be considered to replace monensin, since monensin is not legal in some countries. Two other additives to consider include biotin and mycotoxin binders.

— MICHAEL F. HUTJENS
University of Illinois

Fermentation inhibitors

Combination of organic acids: benzoic, sorbic, acetic, citric, **propionic**

- 1-2 Kg per ton of fresh forage
- Improve bunk life by limiting mold and yeast growth

- Corrosive
- Expensive
- Difficult to handle

Fermentation stimulants
Silage inoculants for high quality silage

Proven through science and in the field conditions

✓ effective additives to drive good fermentation

➡ Protect nutrients

✓ prolong the bunker shelf life

➡ Reduce pathogens

✓ higher hygiene and palatability of silage

➡ Increase animal performants and farm profitability

Silage inoculants: homofermentative vs heterofermentative

How they ferment sugars like glucose and fructose?

Homofermentative ⇨ Glucose: 2 Lactic acid + 2 H2O
Fructose: 2 Lactic acid + 2 H2O

Heterofermentative ⇨ Glucose: 1Lactic acid + 1 Ethanol + 1CO2 + 1 H2O
3 Fructose: 1 Lactic acid + 1 Acetic acid + 2 Mannitol + 1 CO2 + 1 H2O

1 Lactic acid → 0.48 acetic acid
1 Lactic acid → 0.48-propanediole + CO_2

EFSA opinion, Biomin® BioStabil strains registration in EU

L. plantarum (DSM 19457)

http://www.efsa.europa.eu/en/efsajournal/doc/2732.pdf

Overall, the data suggest that *L. plantarum* DSM 19457 has the ability to encourage lactic acid production in material that is easy and moderately difficult to ensile, which can reduce pH, particularly during the early stages of fermentation, and can lead to a reduction in dry matter loss."

L. brevis (DSM 23231)

http://www.efsa.europa.eu/en/efsajournal/doc/3530.pdf

"*Lactobacillus brevis* DSM 23231 has some potential to improve the production of silage from moderately difficult and difficult to ensile materials and to reduce the numbers of clostridia …"

L. kefiri (DSM 19455)

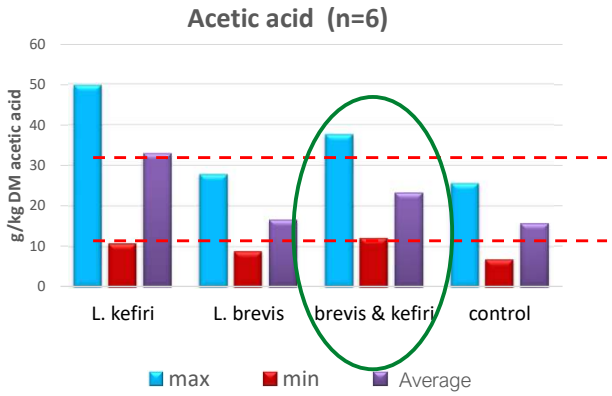
http://www.efsa.europa.eu/en/efsajournal/doc/3177.pdf

"The results of three efficacy studies indicated that *L. kefiri* DSM 19455 has the potential to improve the aerobic stability of silage …"

Mode of Action

- rapid drop of pH/acidification from lactic acid
- increased aerobic stability from acetic acid (heterofermentative bacteria)
- minimized loss of dry matter from immediate acidification
- preserved energy and protein through favorable fermentation and suppression of protein degrading bacteria
- suppression of undesirable microbials like *Clostridia* from acidification and competition

Two heterofermentative strains for: optimal aerobic stability and palatability



Acetic acid: 15-35 g/kg DM optimum level (Kung and Shaver, 2001)

(>35 g/kg DM lower palatability)

Biomin® BioStabil Plus HC scientific trial on grass-clover forage 28%DM Swedish University of Agricultural Sciences (SLU)

- **Objective:**

Efficacy of Biomin® BioStabil Plus HC silage inoculant on grass-clover forage (28% DM)

The experiment was carried out with the aim to meet the German DLG guidelines for certification of silage additives (*DLG 2017*).

- **Methods:**

✓ 1st cut of grass-clover forage was harvested beginning of Jun, classified as difficult to ensile forage (fermentation coefficient 28.7)

✓ Treated forage was inoculated with BioStabil Plus HC at 200 000 cfu/g FM, inoculant suspension was applied at a rate of 5 mL per kg of fresh forage

✓ Sampling time after 14; 21; 42 and 90 days for the fermentation quality parameters and aerobic stability

- Sub-trial where both treatments (Control and BioStabil Plus HC silage) were inoculated with 10^4 Clostridia spores/g FM (*Cl. tyrobutyricum* #SMR213), the fermentation quality parameters measured after 90 days

Biomin® BioStabil Plus HC scientific trial on grass-clover forage 28%DM Swedish University of Agricultural Sciences (SLU)

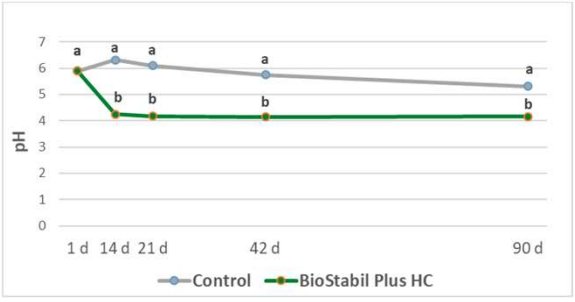


Figure 1. pH at different openings in untreated and treated with Biomin® BioStabil Plus HC grass-clover silage (at all openings P<0.001)

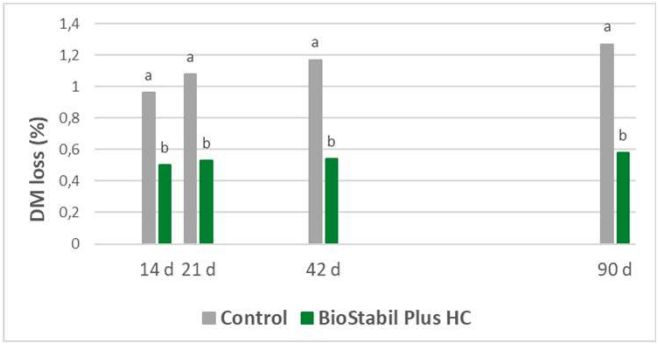


Figure 2. Dry matter loss in untreated and treated with Biomin® BioStabil Plus HC grass-clover silage (at all openings, P<0.001)

BioStabil Plus HC improves fermentation quality of silage

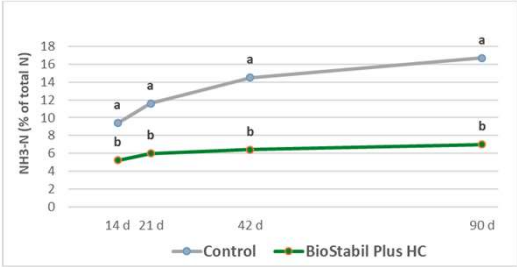


Figure 3. Ammonia-N in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (P<0.05 day 14; P<0.001 all other openings)

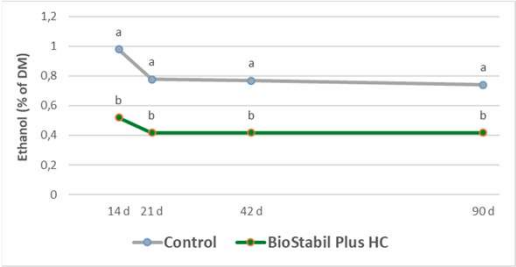


Figure 4. Ethanol level in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (at all openings, P<0.001).

BioStabil Plus HC improves fermentation quality of silage

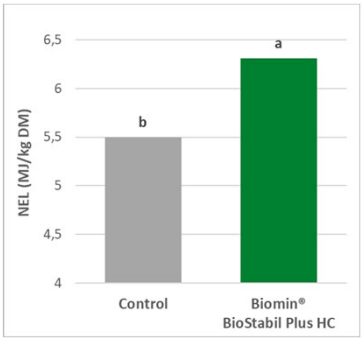


Figure 8. NEL (MJ/kg DM) in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (90 days after ensiling, P<0.001).

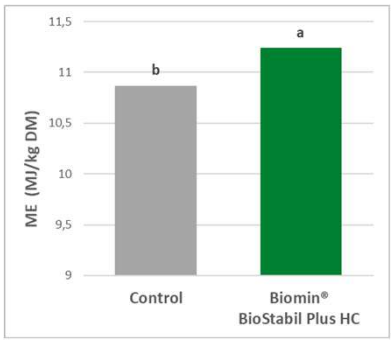


Figure 9. ME (MJ/kg DM) in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (90 days after ensiling, P<0.05).

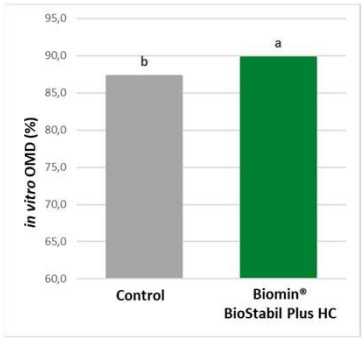
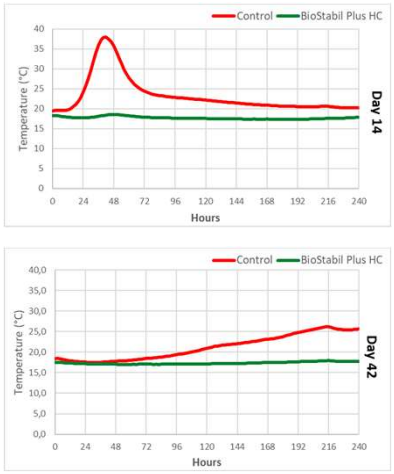
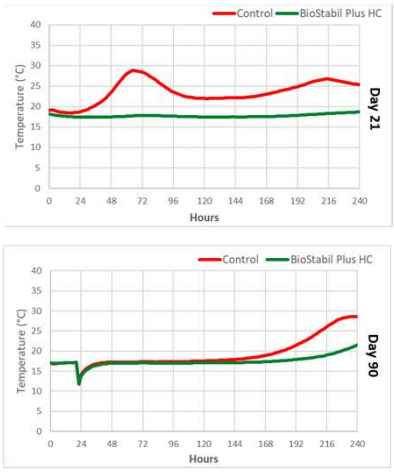


Figure 10. *in vitro* OMD in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (90 days after ensiling, P<0.05).

Biomin®BioStabil Plus HC
Proven Aerobic Stability in grass-clover silage

Temperature changes over time





- Untreated Control
- Low Acetic Acid
- Yeast fermentation
- Elevated temperature
- Decline in nutritive value and palatability

Naturally ahead

Biomin

Biomin® BioStabil Plus scientific trial with Clostridia challenge
Swedish University of Agricultural Sciences

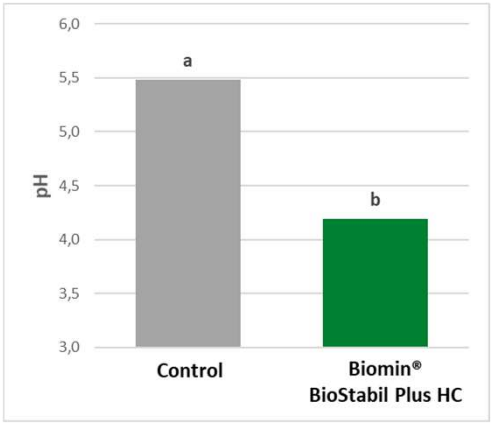


Figure 1. Significantly lower pH in grass-clover silage treated with Biomin® BioStabil Plus (*P<0.001*)

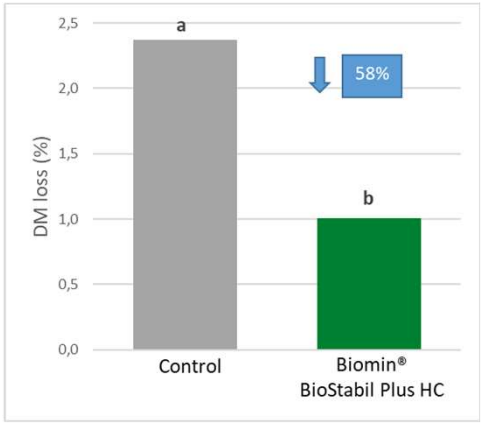


Figure 2. Significantly lower dry matter loss in grass-clover silage treated with Biomin® BioStabil Plus (*P<0.001*)

Naturally ahead

Biomin

Biomin® BioStabil Plus scientific trial with Clostridia challenge

Swedish University of Agricultural Sciences

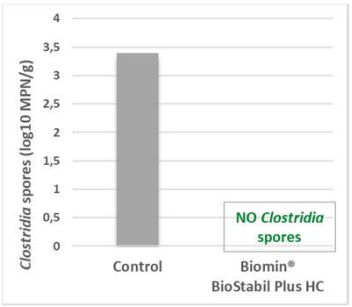


Figure 3. Effect of Biomin® BioStabil Plus HC compared to untreated Control on presence of viable *Clostridia* spores

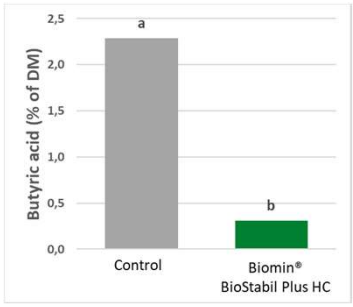


Figure 4. Significantly lower butyric acid with Biomin® BioStabil Plus HC showing minimal *Clostridia* presence (*P<0.001*)

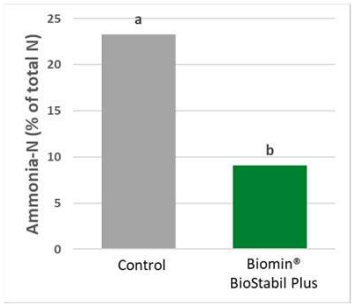


Figure 5. Significantly less ammonia-N in Biomin® BioStabil Plus HC silage (*P<0.001*)

Clostridia Challenge-BioStabil Plus HC improves fermentation quality of silage

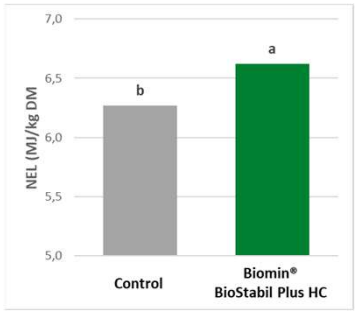


Figure 8. NEL (MJ/kg DM) in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (90 days after ensiling, P<0.001).

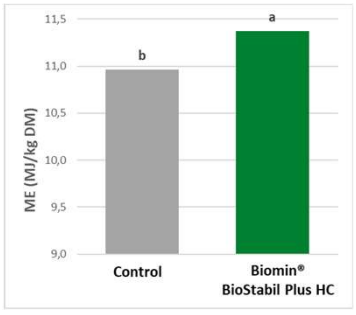


Figure 9. ME (MJ/kg DM) in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (90 days after ensiling, P<0.05).

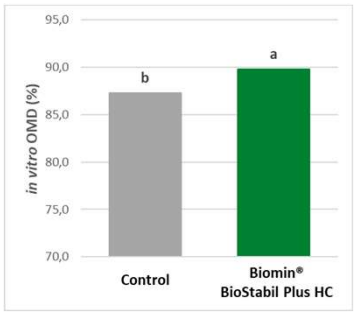
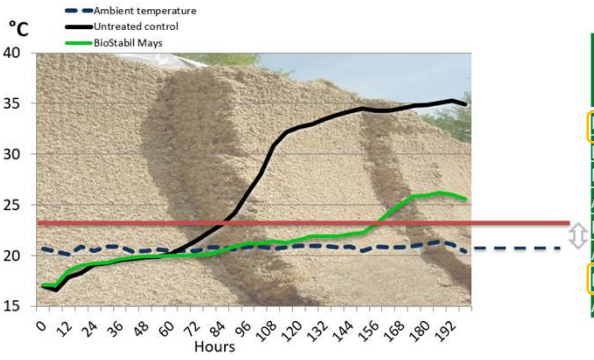


Figure 10. *in vitro* OMD in grass-clover untreated and treated with Biomin® BioStabil Plus HC silage (90 days after ensiling, P<0.05).

Biomin® BioStabil Mays – Scientific Trial
Proven Aerobic Stability in maize silage (35.5% DM)

LITHUANIAN UNIVERSITY OF HEALTH SCIENCES



	Unit	Control	Biomin BioStabil Mays	difference	difference (%)
Fermentation losses	(% DM)	8.74	5.14	-3.6	**-41%**
pH		3.86	3.74	-0.12	-3%
Lactic acid	(g/kg DM)	45.8	63.3	17.5	**38%**
Acetic acid	(g/kg DM)	19.5	21.1	1.6	8%
Butyric acid	(g/kg DM)	0.09	0.02	-0.07	-78%
Ammonia	(% of total N)	5.5	4.0	-1.5	**-27%**
NEL	(MJ/kg DM)	6.6	6.82	0.22	**3%**
Aerobic stability	(hours)	90	198	108	**120%**

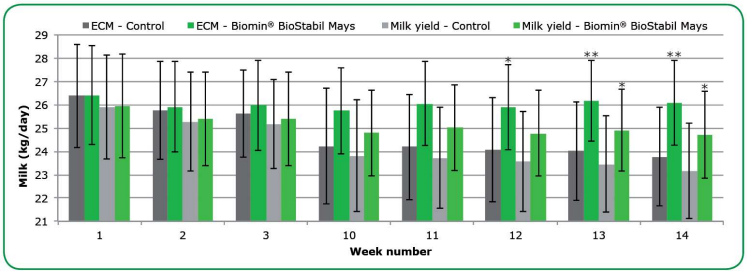
"Longer aerobic stability in silage with BioStabil Mays leads to preserved feed value, higher palatability and better animal productivity"

Naturally ahead

Biomin

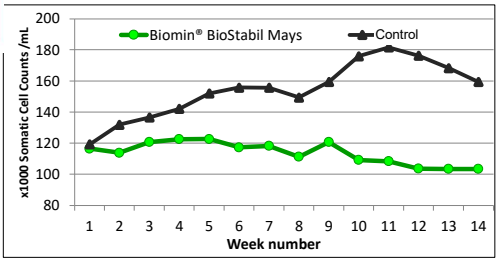
BioStabil Mays Increases Milk Yield and ECM and Lower SCC

ECM and Milk Yield



LITHUANIAN UNIVERSITY OF HEALTH SCIENCES

Somatic cell count



Naturally ahead

Biomin

Field Trials with BioStabil Mays HC in FR_2020

Field Trial BioStabil Mays HC, 27% DM - Omberée d' Anjou
Results – silo opened after 9 weeks, 13/11/2020

analytical results	unit	in kg feedstuff	in kg dry matter	reference value
dry matter	g	349	1000	300 - 350
crude ash	g	14	41	< 45
crude protein (CP)	g	25	73	75 - 90
crude protein (CP)+NH3-N°	g	26	74	
crude fibre	g	77	221	170 - 220
ether extract	g	10	30	25 - 40
sugar	g	12	34	
starch	g	85	243	300 - 380
EDOM	%	23,3	66,7	65 - 75
neutral detergent fiber (aNDFom)	g	156	448	
acid detergent fiber (ADFom)	g	86	248	
acid detergent lignin (ADL)	g	11	32	
non fiber carbohydrates (NFC)	g	143	408	
pH-value		3,9		3,8 - 4,2
ammonia-nitrogen	% of total N		7,2	
soluble Protein (SP)	% of CP		62,8	50 - 60

Energetic result	unit	in kg feedstuff	in kg dry matter	reference value
utilizable crude protein (uCP)	g	45	128	120 - 140
rumen nitrogen balance (rNB)	g N	-3,0	-8,7	-10 - -5
net energy lactation (NEL)	MJ/kg	2,2	6,4	6,3 - 6,8
metabolizable energy (ME)	MJ/kg	3,7	10,7	10,5 - 11,5
Fermentation quality: very good (1)				

microbiological result	unit	value	KZS	evaluation	OV
Fusarium sp.	CFU/g	< 500			
Acremonium sp.	CFU/g	< 500			
Aureobasidium sp.	CFU/g	< 500			
Dematiaceae	CFU/g	< 500			
Ustilago sp.	CFU/g	< 500			
Verticillium sp.	CFU/g	< 500			
product-specific moulds and dematiceae (GG 4)	**CFU/g**	**< 500**	**1**	**normal**	**5.000**
Penicilium sp.	CFU/g	< 500			
Geotrichum sp.	CFU/g	< 500			
Aspergillus sp.	CFU/g	< 500			
Monascus sp.	CFU/g	< 500			
Scopulariopsis sp.	CFU/g	< 500			
Wallemia sp.	CFU/g	< 500			
	CFU/g				
moulds indicated spoilage (GG5)	**CFU/g**	**< 500**	**1**	**normal**	**5.000**
Mucorales sp.	CFU/g	< 500			
Rhizopus sp.	CFU/g	< 500			
mucorales indicated spoilage (GG6)	**CFU/g**	**< 500**	**1**	**normal**	**5.000**
yeasts (Candida spp.)	CFU/g	< 500			
yeasts (GG7)	**CFU/g**	**< 500**	**1**	**normal**	**1.000.000**

RESULT of ANALYSIS

number of test report: 1448782-20201127-090321

comments (conformity assessment):

Orientantion values (OV) microbiological result by VDLUFA II, 28.1.4, 2017

According to the results of the microbiological examination, the feed is given quality grade 1 (normal). Microbial infestination is normal.

Field Trial BioStabil Mays HC, 28% DM
Negrondes Results – silo opened after 12 weeks 01/12/2020

analytical results	unit	in kg feedstuff	in kg dry matter	reference value
dry matter	g	360	1000	300 - 350
crude ash	g	13	37	< 45
crude protein (CP)	g	27	75	75 - 90
crude protein (CP)+NH3-N*	g	27	76	
crude fibre	g	76	210	170 - 220
ether extract	g	9	26	25 - 40
sugar	g	20	54	
starch	g	85	235	300 - 380
neutral detergent fiber (aNDFom)	g	158	438	
acid detergent fiber (ADFom)	g	87	242	
enhanced fibre digestibility (NDFD30h)	% der NDF		56,1	
EDOM	%	25,2	69,9	65 - 75
pH-value		3,9		3,8 - 4,2
ammonia-nitrogen	% of total N		7,7	
soluble Protein (SP)	% of CP		64,1	50 - 60

Energetic result	unit	in kg feedstuff	in kg dry matter	reference value
utilizable crude protein (uCP)	g	47	130	120 - 140
rumen nitrogen balance (nNB)	g N	-3,1	-8,5	-10 - -5
net energy lactation (NEL)	MJ/kg	2,3	6,5	6,3 - 6,8
metabolizable energy (ME)	MJ/kg	3,9	10,8	10,5 - 11,5

Fermentation quality: very good (1)

analytical results acid of fermentation	unit	in kg feedstuff	in kg dry matter	reference value
acetic acid	g	9,02	25,07	
propionic acid	g	< 0,14	< 0,38	
lactic acid	g	17,01	47,25	25 - 80
ethanol	g	1,05	2,91	< 15
1,2-propanediol	g	5,32	14,79	
1-propanol	g	< 0,36	< 1,00	
pH-value		3,9		3,8 - 4,2

Fermentation quality: very good (1)

microbiological result	unit	value	KZS	evaluation	OV
Fusarium sp.	CFU/g	< 500			
Acremonium sp.	CFU/g	< 500			
Aureobasidium sp.	CFU/g	< 500			
Dematiaceae	CFU/g	< 500			
Ustilago sp.	CFU/g	< 500			
Verticillium sp.	CFU/g	< 500			
product-specific moulds and dematiceae (GG 4)	**CFU/g**	**< 500**	**1**	**normal**	**5.000**
Penicilium sp.	CFU/g	< 500			
Geotrichum sp.	CFU/g	< 500			
Aspergillus sp.	CFU/g	< 500			
Monascus sp.	CFU/g	< 500			
Scopulariopsis sp.	CFU/g	< 500			
Wallemia sp.	CFU/g	< 500			
	CFU/g				
moulds indicated spoilage (GG5)	**CFU/g**	**< 500**	**1**	**normal**	**5.000**
Mucorales sp.	CFU/g	< 500			
Rhizopus sp.	CFU/g	< 500			
mucorales indicated spoilage (GG6)	**CFU/g**	**< 500**	**1**	**normal**	**5.000**
yeasts (Candida spp.)	CFU/g	4000			
yeasts (GG7)	**CFU/g**	**4000**	**1**	**normal**	**1.000.000**

RESULT of ANALYSIS number of test report: 1453606-20201210-080655

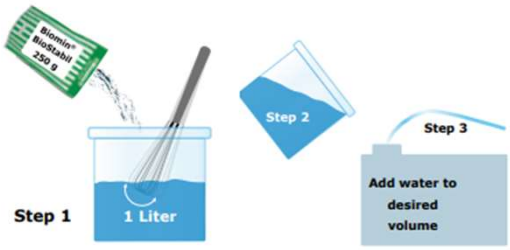
comments (conformity assessment):

Orientantion values (OV) microbiological result by VDLUFA II, 28.1.4, 2017

According to the results of the microbiological examination, the feed is given quality grade 1 (normal). Microbial infestation is normal.

Biomin

Application



Water requirements:
- Water < 38°C
- Chloride < 2 ppm

Dosage:
- 1 g/t fresh matter
- Application effective at low (from 10mL /ton) and standard volume (1 L/ton) application system
- Use the pre-mixture within 24 hours

Biomin

Biomin® BioStabil value proposition

Biomin® BioStabil
- improves the anaerobic fermentation
and increases aerobic stability of silage

- thus limiting growth of undesirable microbes and preventing loss of valuable dry matter, energy and protein from silage

– providing highly nutritive and hygienic silage, which leads to maintaining good animal health and higher productivity

Thank you!

Questions & Answers

Biomin®