

Where did things go wrong?
Silage fermentation characteristics

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UNIVERSITY OF GEORGIA EXTENSION Baleage and Silage Short Course
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Problem silage usually has distinct characteristics

1. Odor
2. Visual
3. Temperature
4. Animal behavior



Jennifer Tucker, UGA

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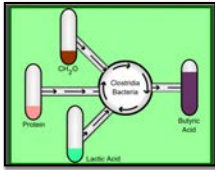
Why does my silage... smell like spoiled milk or fish?

butyric acid

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Clostridia bacteria fermentation

sugars → butyric acid



Caused by:

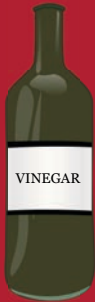
- high moisture (> 70%)
- cutting/raking too close to soil

Consequences:

- ↓ nonstructural carbohydrates
- ↑ ADF
- ↓ protein
- ↓ digestibility
- ↓ palatability
- ↓ intake

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Why does my silage... smell like vinegar?



acetic acid

VINEGAR


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Fermentation dominated by wrong bacteria

sugars → acetic acid

Promoted by:

- ↑ silage moisture
- ↓ lactic acid bacteria
- ↓ crop sugars



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Why does my silage...smell like alcohol?



yeast






Yeast fermentation

sugars → alcohol



- Yeast can metabolize lactic acid → increases pH → spoilage
- Problem in dry, poorly compacted silages that are slowly fed out

More of a concern in corn silage



Why does my silage...smell like ammonia?

excessive protein breakdown

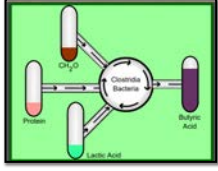


Excessive protein breakdown




protein → ammonia & amines

May be caused by:

- clostridia fermentation
- high pH





Neither condition fosters environment for lactic acid bacteria



Why does my silage...smell sweet?

yeasts & heat damage





Ethanol + acetic acid = sweet

spoilage yeasts → ethanol

heterofermentative bacteria → acetic acid

- ↑ ↑ ↑ DM losses
- prone to heating and spoiling



Why does my silage...look caramelized?

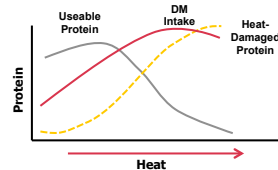

excessive heat damage



Heat damaged silage

Caused by:



- entrapment of excess oxygen
- low moisture content
- long chop
- poor compaction

Why does my silage...smell musty?

mold

Why does my silage...look moldy?

Moldy Silage


Caused by aerobic (oxygen) conditions:

- poor packing
- slow filling
- low moistures
- poor sealing
- slow feed-out
- poor face management

Results in:

- high dry matter losses
- poor palatability
- livestock performance

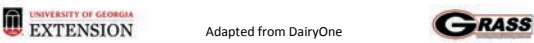
If silage is still hot → microbial activity and spoilage are still underway!



Identifying common types of storage molds

Type	Color	Toxin	Favorable Conditions
Aspergillus	Yellow-green	Aflatoxin, Ochratoxin	Heat and drought stress preharvest, heat and humidity postharvest
Penicillium	Green to green-blue	Ochratoxin, PR Toxin	Cool, wet, and low pH (acid tolerant) postharvest
Fusarium	Red, White, or Pink	Zearalenone, T-2 Toxin, Vomitoxin, Fumonisin	Grows both pre and postharvest. Cool wet growing season with insect damage. Dry conditions mid-season followed by wet weather.
Cladosporium	Dark blue-green, gray, or black	None	Early frost, neutral pH, high grain moisture (30-40%), temperatures at 75-125°F

Adapted from DairyOne





Identifying common types of storage molds

White/black = ok

Red = dead

Blue/green = in between



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Why does my silage...look like it has run-off?


seepage

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Run-off or seepage

Caused by:


- high crop moisture
- dull chopper knives → torn plant cells
- overpacking → bruised plant cells
- poor wrapping/storage ???



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Why does my silage...feel hot?

byproduct of oxidative reactions



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Hot silage

Oxidative reactions with extended respiration or growth of yeast, mold, bacteria populations → **HEAT**

Caused by:

- overly mature crop
- long chop length
- low moisture
- slow filling
- poor distribution or compaction
- structure air leaks
- slow feed-out

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Why does my silage...feel cold?

frozen silage



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Frozen silage

Caused by:

- high moisture
- extended respiration
- bruised crop cells

more problematic
in tower silos

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Why are my animals not eating my silage?

it depends...

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There are many reasons livestock refuse silage...

- clostridial fermentation
- high nitrates
- too wet
- too dry
- high fiber (mature crop)
- contamination with mold, toxic weeds, nitrates

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Challenges facing silage and baleage producers

1. Harvest and store in a timely manner
2. Conserve dry matter
3. Maintain intake potential
4. Feeding to balance demands of production and rumen function

We can control all of these with good agronomic management!

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An ounce of prevention is worth more than a pound of cure!

- Understand the forage
- Harvest at the proper moisture content
- Chop uniformly at the proper length
- Fill/bale rapidly
- Pack sufficiently
- Keep material anaerobic!

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Species affects fermentation

Forages differ in their concentration of water soluble carbohydrates!

Species	WSC, % DM
sorghum	~20
cereal forages	~12
alfalfa	~6
bermudagrass	~3

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Buffering Capacity
Ability to resist pH change when ensiled.

Crop/Species	Range	Mean
Corn silage	149 to 225	183
Timothy	188 to 342	265
Fall oat (ensiled)	300 to 349	323
Orchardgrass	247 to 424	335
Red clover	—	350
Fall oat (best)	360 to 371	366
Italian ryegrass	265 to 389	366
Alfalfa (established)	313 to 482	370
Perennial ryegrass	257 to 558	380
Alfalfa (1/10 bloom)	367 to 508	438
Alfalfa	390 to 570	472
White clover	—	512

↑ BC = harder to ↓ pH
↓ WSC + ↑ BC = most difficult to properly ferment

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What is the single biggest driver of forage quality?

forage maturity
sugar content
bacteria populations
fermentation efficiency


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Effects of Bale Density on Fermentation

Moisture	58.7%		52.4%		
	Density, lbs/ft ³	12.9	10.9	12.4	10.4
pH		4.7	4.9	4.8	5.1
lactic acid, %		7.0	6.5	7.1	6.3
acetic acid, %		2.4	3.8	3.3	2.0
max temp, °F		107	109	108	106
DM REC, %		98.6	98.6	97.8	98.3

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Density is affected by several factors



- tractor ground speed
 - decrease to increase density
- PTO speed
 - increase to increase density
- windrow size
 - smaller will increase revolutions per bale
- forage moisture
 - strive for about 50 percent

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Storage and Face Management



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Slides adapted from:

- DairyOne 2019. Mold and Yeast Interpretation.
- Hancock 2018. Silage Fermentation. (UGA)
- Mahanna and Chase 2003. Practical Applications and Solutions to Silage Problems. (ASA; Silage Science and Technology)
- Penn State Forage Program 2019. Silage Fermentation. (PSU)
- Selgar 2014. Diversity of silage molds produces harmful mycotoxins. (Progressive Forage)

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2019 Baleage and Silage Short Course:
Silage Fermentation Characteristics

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Questions?

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