

Wild Yeasts and Aerobic Stability of Silages and TMR

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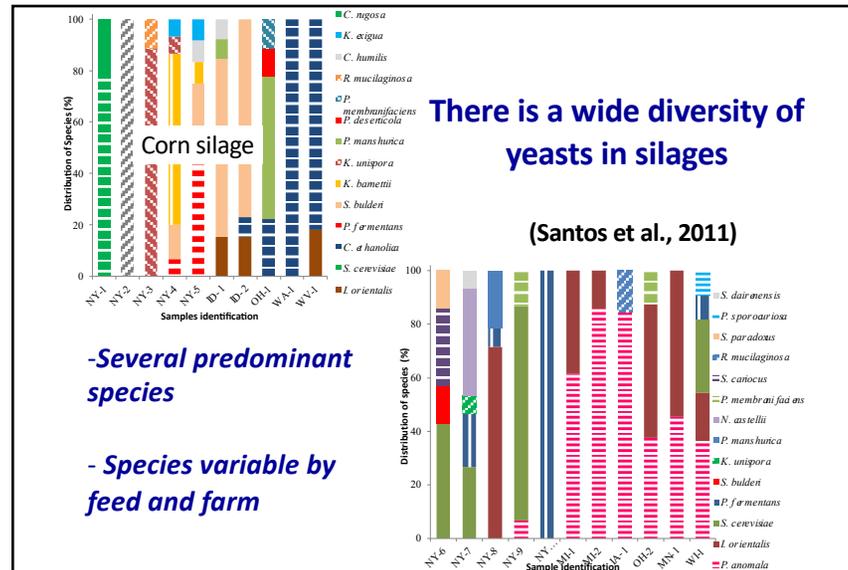


1

Presentation Topics

- Metabolism of wild yeasts in silages
- Undesirable characteristics of wild yeasts
- Effects of yeasts on aerobic stability of silages and TMR
- Potential direct negative effects on ruminants
- Methods to minimize wild yeasts in silages

2

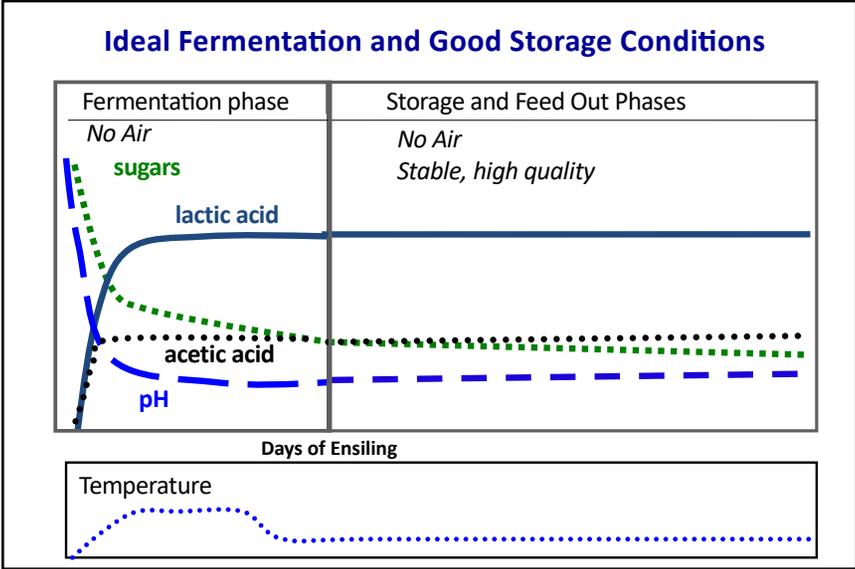


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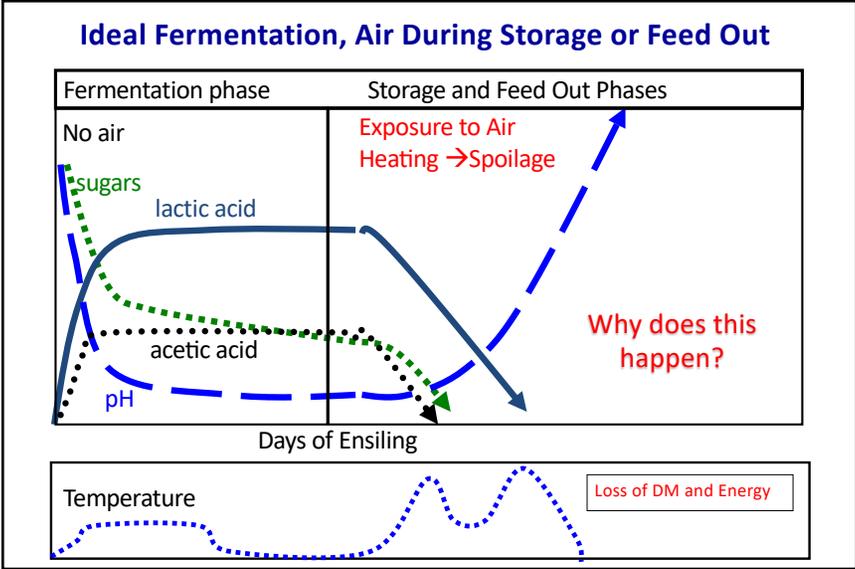
Metabolism of Wild Yeasts in Silage

- Anaerobic conditions – Fermenting yeasts convert sugars to ethanol, CO₂ and H₂O
 - Result: Inefficient glucose fermentation yields only 51% recovery of DM
- Aerobic conditions – Lactating assimilating yeasts oxidize lactic acid to CO₂ and H₂O
 - Result: Loss of DM and primary initiators of aerobic spoilage

4



5



6

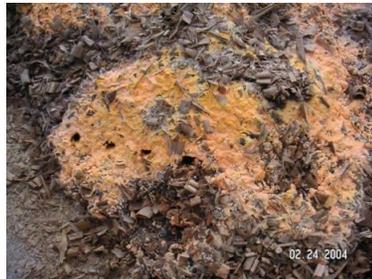
The “Domino Effect” of Air and Wild Yeast on Spoilage in Silages

- ➔ Silage is exposed to air
 - ➔ Yeasts ‘wake up’ and degrade lactic acid
 - ➔ Numbers of yeasts increase
 - ➔ **Highly degradable nutrients are destroyed**
 - ➔ Heat is produced
 - ➔ pH increases
 - ➔ Molds/bacteria ‘wake up’ causing further spoilage
 - ➔ More heating
 - ➔ **Massive spoilage**



7

Molds Are Not Responsible for Aerobic Instability



8

Dry Matter Losses From Good and Poor Silo Management

Losses From	Good Management	Poor Management
Respiration	0-4%	5-15%
Fermentation	4-6%	10-20%
Seepage	0-1%	5-10%
Aerobic instability during storage/feeding	5-7%	10-20%
Total	10-15%	20-30%

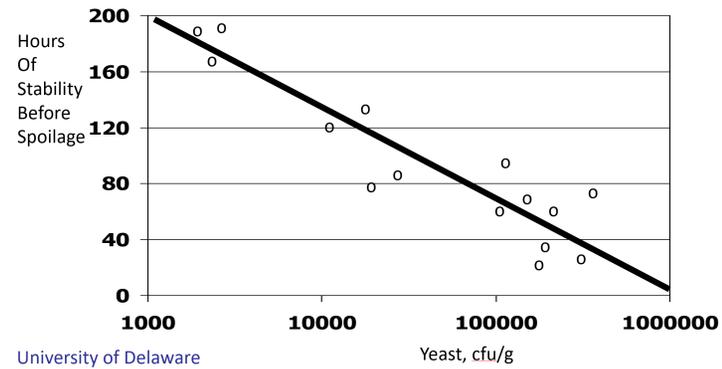
9

Value of Forage DM Lost From Poor Fermentations and Aerobic Spoilage–

1. Loss of DM
2. Loss of production because of reduced intake
3. Increased cost of ration
4. Cost of other health challenges

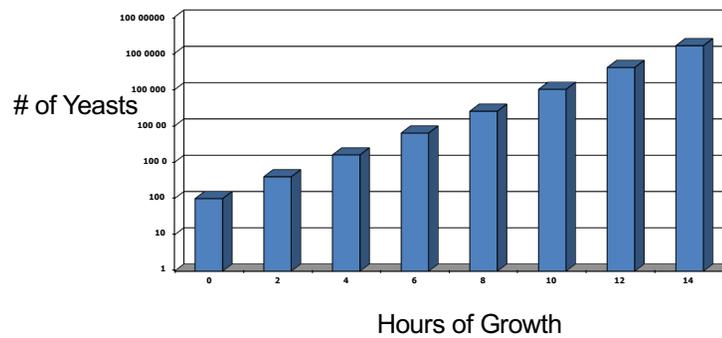
10

The Negative Relationship Between Number of Yeasts and Aerobic Stability



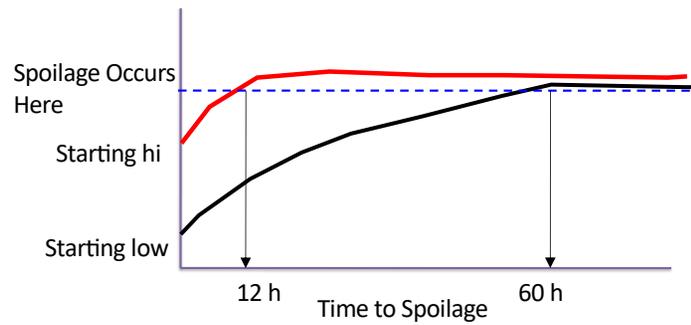
11

Theoretical Growth of Yeasts if Doubling Time = 1-2 h



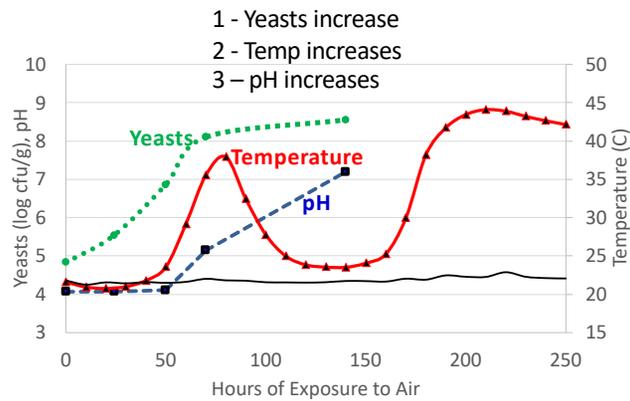
12

How do Initial Populations of Yeasts Affect Time to Spoilage?



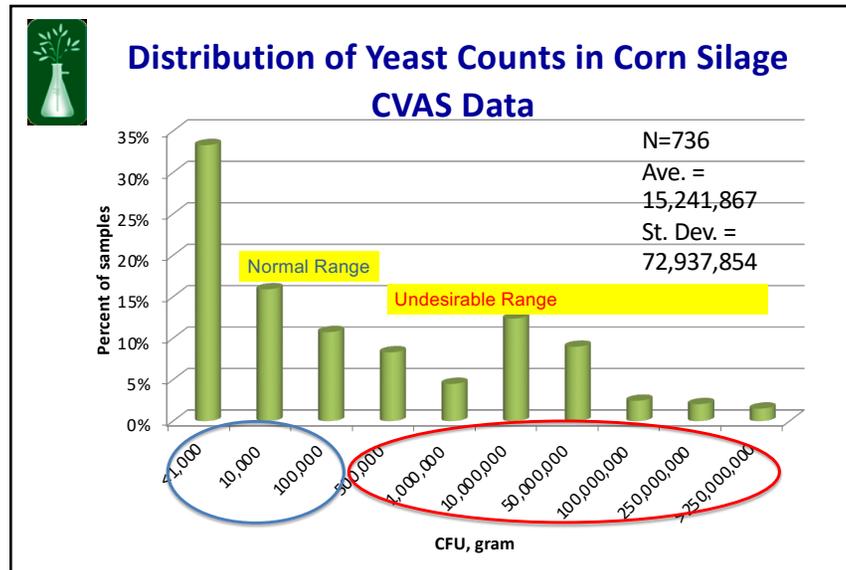
13

Changes in Yeasts, pH and Temperature of Aerobically Spoiling High Moisture Corn



Kung et al., University of Delaware

14



15

Value of Forage DM Lost From Poor Fermentations and Aerobic Spoilage—

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16

Silages Are Mixed into TMR- Aerobic Instability of TMR on Farms in the Northeast USA During the Summer

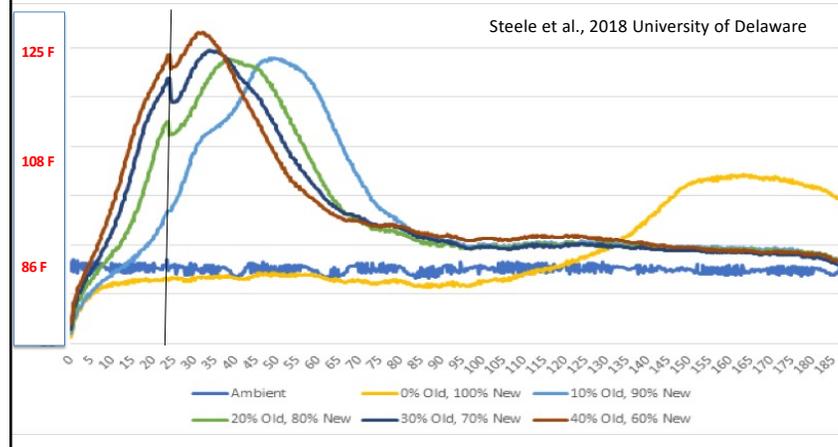
-----TMR aerobic stability-----

	<12 h	12-24 h	>24 h	Total TMR number
Year 1	8	4	0	12
Year 2	8	5	5	18

Mortes and Kung, 2005

17

Mixing as Little as 10% of Spoiling Silage Can Destabilize a TMR



18

Why Should We Be Concerned With Aerobically Spoiling Silages?



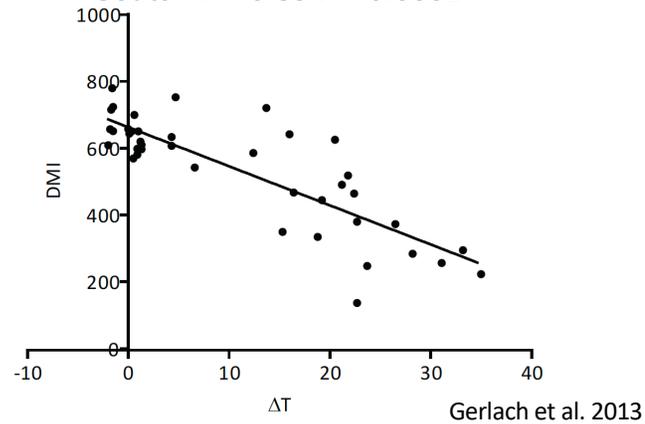
19

Potential Negative Effects of Yeasts in Silages and TMR

- Heating silage in the silo and feed bunk
- Reduced intakes
- Acidosis like conditions
- Milk production and fat depressions

20

**Correlation Between Change in Corn Silage
Temperature From Aerobic Spoilage and DMI in
Goats $R = -0.85$ $P < 0.0001$**



21

**The Effect of Feeding a Spoiling TMR
to Heifers**

- Treatments:
 - Fresh TMR
 - Spoiling TMR: Fresh TMR was placed in bins (with holes) in a heated room for ~2 d prior to feeding.
 - *When the spoiled TMR was fed to heifers, it was between 90 – 130°F*

2013 Windle and Kung

22

Experiment Using Fresh and Spoiling Corn Silage Used to Make a TMR

Item	DM, %	pH	Yeasts, cfu/g	Molds, cfu/g	Aerobic Stability, hours
Fresh corn silage	46	3.85	3.63	3.87	138
Spoiling corn silage	40	6.57	7.95	7.99	0

Steele et al., 2018 University of Delaware

23

Nutrient Analysis of TMR

Item	Fresh TMR	Spoiling TMR	P-Value
DM, %	48.89	49.37	0.59
CP, %	10.57	11.19	0.27
Soluble protein, % CP	42.49	38.80	0.11
ADF, %	24.87	24.03	0.23
NDF, %	41.27	40.66	0.54
NDF-D, % NDF	63.65	61.46	0.49
Starch, %	26.58	28.22	0.26
Starch-D, % Starch	80.01	78.69	0.20

2013 Windle and Kung

Technically, these diets were not different

24

Fermentation Analysis and Numbers of Yeasts in TMRs Fed to Heifers

Item	Fresh TMR	Spoiling TMR	P-Value
pH	4.16	5.17	<0.01
WSC, %	2.46	1.85	<0.01
Lactic acid, %	4.17	2.59	<0.01
Acetic acid, %	0.97	0.64	<0.01
Ethanol, %	5.82	6.07	<0.01
Yeasts, log ₁₀ cfu/g	5.03	7.82	<0.01

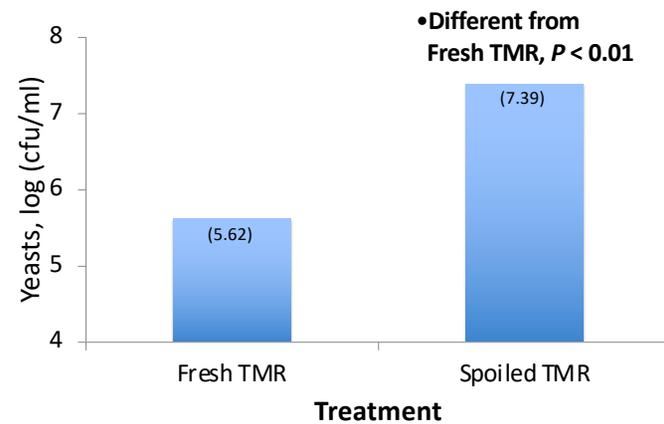
2013 Windle and Kung

107,151 yeasts/g

66,069,345 yeasts/g

25

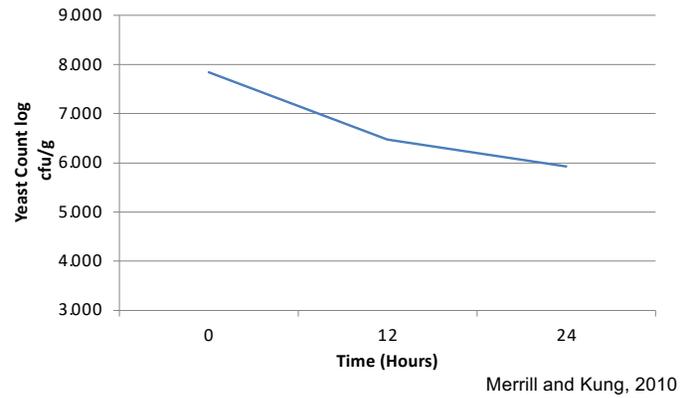
Numbers of Yeasts in Rumen Fluid



2013 Windle and Kung

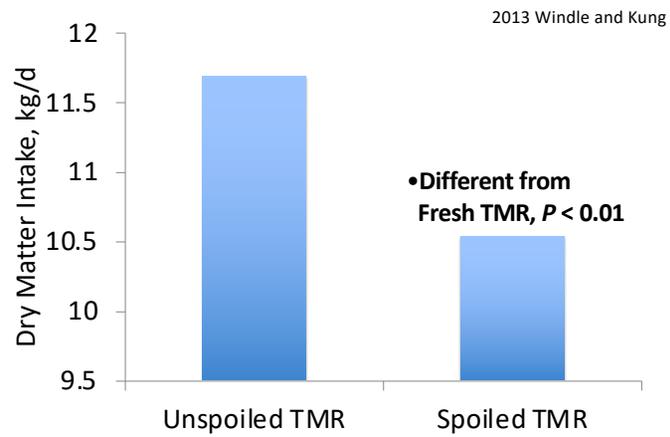
26

Survival of Silage Yeasts in Ruminal Fluid



27

Dry Matter Intake of Heifers Fed Fresh vs. Aerobically Spoiling TMR



28

What Causes the Negative Effect of Feeding Spoiled Silages and TMR?

- Production of toxic end products:
e.g. mycosis
- Alterations in nutritive value:
 - fatty acid content of yeast cell walls
 - alterations in biohydrogenation of fatty acids
- Organoleptic effects:
 - Taste
 - Smell
 - Hot feel



29

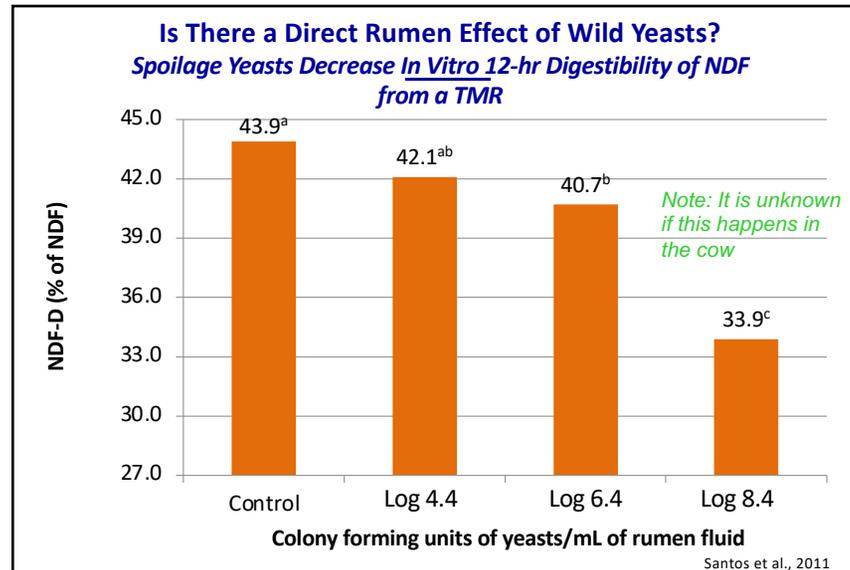
Theoretical Intake of Wild Yeasts by Dairy Cows Can Be Extremely High

Treatment	Levels			
	0x	1x	100x	10,000x
Yeast population in corn silage, log ₁₀ CFU/g of Fresh Forage	0.0	5.0	7.0	9.0
Theoretical concentration of yeast in rumen, log ₁₀ CFU/ml of rumen fluid*	0.0	4.4	6.4	8.4
Equivalent intake of Lev cell (g/cow/day)**	0.0	0.15	15	1500

*Assuming a cow ate 66 lb (wet weight of 35%DM material) of the silage above

**For comparison purposes only

30



31

How Do We Minimize “Wild Yeasts” in Silages?

- Ensilage at optimum DM and particle size
- Keep the silage mass away from air
 - Fill fast, pack densely, use good plastic and weights, feed out rate, facers, etc.
- Use an additive designed to minimize yeasts and improve aerobic stability
 - *L. buchneri* based inoculant
 - Organic acids

32

Excellent Silo Management is Needed to Maintain High Quality Silage



33

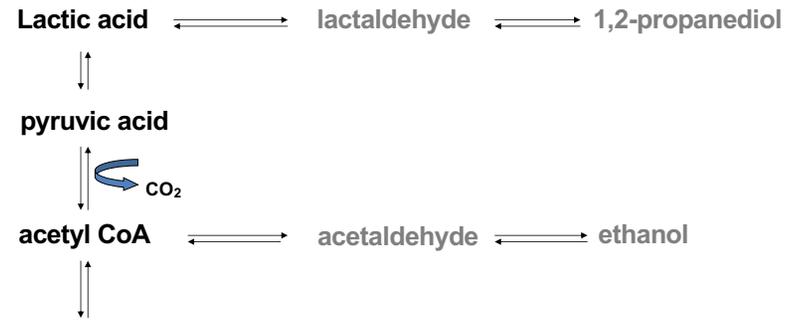
Additives to Control Wild Yeasts

- Silage inoculants
 - *L. buchneri*, *L. diolivorans*, *L. hilgardii*
 - Producing moderate levels of acetic acid
- Add organic acids
 - At ensiling
 - As a TMR saver

34

Pathway of Lactic Acid Degradation by *L. buchneri*

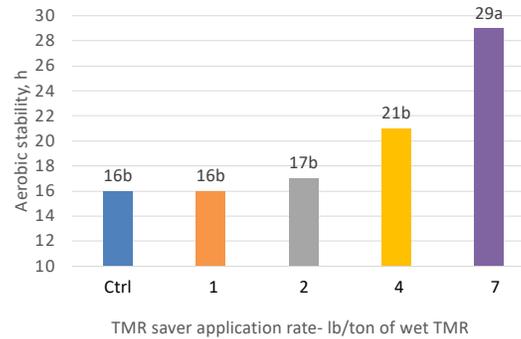
(Oude Elferink et al., 2001)



acetic acid \rightarrow inhibits yeasts \rightarrow improves aerobic stability

35

Effect of Adding a TMR-Saver Product on the Aerobic Stability of TMR From 9 Farms in the NE

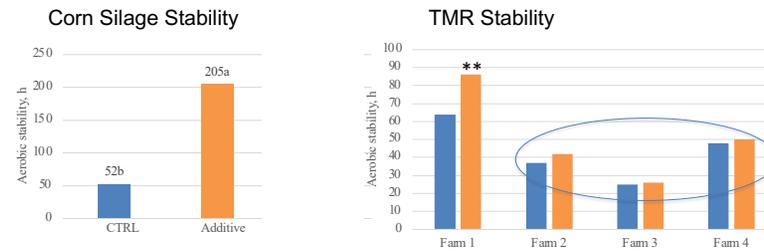


Liu and Kung, 2023 UD

36

Improving the Aerobic Stability of Corn Silage Does Not Always Result in Improved Stability of the TMR

- CTRL and Additive treated corn silage from Farm 1
- Used ingredients from Farms 1 to 4 to make TMR



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37

Why Are High Levels of Acids Needed to Stabilize TMR as “Savers” and Why Isn’t There Always Direct Carryover Effects of Additives for Stability in TMR?

- TMR components add buffering capacity and raise pH
 - Common for NE TMR to have pH of ~ 4.8 to 5
 - Of 9 farms average TMR pH was 4.88 ± 0.2

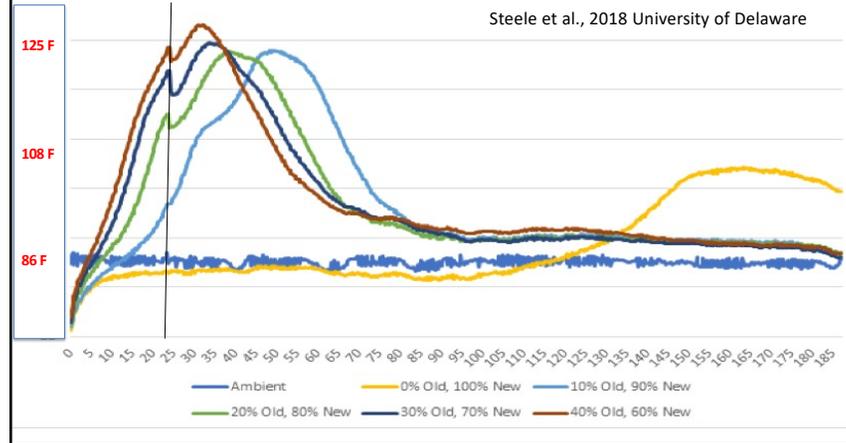


- TMR components may also bring contaminating wild yeasts
 - e.g. spoiling silages, wet brewer’s grains, etc.



38

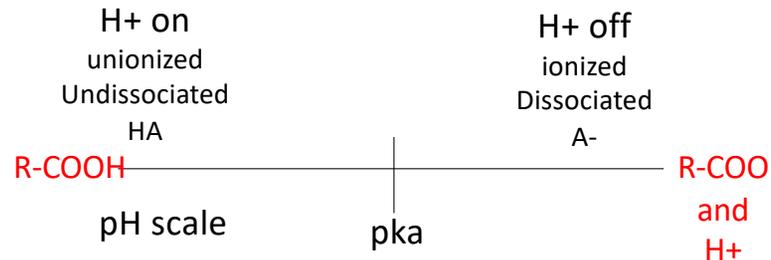
Mixing as Little as 10% of Spoiling Silage Can Destabilize a TMR



39

pH Affects the Activity of Antifungal Acids

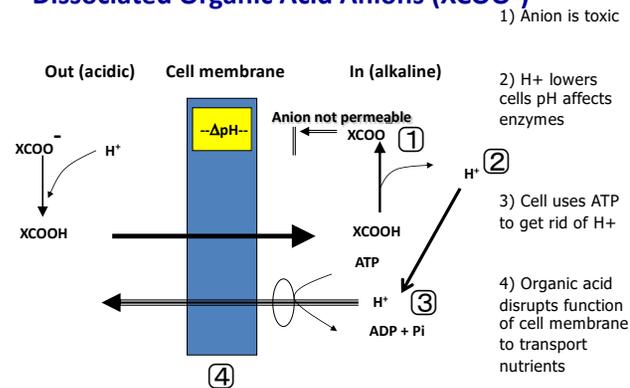
$pka = pH$ of acid at half dissociation $[A^-]=[HA]$



Example: If an acid has a pka of 4.6, then if the pH is 4.6, 50% is undissociated, 50% is dissociated. If the pH increases then the % that is dissociated increases (become less effective).

40

How Organic Acids Inhibit Wild Yeasts - Effect of pH Gradient on Accumulation of Dissociated Organic Acid Anions (XCOO⁻)



41

Summary

- All types of yeasts are undesirable in silages and TMR
- Lactate assimilating yeasts primarily initiate aerobic spoilage
- Spoiled/spoiling silage is associated with detrimental effects on animals
- Practicing good silo management should be the first place where improvements are made to minimize yeasts in silages but various additives should be considered to help this cause
- Maintaining high quality TMR for feeding in warm weather is not as simple as just using silage additives. Feeding management and sources of yeast contamination should be considered

42

Questions?

