Corn silage utilization in dairy rations

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Objectives

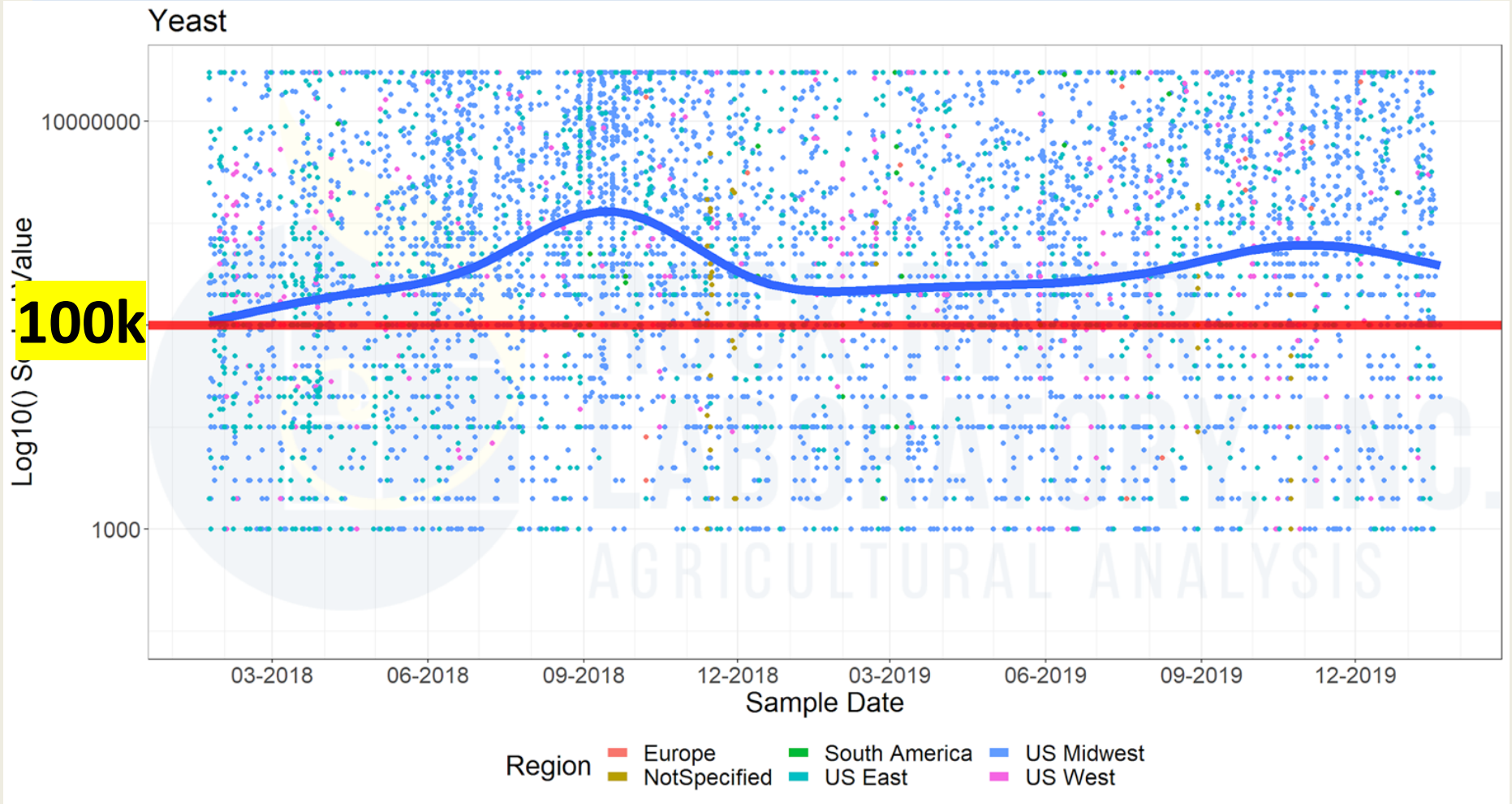
- Discuss the potential impacts of yeast counts on corn silage nutritive value
- Highlight the impact of nutrient variation on dairy cow performance
- Speculate about the need for diet formulation accounting for silage fermentation/microbial quality

Suggested range of fermentation end products

Item	Legume (30-35% DM)	Grass (25-35% DM)	Corn silage (30-40% DM)	HMC (70-75% DM)
pH	4.3 – 4.5	4.3 – 4.7	3.7 – 4.0	4.0 – 4.5
Lactic acid (% DM)	6 - 8	6 – 10	3 – 6	0.5 – 2.0
Acetic acid, (% DM)	2 – 3	1 – 3	1 – 3	< 0.5
Propionic acid (% DM)	< 0.5	< 0.1	< 0.1	< 0.1
Butyric acid (% DM)	< 0.5	< 0.5-1.0	0	0
Ethanol (% DM)	0.5 – 1.0	0.5 - 1.0	1 – 3	0.2 – 2.0
NH3-N (% total N)	10- 15	8 - 12	5 - 7	<10

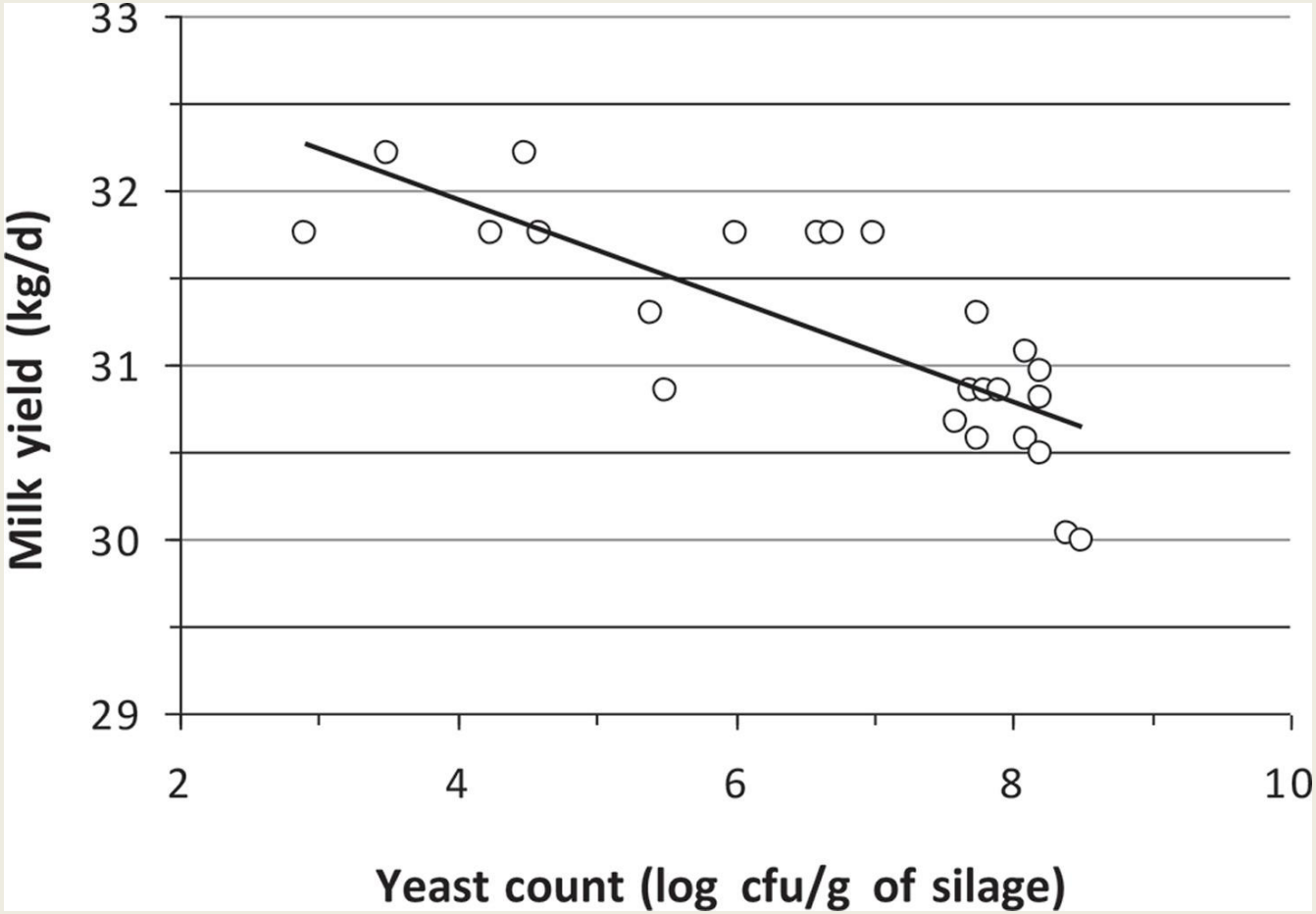
Adapted from Kung et al. (2018)

Yeast load, cfu/g



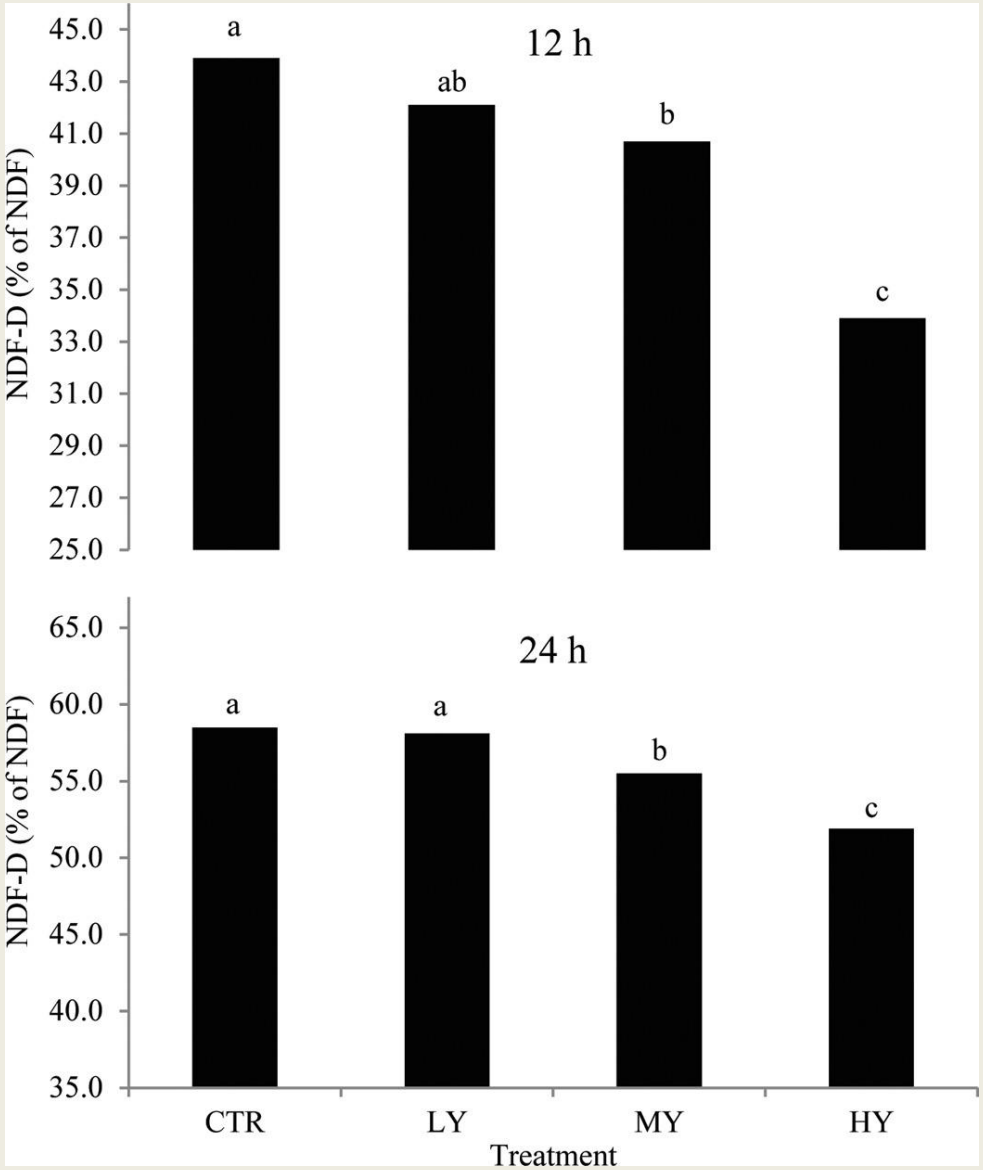
Fungal contamination is a substantial opportunity

Yeasts reduce production



Borreani et al., 2018 (adapted from Hoffman and Ocker, 1997)

Spoilage reduces NDFD



Santos et al., 2015

Spoilage reduces NDFD

12 h	Yeast, log cfu	NDFD, %NDF	Milk/ton
CTR	-	43.9%	3010
LY	4.02	40.7%	2976
HY	8.18	33.9%	2896

UW Yeast Trial

- **Yeast colonies isolated from HMC and inoculated to rehydrated corn before ensiling**
  - **CON: Distilled water**
  - **Low:** *5.3 cfu/g of fresh material*
  - **Med:** *6.3 cfu/g of fresh material*
  - **High:** *7.3 cfu/g of fresh material*

Storage length: 30 and 90 d

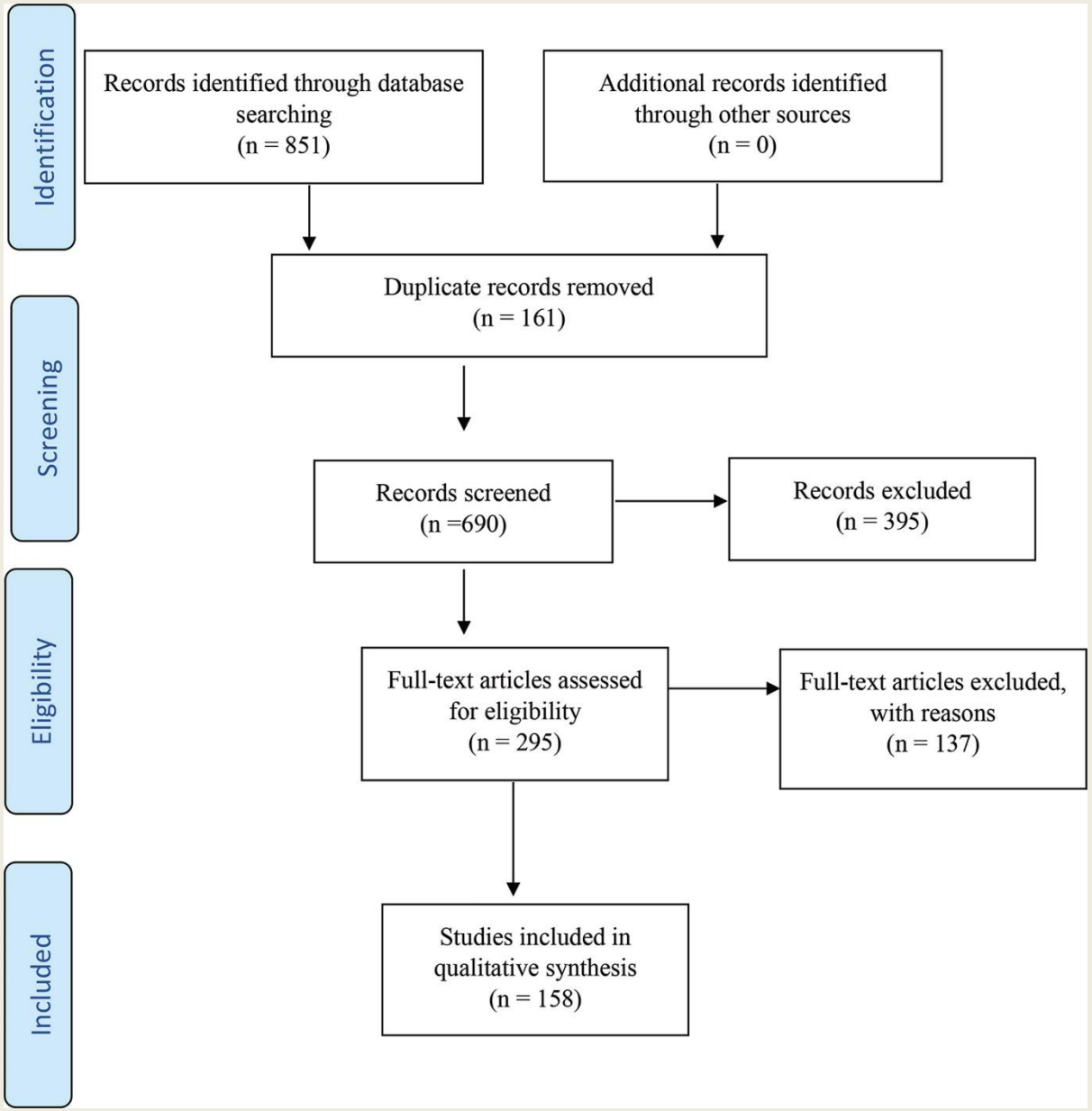
Rodrigues et al., 2024; ADSA Abstract

UW – yeast contamination study

Item[2]	CON[1]	Low	Med	High	SEM[3]	P-value
pH	4.55	4.85	4.81	4.75	0.10	0.06
Total acids, %DM	0.99	1.00	1.20	1.23	0.20	0.53
Lactic acid, %DM	0.83	0.76	0.91	0.93	0.17	0.75
Acetic acid, %DM	0.12^{b}	0.21^{a}	0.24^{a}	0.27^{a}	0.03	0.01
Ethanol, %DM	0.57^{c}	1.33^{b}	1.69^{a}	1.90^{a}	0.12	0.001
Ammonia-N, %CP	2.53	2.58	2.81	2.63	0.28	0.76
Yeast, log cfu/g	3.36^{b}	5.47^{a}	5.73^{a}	5.68^{a}	0.18	0.001
Aerobic stability, h	12.1	17.5	15.6	13.4	3.26	0.40
7h DMD, %DM	63.4^{a}	$57.4^{a,b}$	56.2^{b}	53.3^{b}	2.40	0.004

Rodrigues et al., 2024; ADSA Abstract

L. buchneri microbial inoculants meta-analysis



Arriola et al., 2021

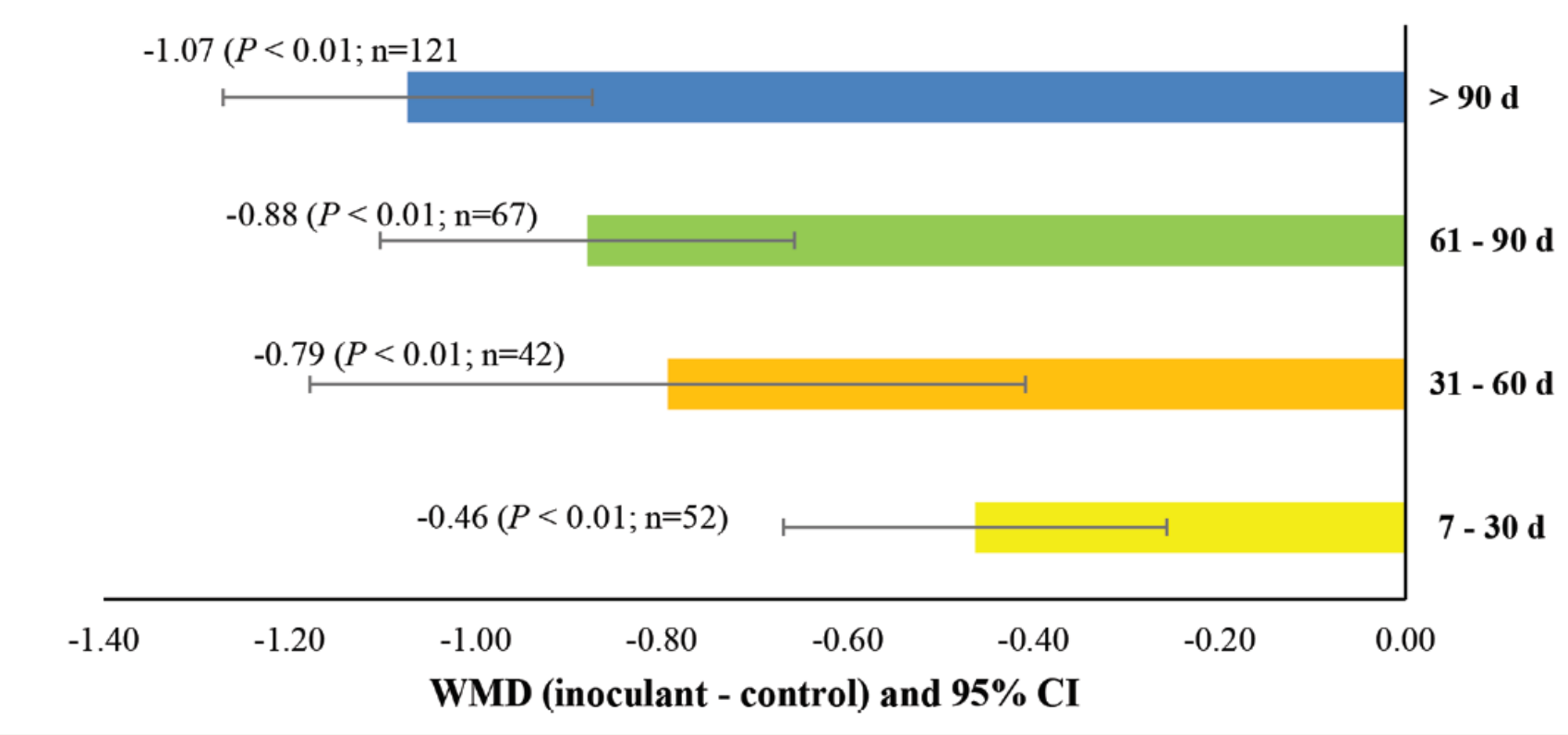
L. buchneri microbial inoculants meta-analysis

Item	Control	Difference	*P*-value
pH	4.13	0.06	0.01
DM recovery, %	93.8	-0.4	0.23
Lactate, % of DM	4.30	-0.31	0.01
Acetate, % of DM	1.70	1.05	0.01
Butyrate, % of DM	0.28	-0.03	0.03
1,2-Propanediol, % of DM	0.22	0.80	0.001
Yeast, log cfu/g	4.19	-0.84	0.01
Mold, log cfu/g	2.89	-0.40	0.01
Aerobic stability, h	111	82	0.01

Difference calculated as TRT - CON

Arriola et al., 2021

Yeast counts, log cfu/g



Arriola et al., 2021; JDS

Corn silage trial - UW

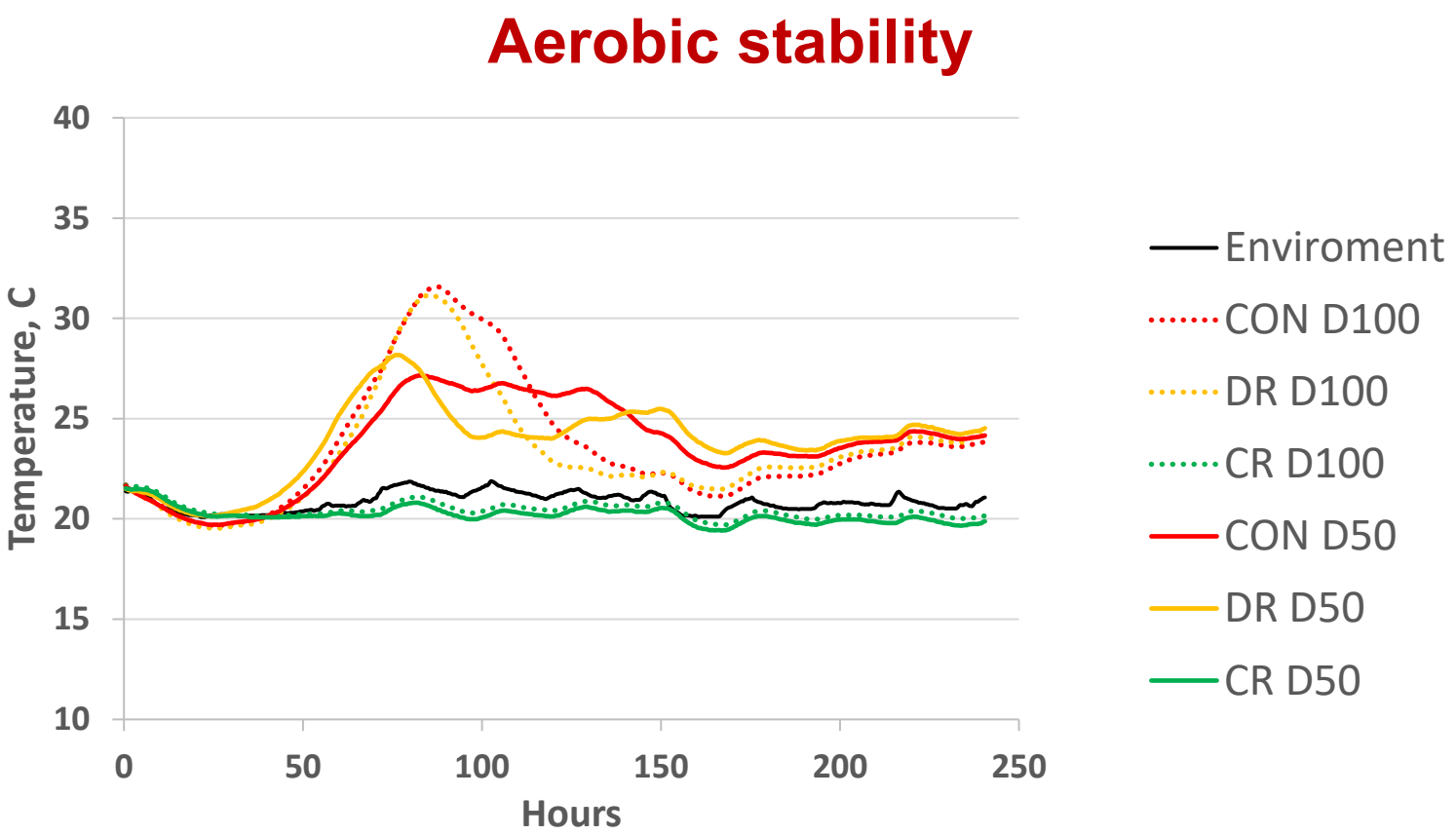
Microbial inoculation x Packing density x Aerobic exposure

- **Microbial inoculation:**
  - **CON: Distilled water**
  - **CR (Heterofermentative):** *Lactiplantibacillus plantarum and Lentilactobacillus buchneri*
  - **DR (Homofermentative):** *Pediococcus pentosaceus, Lactiplantibacillus plantarum, and Pediococcus acidilactici*
- **Packing Density:** 100% and 50%
- **Storage length:** 120 d
- **Aerobic exposure:** 0, 3, 6 and 9 d

Vieira et al., unpublished

Corn silage trial - UW

Microbial inoculation x Packing density x Aerobic exposure



Vieira et al., unpublished

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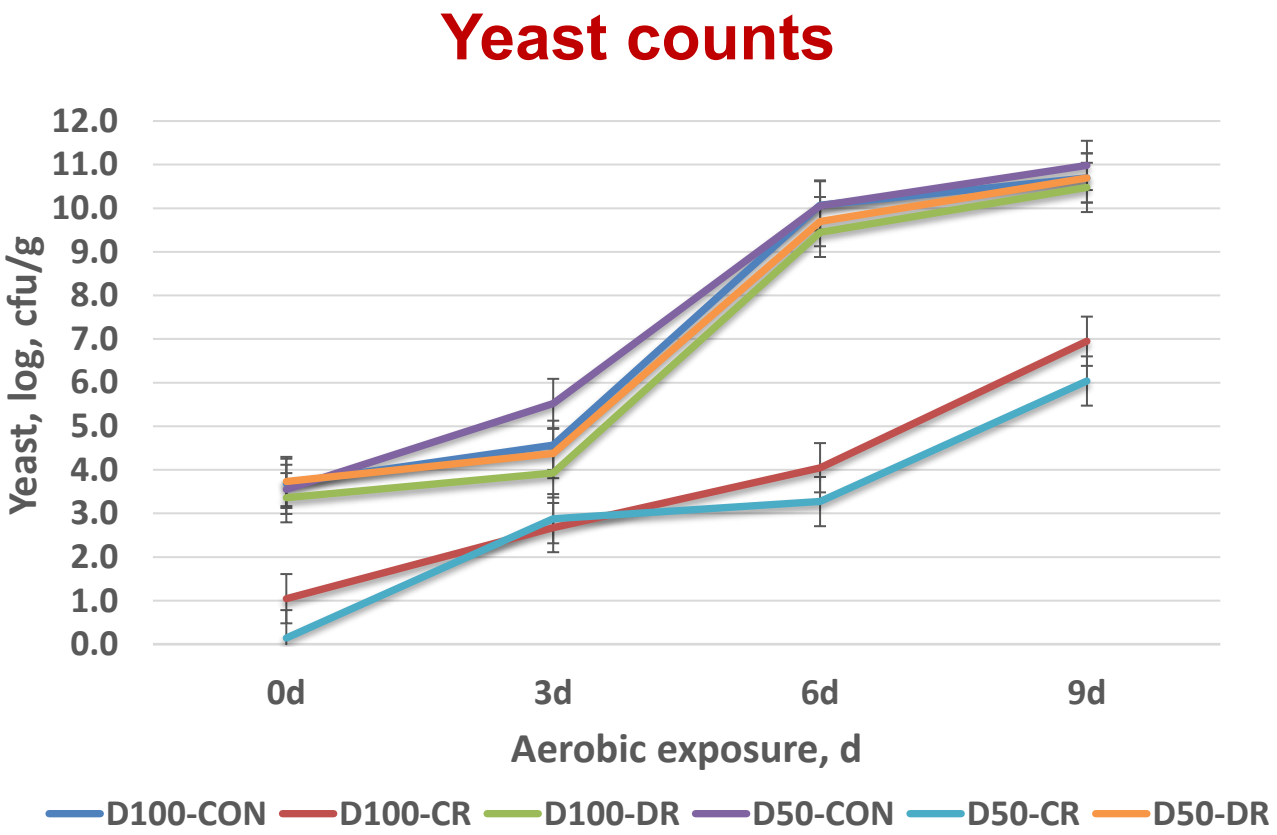

Vieira et al., unpublished

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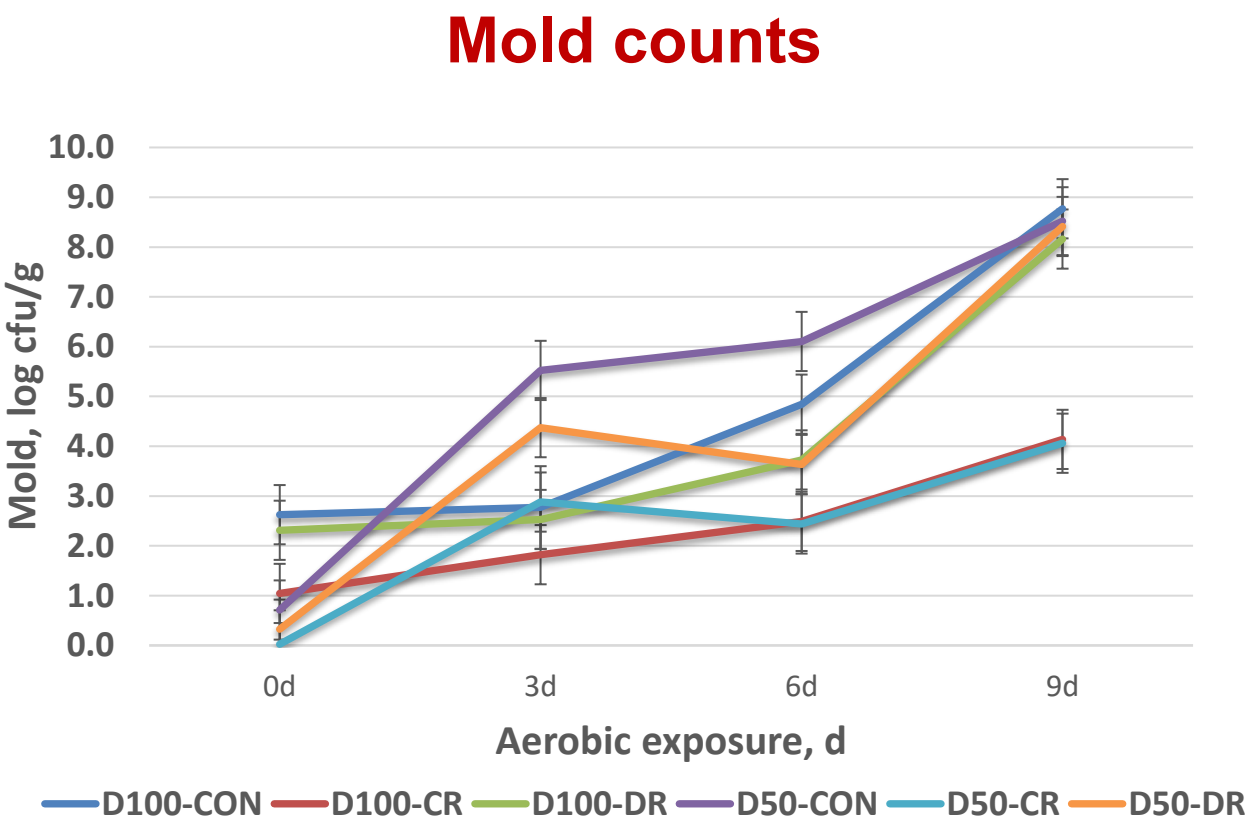

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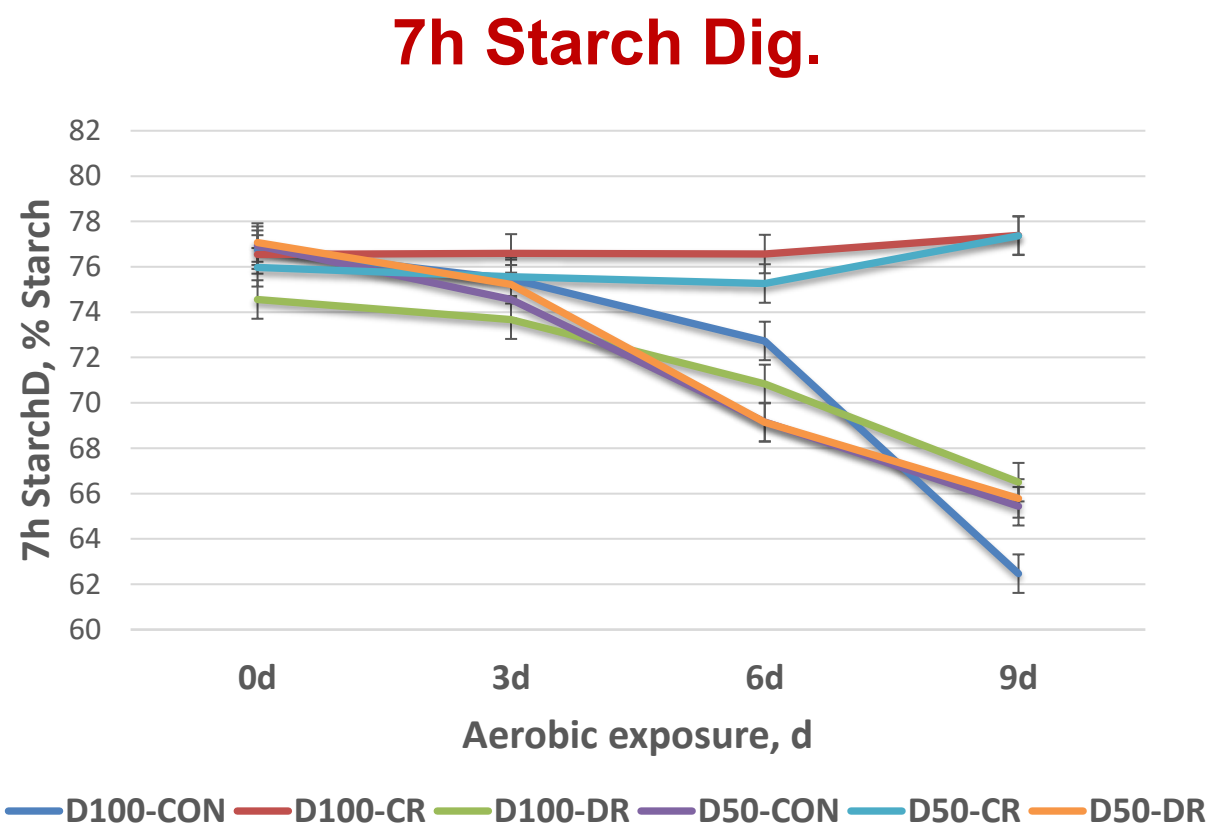


Vieira et al., unpublished

Face management attenuate this effect

Minimize face damage by keeping silage face vertical and tight

Photo sources: Hoard's Dairyman and Progressive Dairyman

Face management attenuate this effect

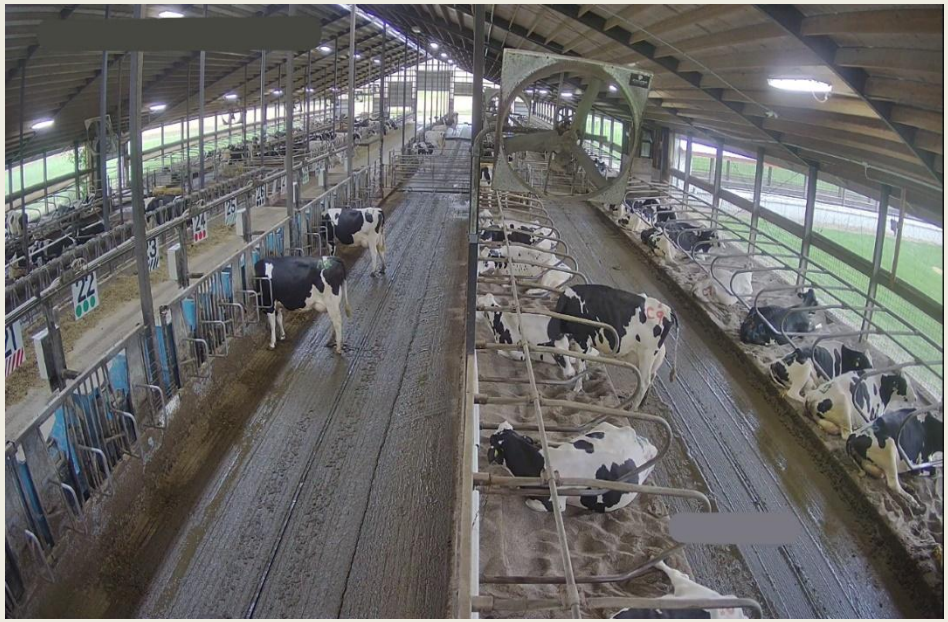
- Air penetrate 35 inches/d in the silo, regardless of how well packed and preserved the silo is
- Remove enough material to prevent heating and spoilage (8 to 12 inches/d)
- If possible, do not remove feed more than 1 or 2 h prior to feeding
- Avoid cutting back more than 2 or 3 days worth of plastic
- Check silo bags for holes and close as soon as you can

UW – starch oscillation study

What are the effects of prolonged nutrient oscillation?

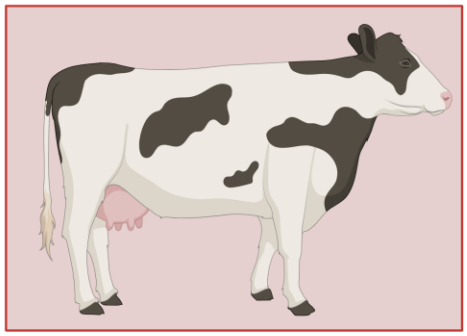
Any effects on feeding behavior?

Would the rumen microbiome change?



Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study



64 cows

47 ± 21 DIM

720 ± 71 kg BW

Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study

- All cows fed the same diet during the acclimation period (1 week) and covariate period (2 weeks). Cows were fed treatment diets for 8 weeks:
  - NS-CON: static dietary starch concentration and no supplementation of a feed additive
  - NS-TRT: static dietary starch concentration and the supplementation of a feed additive
  - OS-CON: oscillating dietary starch concentration with diet changes at 48 h intervals and no supplementation of a feed additive
  - OS-TRT: oscillating dietary starch concentration with diet changes at 48 h intervals and the supplementation of a feed additive

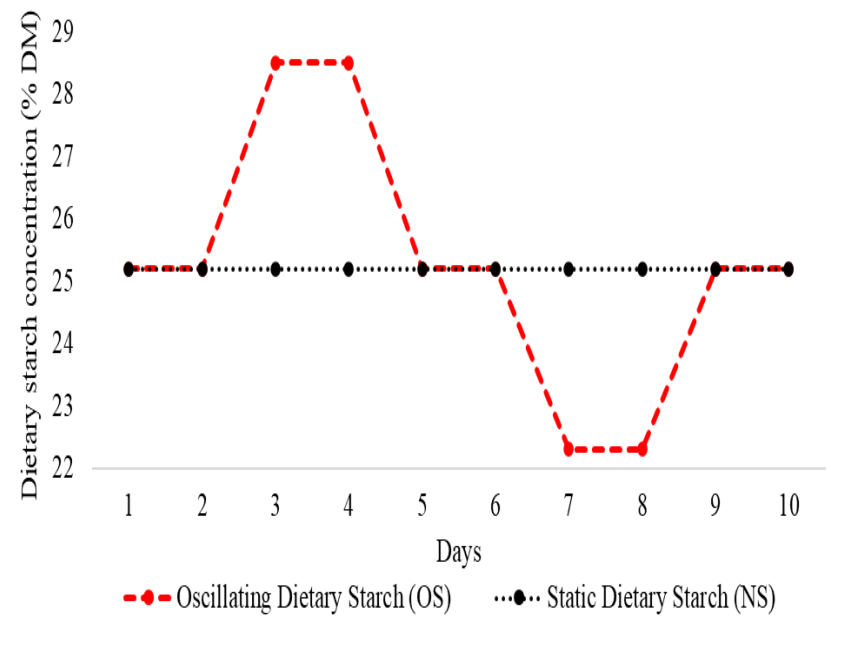


Figure 3. Feeding sequences with static dietary starch concentration containing 25% DM (NS) or oscillating dietary starch concentration (OS) with diet changes at 48 h intervals: normal (25% DM), high (29% DM), and reduced (22% DM).

Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study

Item	Covariate Diet	NS	RS	HS
	% DM			
Corn Silage	28.4	35.7	44.9	26.7
Alfalfa Silage	23.1	23.2	23.2	23.2
High-Moisture Corn	12.7	9.2	0.0	18.2
Whole Cottonseed	4.5	4.5	4.5	4.5
Concentrate Mix	31.3	27.4	27.4	27.4

[1]Covariate diet offered during the acclimation and covariate periods; Normal Starch diet (NS; starch at 25% DM); Reduced Starch diet (RS; starch at 22% DM); High Starch diet (HS; starch at 29% DM) offered during treatment period.

Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study

Item[1]	NS	OS	SEM	*P* - Values
Total DMI, kg of DM	32.6	32.6	0.44	0.82
Milk, kg/d	53.1	52.9	0.82	0.79
4% FCM, kg/d	53.7	52.9	0.82	0.22
ECM, kg/d	56.8	56.2	0.82	0.27
SCM, kg/d	52.5	51.9	0.79	0.31

Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study

Item[1]	NS	OS	SEM	*P* - Values
Fat, %	4.13	4.03	0.10	0.17
Fat Yield, kg/d	2.16	2.12	0.05	0.21
Protein, %	3.20	3.19	0.03	0.97
Protein Yield, kg/d	1.68	1.68	0.03	0.89
Lactose, %	4.73	4.73	0.02	0.74
Lactose Yield, kg/d	2.51	2.50	0.04	0.89
Solids non-Fat, %	9.02	9.02	0.04	0.76
MUN, mg/dL	14.3	14.2	0.30	0.69

Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study

Item	NS	OS	SEM	*P* - Values
Bunk visits, no./d	39.4	41.0	2.93	0.50
Eating time, min/d	202.1	211.6	5.25	0.02
Eating rate, kg of DM/min	0.182	0.172	0.01	0.16
Meal frequency, no./d	5.81	6.05	0.16	0.02
Meal length, min/meal	36.9	36.9	1.56	0.99
Largest meal size, kg of DM	11.0	10.8	0.39	0.49
Interval between meals, min	194.2	187.5	4.98	0.04
Largest interval between meals, min	335.0	325.6	8.13	0.04

Pupo et al., 2025; ADSA Abstract

UW – starch oscillation study

Item	NS	OS	SEM	*P* - Values
Log-Var-DMI	1.30	1.30	0.07	0.99
Log-Var-Milk	1.58	1.66	0.08	0.08
Log-Var-Eating time	851	1177	240.4	0.01
Log-Var-Meal frequency	1.52	1.45	0.24	0.50
Log-Var-Interval between meal	1395	1560	285.4	0.31

Pupo et al., 2025; ADSA Abstract

Implications

- Multiple factors affect silage fermentation, but modulating fermentation with bacterial inoculants can help minimize losses
- Yeast contamination is an under looked factor but create challenges for fermentation and nutritive value
- Cows can adjust to nutrient variation (oscillation), but at the expense of feeding behavior changes

Questions

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