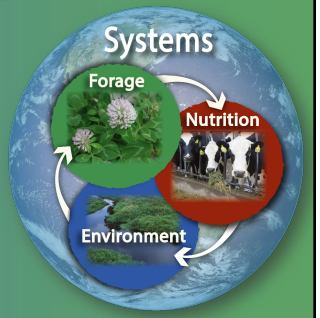
USDA United States Department of Agriculture

Further Considerations for Making Baled Silages



World Dairy Expo
Dairy Forage Seminar Series

October 2, 2021

Wayne Coblentz, USDA-ARS
US Dairy Forage Research Center
Marshfield, WI

U.S. Dairy Forage Research Center, USDA Agricultural Research Service

1

What is Baled Silage?

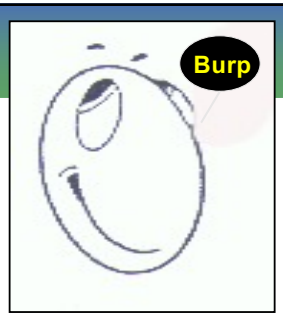
Forage is baled conventionally in the field, and then wrapped in plastic film to exclude air. Options exist for wrapping bales individually (left), or with an in-line system (right).

2

Baled Silage vs. Precision-Chopped Haylage

- *most principles of silage management are the same (or similar)*
- *however, fermentation within baled silages is restricted by:*
  - *lack of chopping action*
  - *lower moisture concentrations*
  - *reduced DM density (maybe)*

3



Lactic Acid, The "Good Silage" Acid

plant sugars → lactic acid

Homofermentative

glucose or fructose + 2ADP + 2 Pi → 2 lactate + 2 ATP + 2 H_2O

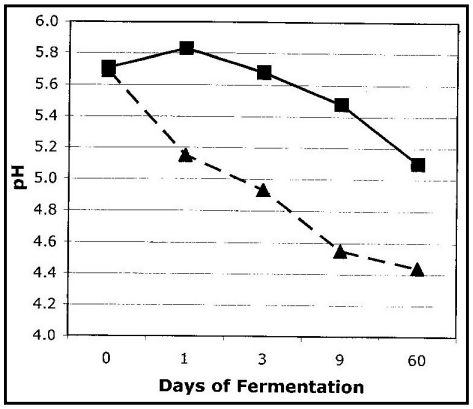
Heterofermentative (multiple pathways)

glucose or fructose + ADP + Pi → lactate, acetate, ethanol, mannitol, ATP, H_2O, and CO_2

4

Baled vs. Precision-Chopped Silage Alfalfa/Grass

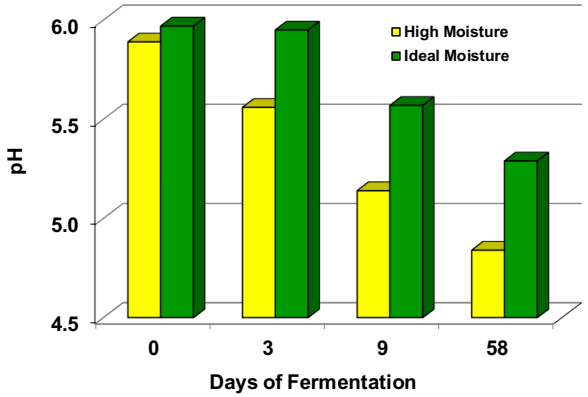
■ Baled Silage
▲ Chopped Silage



Muck (2006) – adapted from *Nicholson et al. (1991)*; mean moisture concentration was 61%

5

Fermentation Characteristics of Alfalfa Forages Ensiled in Large-Round Bales at High (60 to 65%) or Ideal (49 to 54%) Moisture



Nicholson et al. (1991)

6

Short Presentation Topics

- *bale-cutting mechanisms*
- *wrapping delays*
- *silage fermentation in cold weather*
- *aerobic stability**
- *wet silages**
- *dry silages**

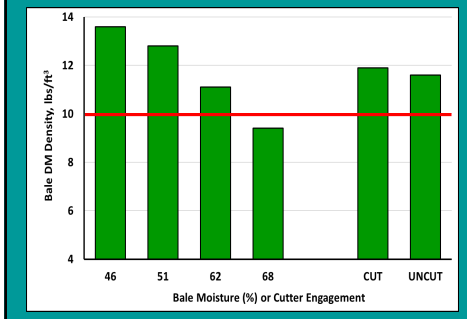
7

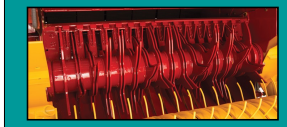
1) Bale-Cutting Mechanisms

- 15 retractable knives
- 3-inch cut

8

Goal: Bale Density >10 lbs DM/ft³ (162 kg DM/m³)



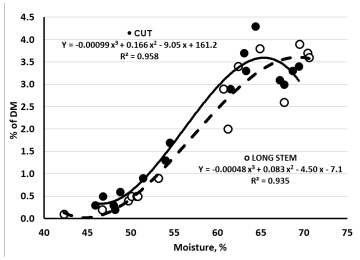


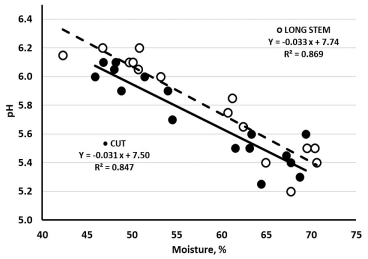
Coblentz and Akins, 2019

5.5 mph constant ground speed

9

Bale-Cutting Effects: Long-Stem vs. Cut Baled Alfalfa/Grass Silages





Lactic Acid ***Final pH***

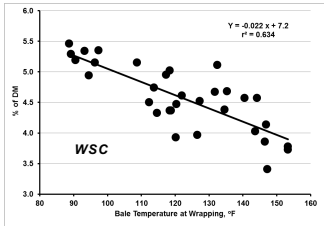
Coblentz and Akins (2019)

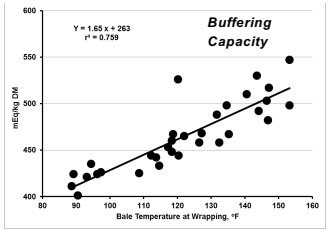
10

2) Wrapping Delays

11

Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays



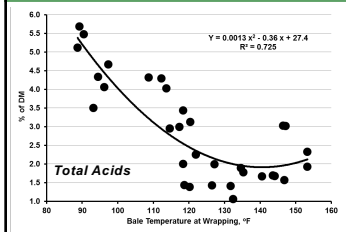


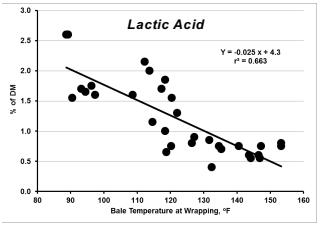
**** Round bales of alfalfa forage wrapped in plastic immediately after baling, or after 1-, 2-, or 3-day delays.***

Coblentz et al. (2016)

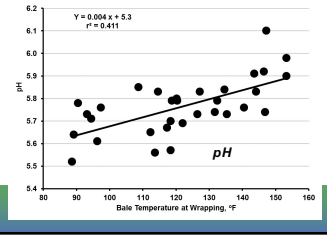
12

Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays





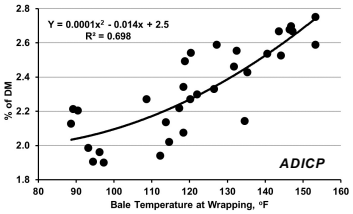
Initial Bale Moisture = 59.1%

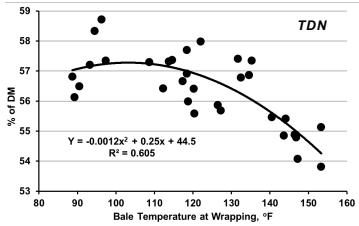


Coblentz et al. (2016)

13

Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays





Initial Bale Moisture = 59.1%

** While bales should be wrapped as soon as possible, this study suggests damage within the first 24 hours is relatively minor.*

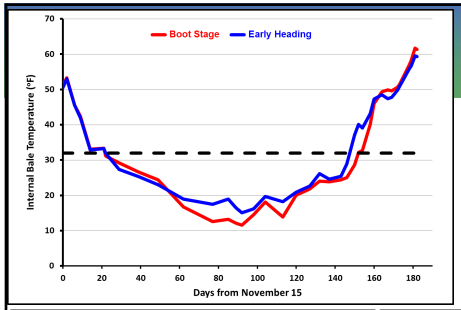
Coblentz et al. (2016)

14

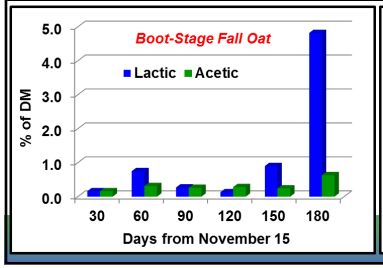
3) Silage Fermentation in Cold Weather

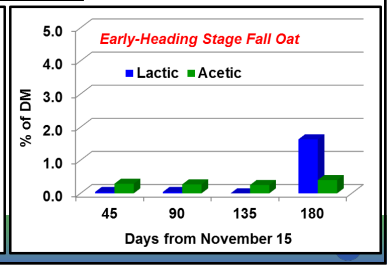
15

Effects of Cold Weather on Fermentation of Fall-Grown Oat



Coblentz et al. (2015)





16

4) Aerobic Stability

Common Question:

Silage is perishable. If I want to sell exposed bales, or feed them at some distance from the storage site where individual bale transport is inefficient, how long are they stable in air?

17

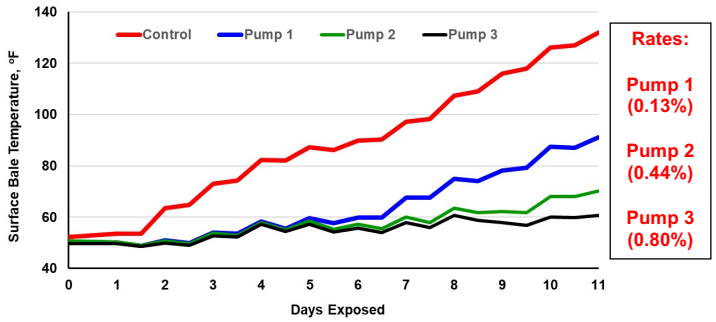
Use of Propionic-Acid Based Preservatives to Improve Aerobic Stability of Alfalfa-Grass Silages[1]

Treatment	pH	WSC, %	Lactic Acid, %	Acetic Acid, %	Total Acids. %
Application Rate, % of wet bale weight					
Control	5.54	5.13	1.25	0.25	1.84
0.13	5.58	6.25	0.91	0.19	1.24
0.44	5.49	6.19	1.00	0.20	1.34
0.80	5.45	6.42	0.85	0.15	1.09
Linear (P > F)	0.107	0.010	0.245	0.156	0.107
Moisture					
Ideal	5.36 b	5.38 b	1.49 a	0.29 a	2.04 a
Dry	5.68 a	6.62 a	0.52 b	0.11 b	0.71 b

[1] Alfalfa/grass forages were ensiled at 52 or 44% moisture and stored for 242 days.

18

Use of Propionic-Acid Based Preservatives to Improve Aerobic Stability of Alfalfa-Grass Silages[1]



[1] Alfalfa/grass forages were ensiled at 52 or 44% moisture and stored for 242 days. Bales were then exposed for 11 days (May) when the mean maximum air temperature was 57.6°F.

19

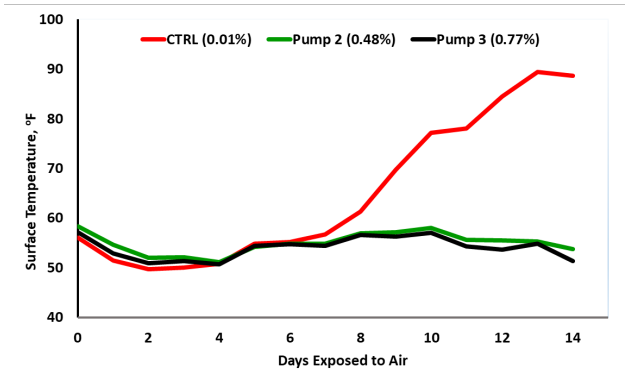
Eleven Days Post-Exposure: Surface Layer[1]

Treatment	pH	WSC, %	Lactic Acid, %	Acetic Acid, %	Total Acids. %
Application Rate, % of wet bale weight					
Control	6.52	3.45	0.68	0.09	0.88
0.13	6.03	5.22	0.69	0.08	0.86
0.44	5.63	5.93	0.93	0.19	1.22
0.80	5.41	5.91	0.96	0.18	1.21
Linear (P > F)	0.002	0.001	0.110	0.107	0.145
Moisture					
Ideal	5.95	4.78	1.15 a	0.19 a	1.46 a
Dry	5.84	5.48	0.48 b	0.07 b	0.63 b

[1] Alfalfa/grass forages were ensiled at 52 or 44% moisture and stored for 242 days.

20

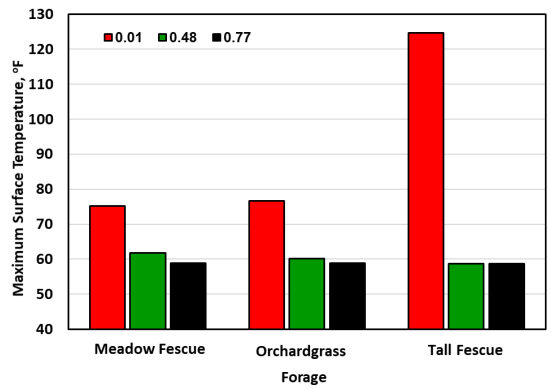
Use of Propionic-Acid Based Preservatives to Improve Aerobic Stability of Grass Silages [1]



[1] Meadow fescue, orchardgrass, and tall fescue forages were ensiled at 38% moisture and stored for 84 days. Bales were then exposed for 14 days (October) when the mean maximum air temperature was 57.7°F.

21

Use of Propionic-Acid Based Preservatives to Improve Aerobic Stability of Grass Silages[1]



[1] Meadow fescue, orchardgrass, and tall fescue forages were ensiled at 38% moisture and stored for 84 days. Bales were then exposed for 14 days (October) when the mean maximum air temperature was 57.7°F.

22

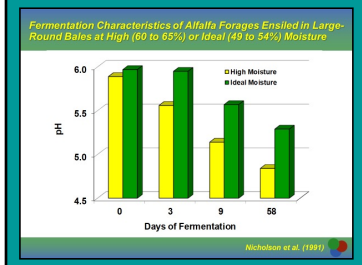
Use of Propionic-Acid Based Preservatives to Improve Aerobic Stability of Grass Silages[1]

Treatment	N[1]	ND[2]	--- Yeast (log cfu/g) --- Mean[3]	SD[4]
Application Rate[2], % of wet bale weight				
0.01 (Control)	12	1	6.46	0.589
0.48	6	1	4.56	0.902
0.77	6	2	4.53	1.018
Forage				
Meadow Fescue	8	2	4.67	1.326
Orchardgrass	8	1	6.01	1.006
Tall Fescue	8	1	5.99	0.977

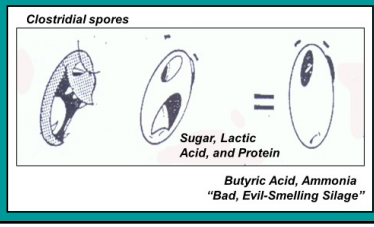
[1] N, number of total bales within each application rate or forage species.
[2] ND, number of bales in which yeasts were not detected at a 1000 cfu/g (3.0 log cfu/g).
[3] Mean of bales with yeast counts ≥ 3.0 log cfu/g.
[4] SD, standard deviation of yeast counts for bales ≥ 3.0 log cfu/g.

23

5) Wet Silages

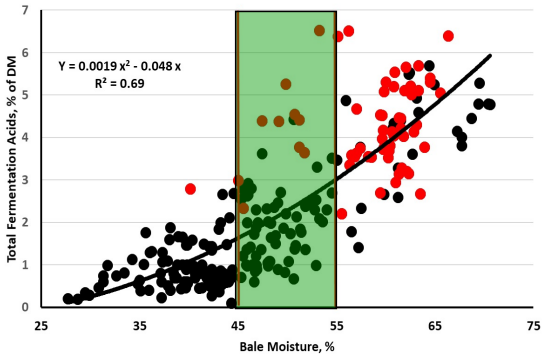


- **Safety**
  - undersized tractors, 4 x 4-ft (1.2 x 1.2-m) bale can weigh 1500 lbs (680 kg)
- **Equipment/Baler**
  - most balers handle drier forages better than wet ones
- **Clostridial Fermentations***



24

Butyric Acid in 243 Round-Baled Silages at Marshfield, WI[1]



[1] Red dots (•) indicate bales with butyric acid concentrations > 0.25% of DM.

25

Head off baleage feeding issues

by Jimmy Henning

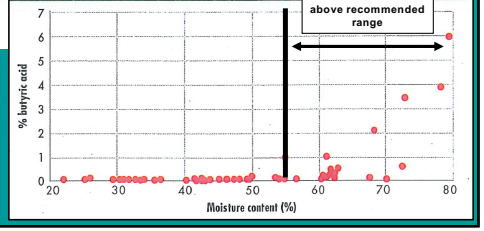
Hay and Forage Grower

February 2020

Kentucky Producer Survey

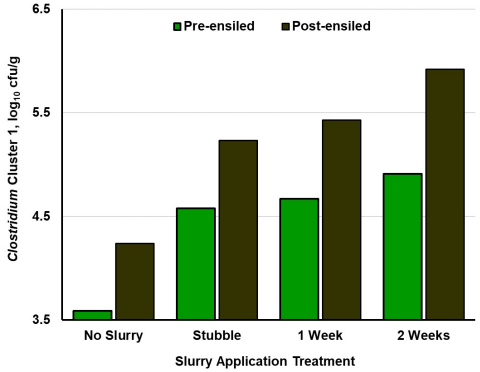
• Butyric Acid

Figure 3. Effect of moisture content on butyric acid concentration, Kentucky baleage, 2019



26

Clostridial Counts (log_{10} genomic copies/g) for Pre-Ensiled and Post-Ensiled Alfalfa Forages Following Applications of Dairy Slurry Using qPCR Methods[1]

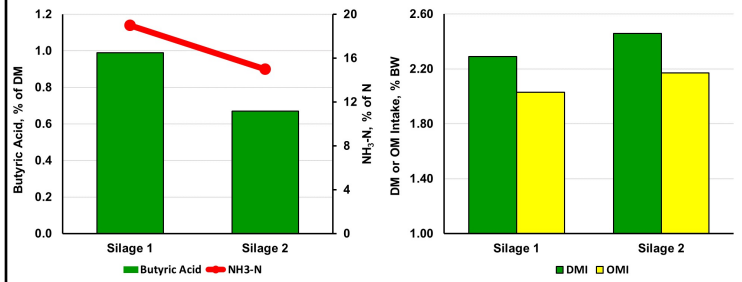


[1] *Clostridium tyrobutyricum* was not detected in dairy slurry or any forage/silage.

Coblentz et al. (2014)

27

Butyric Acid in Alfalfa Round Bale Silage and Voluntary Intake by Gestating Sheep



Adapted from Coblentz et al. (2016) and Niyigena et al. (2019)

28

6) Dry Silages

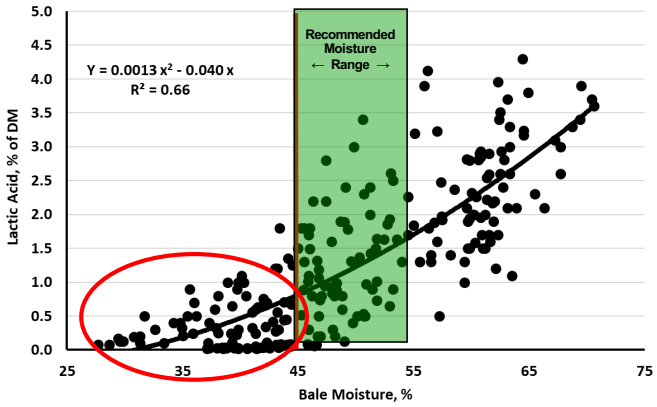
"An implication for management is that fermentation (or decreasing pH) is relatively unimportant in producing high-quality dry (> 55% DM) silages."

R.E. Muck [J. Dairy Sci. 71:2992-3002 (1988)]

** An observational trend (mine) is that producers (generally) are moving towards drier baled silages, placing increased emphasis on excluding air, and less on fermentation.*

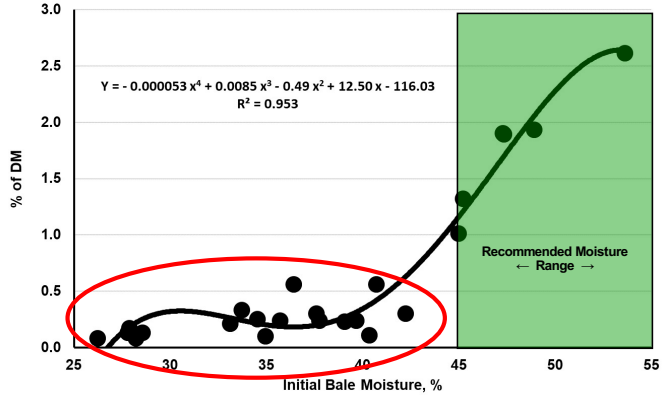
29

Lactic Acid Production in 243 Round-Baled Silages at Marshfield, WI[1]



30

Lactic Acid Production in 24 Round-Baled Grass Silages at Marshfield, WI[1]



31

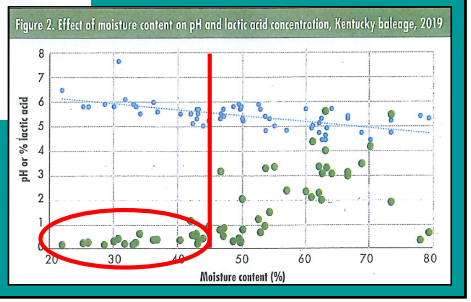
Hay and Forage Grower

February 2020

Kentucky Producer Survey

Head off baleage feeding issues

by Jimmy Henning



- pH
- Lactic acid

32

Question: What About Situations When Dry Hay Is Desired, But You Can't Get It Quite Dry Enough?

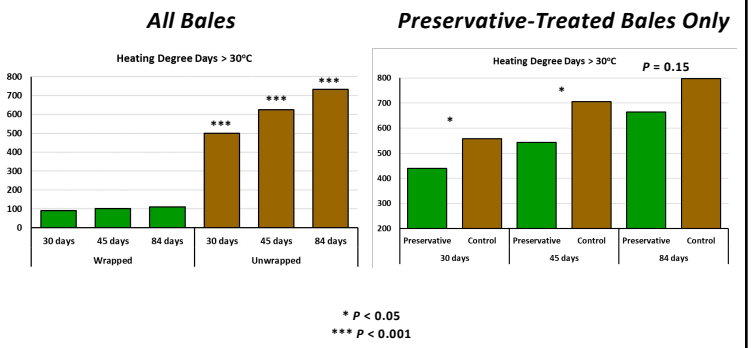
	-- Preservative[1] --		-- Plastic Wrap[2] --		
Characteristic	Yes	No	Yes	No	SEM
Diameter, ft	4.9	4.9	4.9	4.9	0.02
Volume, ft³	73.9	73.2	73.6	73.6	0.54
Wet Weight, lbs	1184	1160	1166	1177	17.2
Moisture, %	26.2	25.4	25.9	25.8	0.41
Dry Weight, lbs	873	864	864	873	11.9
DM Density, lbs/ft3	11.8	11.8	11.7	11.9	0.17
WSC, %	8.17	8.46	8.33	8.30	0.171

[1] Propionic-acid-based preservative applied at 0.27 ± 0.025% of wet bale weight.
[2] Bales wrapped individually in 7 layers of plastic film.
[3] Project supported by the National Alfalfa Forage Alliance US Alfalfa Farmer Research Initiative.

Coblentz et al. (2021); Applied Animal Science (accepted 6/25/2021)

33

Question: What About Situations When Dry Hay Is Desired, But You Can't Get It Quite Dry Enough?

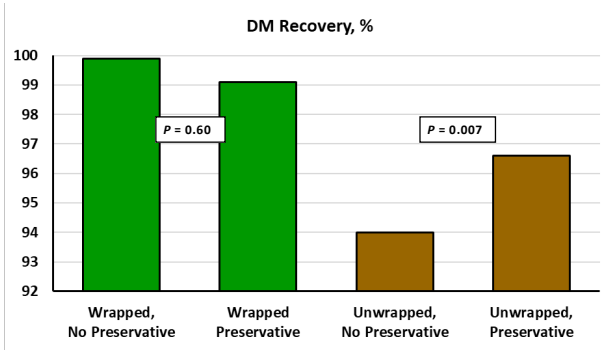


* $P < 0.05$
*** $P < 0.001$

Coblentz et al. (2021); Applied Animal Science (accepted 6/25/2021)

34

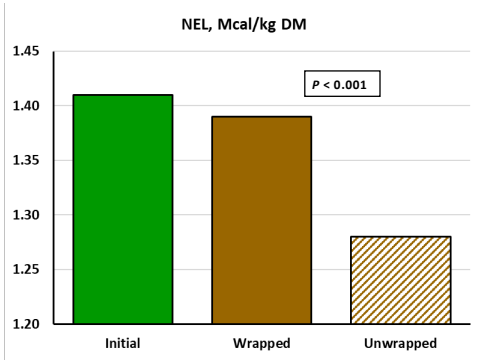
Question: What About Situations When Dry Hay Is Desired, But You Can't Get It Quite Dry Enough?



Coblentz et al. (2021); Applied Animal Science (accepted 6/25/2021)

35

Question: What About Situations When Dry Hay Is Desired, But You Can't Get It Quite Dry Enough?



Unwrapped bales changed statistically from pre-storage energy levels ($P < 0.001$), but wrapped bales did not.

Coblentz et al. (2021); Applied Animal Science (accepted 6/25/2021)

36

Question: What About Situations When Dry Hay Is Desired, But You Can't Get It Quite Dry Enough?

Item	Preservative	No Preservative	SEM	*P > F*
Number Bales	8	8	. . .	. . .
Moisture,%	26.0	24.6	0.78	0.170
pH	5.84	5.95	0.020	0.007
WSC, %	7.74	7.66	0.233	0.793
Lactic Acid, %	0.34	0.30	0.023	0.124
Acetic Acid, %	0.32	0.29	0.021	0.336
Total Acids, %	1.01	0.94	0.051	0.231
Total Alcohols, %	0.71	0.50	0.019	< 0.001

Coblentz et al. (2021); Applied Animal Science (accepted 6/25/2021)

37

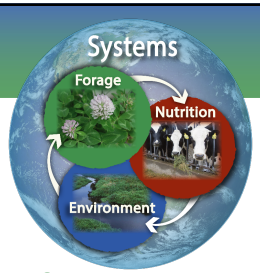
Yeast Counts of Wrapped Bales after 33 Days of Exposure: November 6 - December 9, 2020

Item	Preservative	No Preservative
Number Bales	8	8
Surface (6 inches)		
Non-Detectable	2	1
Mean, log_{10} cfu/g	4.90	5.59
SD, log_{10} cfu/g	1.250	1.107
Core		
Non-Detectable	4	1
Mean, log_{10} cfu/g	3.69	4.18
SD, log_{10} cfu/g	1.200	0.610

Coblentz et al. (2021); Applied Animal Science (accepted 6/25/2021)

38

QUESTIONS?



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39