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UNIVERSITY of FLORIDA

Range Cattle
Research & Education Center



The use of additives to improve
fermentation and nutritive value
of warm-season forage haylage

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Outline

- **Introduction**
- Wilting
- Inoculant
- Additives
- Conclusions

Introduction

- Definition (Vendramini and Moriel, 2019)

Baleage = Forage preserved by fermentation in a bale with lesser DM concentration than hay ($\leq 85\%$ DM) but greater than silage ($\geq 30-35\%$ DM)

Haylage = Forage preserved by fermentation with lesser DM concentration than hay ($\leq 85\%$ DM) but greater than silage ($\geq 30-35\%$ DM)

Silage = Forage preserved by fermentation at $\leq 30-35\%$ DM

Introduction



- In tropical and subtropical regions, silage has been used as a method of forage conservation for decades, primarily by dairy or feedlot operations



Introduction



- The development of machinery to wrap round bales has triggered the interest of beef cattle producers to produce warm-season grass silage



Introduction



- Warm-season grasses have undesirable characteristics for successful preservation by fermentation
 - High water concentration
 - Decreased concentration of water soluble carbohydrates (WSC)
 - The main WSC stores is starch, and LAB do not have the ability to ferment starch directly (McDonald et al. 1991)

Introduction

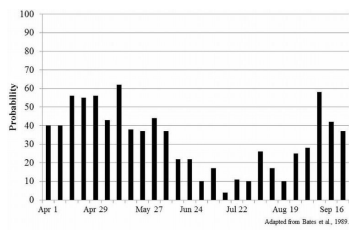
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Introduction

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- However, it may be the only option to preserve forages in tropical and sub-tropical regions during the summer



Introduction

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	Target Values
Dry matter (%)	> 30%
pH	< 5
Lactic acid (%)	6-8
Acetic acid (%)	< 2
Propionic acid (%)	0-1
Butyric acid (%)	< 0.1
Mold count (cfu/g)	< 300,000

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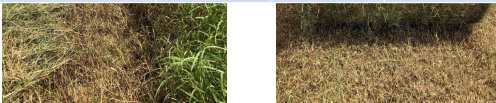
Dry matter concentration



DM concentration



	High DM	Low DM	P value
DM (%)	53	22	<0.01
pH	4.7	4.4	<0.01
Lactic acid (%)	4.3	2.8	<0.01
Acetic acid (%)	1.2	3.9	<0.01
Ammonia (%)	7.6	13.7	<0.01



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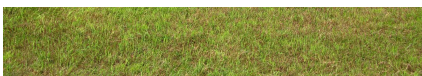
Inoculants



Inoculants



Item	Inoculant								P value	SE
	Control	B500	BPII	ESA	F20	F600	HQ	VS-3		
pH	4.6 ^a	4.95 ^{ab}	4.9 ^a	4.8 ^a	4.6 ^{ab}	4.91 ^{ab}	4.7 ^a	4.6 ^a	0.007	0.1
Lactic acid, % DM	2.23 ^a	0.60 ^{ab}	0.91 ^{ab}	1.64 ^{ab}	1.59 ^{ab}	0.47 ^a	1.64 ^{ab}	1.97 ^a	0.01	0.68
Acetic acid, % DM	2.45 ^{ab}	3.32 ^a	2.35 ^{ab}	2.46 ^{ab}	2.41 ^{ab}	1.84 ^{ab}	2.03 ^{ab}	0.32 ^a	0.04	0.32
Propionic acid, % DM	0.35	0.39	0.29	0.40	0.35	0.57	0.31	0.27	0.40	0.15
Butyric acid, % DM	3.24	3.90	3.19	4.78	4.11	4.73	4.22	3.88	0.64	1.1
Isobutyric acid, % DM	0.15	0.17	0.20	0.25	0.11	0.11	0.14	0.09	0.28	0.3
Ammonia, % CP	21.2	28.0	29.6	26.1	18.6	20.6	21.6	19.8	0.09	6.1



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Fermentation Enhancer



<https://www.youtube.com/watch?v=9sTKjVxFmKQ&t=210s>


Fermentation Enhancer




	Control	Molasses	P value
DM (%)	22	24	0.64
CP (%)	13.1	12.3	0.18
WSC (%)	0.4	1.0	<0.01
IVTD (%)	53	58	<0.01
pH	4.8	4.6	<0.01
Lactic acid (%)	2.7	3.6	<0.01
Acetic acid (%)	0.8	0.9	0.13
Ammonia (%)	8.3	9.8	0.15

Fermentation Enhancer

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	Control	Molasses	<i>P</i> value
Digestibility (%)	56	59	0.07
Intake (% BW)	1.4	1.7	<0.01




Propionic Acid

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Propionic Acid

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	Propionic acid (% Green Forage)			Contrast	SE
	0	0.5	1.0		
DM (%)	27.6	29.4	29.9	Linear	0.41
CP (% DM)	14.6	14.5	14.9	NS	0.14
ADF (% DM)	37.9	35.1	34.9	Linear	0.42
NDF (% DM)	66.8	62.9	62.5	Linear	1.30
TDN (% DM)	55.3	56.6	56.5	Linear	0.44



Propionic Acid

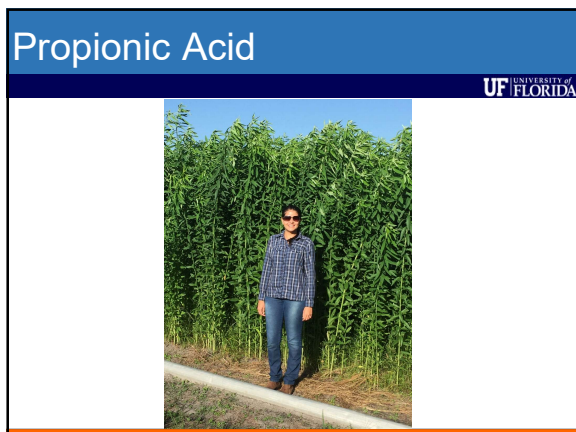
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	Propionic Acid (% Green Forage)			Contrast	SE
	0	0.5	1.0		
DM (%)	27.6	29.4	29.9	Linear	0.41
pH	5.2	4.6	4.3	Linear	0.2
Lactic Acid (% DM)	2.10	4.40	3.53	Quadratic	0.65
Acetic Acid (% MS)	0.40	0.85	0.77	Quadratic	0.07
Propionic Acid (% DM)	0.13	1.15	2.96	Linear	0.04
Butyric Acid (% DM)	3.59	0.43	0.07	Linear	0.15
Isobutyric Acid (% DM)	0.24	0.003	0	Linear	0.06
Ammonia (% N)	14	11	14	Quadratic	0.8
Mold and Yeast (log CfU/g)	1.7	0.3	0.3	Linear	0.2

Propionic Acid

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	Propionic Acid (% Green Forage)				SE
	0	0.5	1.0	0.5+ESA	
DM (%)	24	27	26	24	0.41
CP (%)	11.0	11.4	14.0	11.6	0.65
pH	5.1a	4.5b	4.3b	4.5b	0.14
Lactic Acid (% DM)	0.1c	3.8b	5.3a	3.8b	0.60
Acetic Acid (% MS)	1.6a	0.8b	0.9b	0.9b	0.08
Propionic Acid (% DM)	0.5c	0.8bc	2.1a	0.9b	0.15
Butyric Acid (% DM)	4.5a	1.3b	0.1b	1.3b	0.06
Isobutyric Acid (% DM)	0.2a	0.05b	0.00b	0.05b	0.03
Ammonia (% N)	31.8a	16.6b	19.8b	19.8b	3.5



Propionic Acid

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	Propionic Acid (% Green forage)			Contrast	SE
	0	0.5	1.0		
pH	5.6	5.4	4.5	Linear	0.18
Lactic acid (% DM)	0.03	1.47	5.68	Linear	1.17
Acetic acid (% DM)	5.00	2.39	2.16	Linear	0.23
Propionic acid (% DM)	1.78	2.40	3.80	Linear	0.30
Butyric acid (% DM)	5.09	3.93	0.38	Linear	0.91
Ammonia (% N)	57	42	21	Linear	7.7



Propionic Acid

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Control (Untreated)



0.5% Propionic Acid



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Conclusions



- Additives to promote fermentation may improve fermentation characteristics and nutritive value
- Propionic acid (0.5% green forage) has been effective to improve nutritive value and fermentation of warm-season perennial grass haylage
- The estimated cost to add propionic acid to haylage in Florida is approximately \$10 / ton of haylage.

Thank you



Southeast Dairy Inc. and the Milk Check-Off Research and Education Committee

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