Evaluation of a *Bacillus* spp. probiotic on beef cattle performance, nutrient digestibility and enteric methane emissions

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Introduction

- Probiotics have been proposed as a 'natural' alternative in an attempt to increase profitability while reducing the environmental impact
- *Bacillus* spp. is a spore forming bacteria, presenting an advantage when compared to other probiotics to be used as a feed additive due to the resistance to manufacturing and handling
- Most of the research has been done in dairy, and there is still limited information regarding the effects of *Bacillus* spp. probiotics on beef cattle

We hypothesized that the inclusion of a *Bacillus* spp. probiotic in growing beef heifers' diet could enhance nutrient digestibility and possibly decrease CH_4 emissions improving animal performance or efficiency.

Thus, the objective of this study was to evaluate a multi-strain *Bacillus* probiotic composed of *B. subtilis* and *B. licheniformis* on beef heifers' performance, nutrient digestibility, and enteric CH_4 emissions.

Materials & Methods

- The experiment was conducted at the NFREC, Feed Efficiency facility
- A total of 108 Angus-crossbreed heifers were used in a generalized randomized block design
- Heifers were sorted in 12 pens equipped with Growsafe System and fed a sorghum-silage based diet containing 1 of the 2 following treatments

1- control (CTL, no additive)

2- *Bacillus* spp. probiotic (BSL, 310 mg/kg of diet DM)

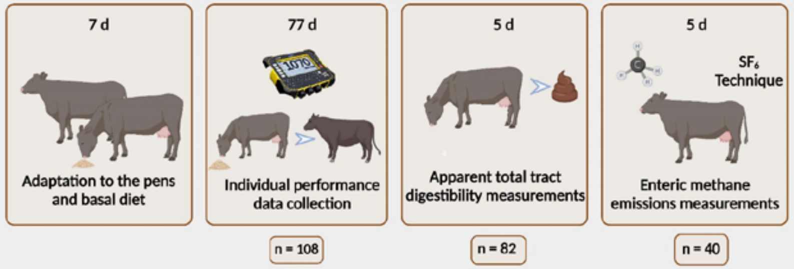
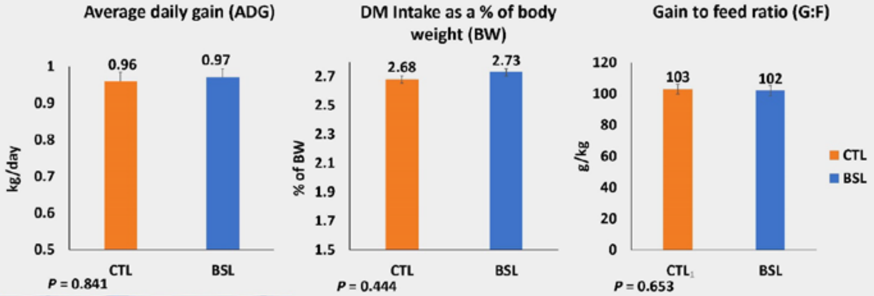


Figure 1. From left to right: Heifers in the pens; Heifer with a yoke utilized for methane measurement; Feed efficiency facility

Results

Performance



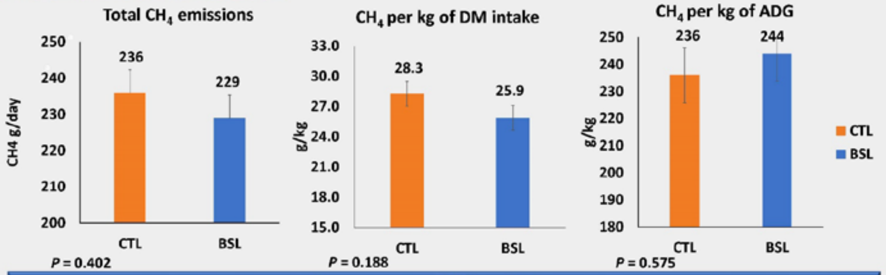
Apparent total tract digestibility

Table 1. Apparent total tract digestibility of nutrients as a percentage of DM.

	Treatment			
Item[1]	Control	*Bacillus* spp.	SEM[2]	*P*-value[3]
Digestibility, % DM				
DM	51.28	51.68	0.462	0.547
OM	52.81	53.51	0.489	0.315
CP	42.13	43.51	0.691	0.161
NDF	43.64	42.95	0.476	0.312
ADF	42.56	41.73	0.537	0.278
Starch	82.74	79.46	1.021	0.027

[1]DM= dry matter; OM= organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber.
[2]Standard error of the mean. n = 41 heifers/treatment.
[3]Observed significance level for Treatment (n = 41 heifers/mean).

Enteric methane (CH_4) emissions



Summary and Conclusions

- No differences were observed on heifers' performance
- Digestibility of DM, OM, NDF, ADF, and CP did not differ, whereas starch digestibility decrease
- Enteric methane emissions were not reduced when the probiotic was included in the diet

The multi-strain *Bacillus* spp. probiotic did not improve performance or efficiency when fed at 310 mg/kg of DM to growing beef heifers

Below ground benefits of cactus Opuntia stricta under rangeland conditions in Laikipia, Kenya

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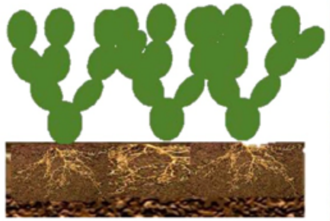
FORAGE TEAM

Introduction

- The ability of cactus to tolerate poor soils and accumulate biomass under low precipitation has attracted studies into its potential use for biofuel and livestock feed.
- However, few studies have assessed the below-ground benefits associated with the plant
- Cactus roots could be a potential sink for the below-ground carbon, offsetting emissions of greenhouse gases while offering other below-ground ecosystem services.
- Evaluating and documenting these benefits is imperative for policymakers, especially in regions where the invasive species cactus is viewed as an 'evil plant' that should be eradicated



- **The objective** was to evaluate root mass and soil properties along cluster gradients of invasives cactus species under rangeland conditions.
- **We hypothesized** differences in root mass and soil properties along cluster gradients of cactus

Methods

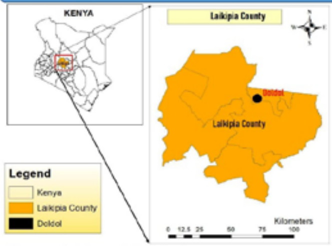


Figure 1: Map of the study area

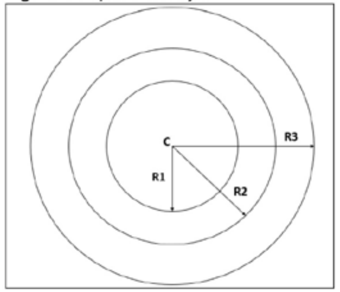


Figure 2: Cluster gradients for soil and roots samples

The experiment was laid out in a randomized complete block design with ten (10) replicates, each measuring 30 × 30 m.

Each block was further subdivided into three plots of 10 × 30m

Treatments- 4 gradients of root and soil sampling:

1) C=center of the cluster - 0 m
2) R1= first radius (inner most) - 1.2 m
3) R2= second radius - 2.4 m
4) R3=third radius (outer most) - 3.6 m

A total of three clusters were sampled from each plot

Response variables

- Root data - dry root biomass, % carbon, %nitrogen
- Soil data pH, bulk density, % moisture, % nitrogen

Data analysis model; Y= μ + block + β_n + Error.

Significant means were separated using Tukey's HSD $P \leq 0.05$.

Results

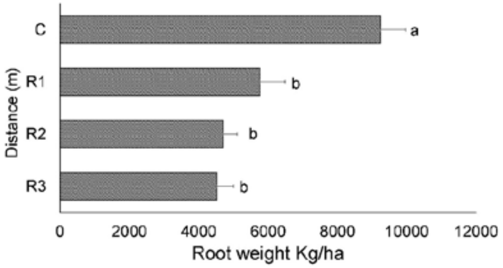


Figure 4: Root mass along cluster gradients

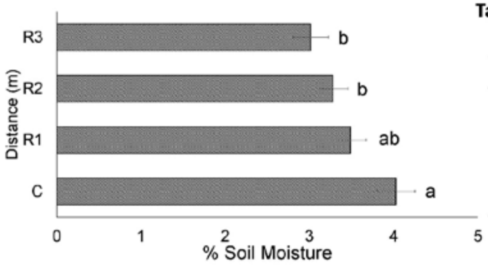


Figure 5: Soil moisture along cluster gradients

Table 1: Soil properties along different gradients of cactus clusters

	Distance					
Variables	**C**	**R1**	**R2**	**R3**	**SEM**	***P*-value**
pH	6.71[a]	6.88[ab]	7.04[bc]	7.08[c]	0.08	<.001
Bulk density (g/cm^3)	1.25[a]	1.40[b]	1.46[bc]	1.47[c]	0.03	<.001
% Nitrogen	0.15	0.13	0.11	0.11	0.02	NS

*Averages followed by the same letter do not differ by the Tukey test ($P \leq 0.05$)

Conclusion

- The roots of invasive cactus *Opuntia stricta* play an important biological role in sustaining the ecological functions of rangeland soils such as those in Laikipia, Kenya
- Ability to accumulate root biomass under harsh conditions in drylands offers a great potential for the use of cactus as an alternative crop for carbon storage in drylands
- Similarly, the ability of this plant to modify the physical and chemical properties of soils could potentially be tapped into to reclaim marginal lands in ASAL regions.
- We conclude that invasive cactus species are alternative rangeland resources that call for sustainable management approaches, not eradication.

Effect of feeding a *Saccharomyces cerevisiae* fermentation product on ruminal fermentation, methane emissions and nutrient utilization in beef cattle.

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Introduction

- *Saccharomyces cerevisiae* fermentation product **(SCFP)** is a product of yeast fermentation, as opposed to live yeast, which has not gone through the fermentation process. SCFP is produced via an anaerobic fermentation process by fermenting selected liquid (e.g., cane molasses) and cereal grain raw ingredients (e.g., roughage products and processed grain by-products) with *S. cerevisiae*
- It has been proposed that SCFP contains fermentation metabolites as stimulatory nutrients to specific fiber-digesting (Wiedmeier et al., 1987) and lactate-utilizing (Callaway and Martin, 1997) bacteria

We hypothesize that by affecting the ruminal microbial population with the use of SCFP, could result in a modification of the fermentation profile to more favorable fermentation pathways. Therefore, the objective was to evaluate the effects of feeding a SCFP on ruminal fermentation parameters, enteric methane emissions and nutrients utilization in beef steers fed a high-grain diet.

Materials & Methods

6 ruminally cannulated Angus-crossbred steers were used in a crossover design. 2 periods 42 days each

Treatments:
- **CTL**, steers received only 250 g of a carrier (DDGS)
- **SCFP**, steers received 250 g of a carrier (DDGS) + 28 g of **SCFP**

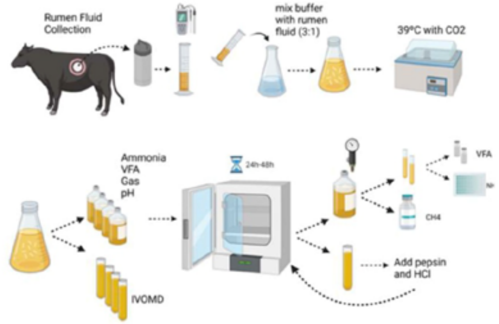
Adaptation | Week of measurements | Washout

Day 0
Ex situ Batch culture (24 h Incubation)
- **before treatment dosing**

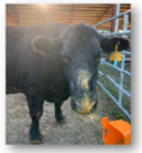
Day 21
Ex situ Batch culture (24 h incubation)
- **after 21 d of adaptation to treatments)**

Day 23
24 h collection (ruminal fluid collection every 3 h)

Day 24 to 28
Apparent Total tract digestibility
- **Feed samples (iNDF)**
- **Feces samples (iNDF)**



Ex-situ (in vitro) batch culture incubation



Results & Conclusion

In vitro batch culture incubation

No significant differences
P > 0.05

pH | In vitro organic matter digestibility | Ammonia Nitrogen | Volatile fatty acids (VFA) | Methane Production

In vivo 24h rumen fluid collection

No significant differences **P > 0.05** → Ammonia Nitrogen, pH

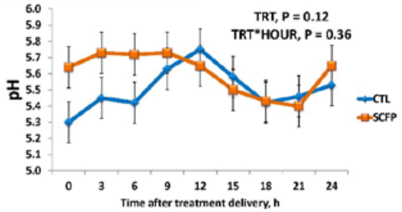


Figure 1: Rumen fluid pH after treatment delivery

Significant differences **P < 0.05** → Volatile fatty acids (VFA)

	Increase	Decrease
(m*M*)	A:P	Total VFA Propionate Butyrate
(mol/100 mol)	Acetate	Propionate Butyrate

Apparent total tract digestibility

No significant differences **P > 0.05** → Organic matter digestibility, Fiber digestibility (NDF, ADF)

Significant differences **P < 0.05** → **Increase**: Dry matter digestibility, Crude Protein digestibility, Starch digestibility

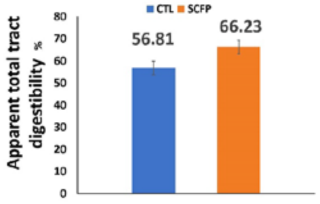


Figure 2: Dry matter apparent total tract digestibility

Given these results, the supplementation of *Saccharomyces cerevisiae* fermentation product at 28 g/d altered rumen fermentation in vivo and improved nutrient utilization in beef steers fed a high grain diet.