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

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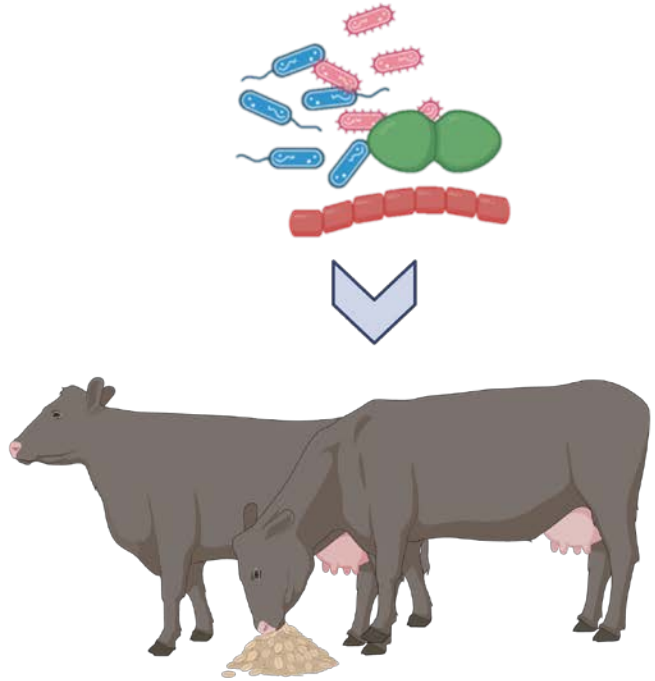
Probiotics

Live microorganisms that, when administered in adequate amounts, confer a benefit to the host[1]

Inhibits pathogen colonization

Support the immune system



Enhance performance and production

Enhance the fermentative process

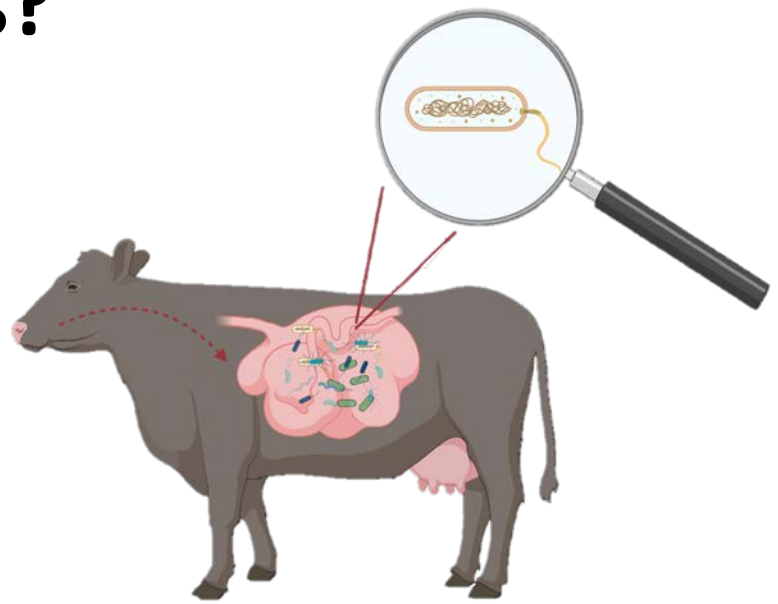
Improve nutrient utilization and feed efficiency

Mitigate enteric methane emissions

[1] FAO, 2001
Adapted from: Dhama et al., 2008

Why *Bacillus* species?

- ***Bacillus*** **spp. are Gram positive, aerobic or facultative anaerobic endospore forming bacteria**

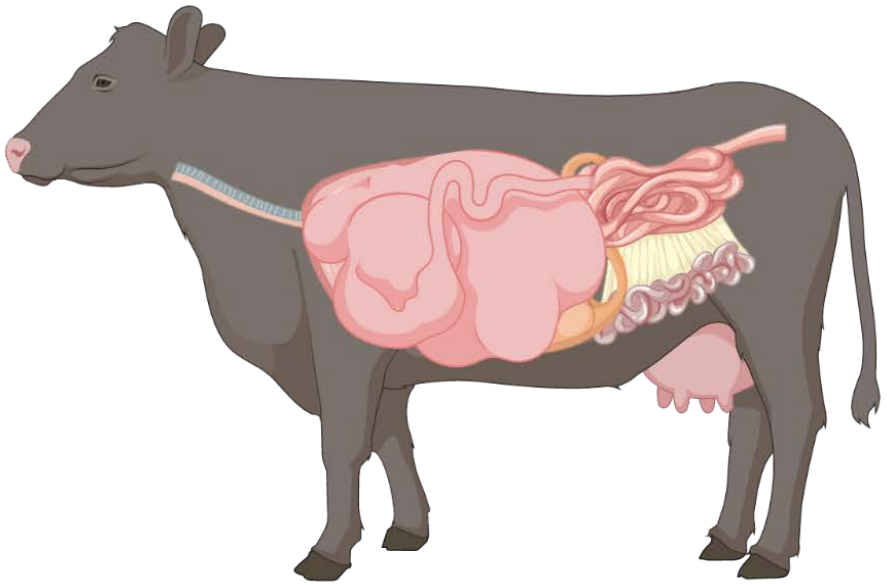


Spores → **Resistant to physical and environmental factors** → **Useful for long storage and handling** → **Versatility**

Bacillus spp. mode of action

Rumen

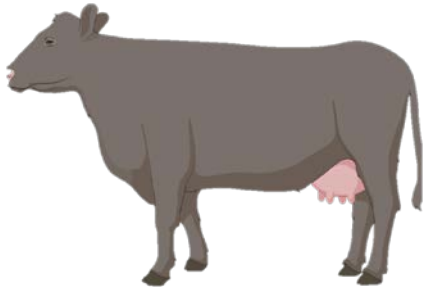
- Modify microbial population
- Alter the fermentation patterns
- Antimicrobial activity
- Enzymatic release
- Secret bacteria growth factors and nutrients



Post-ruminal gastrointestinal tract

- Competitive exclusion
- Stimulation of the immune system
- Synthesis of antimicrobials
- Modulation of the gut microbiota

Previous research



Milk components[1,2]
Milk yield [3]

Nutrient digestibility[2]
VFA production[1]
Microbial protein[1]

Improve performance[4]

Feed efficiency[7]

Promote maturation of rumen microbiota[5]

Reduction of enteric CH_4 emissions[8]

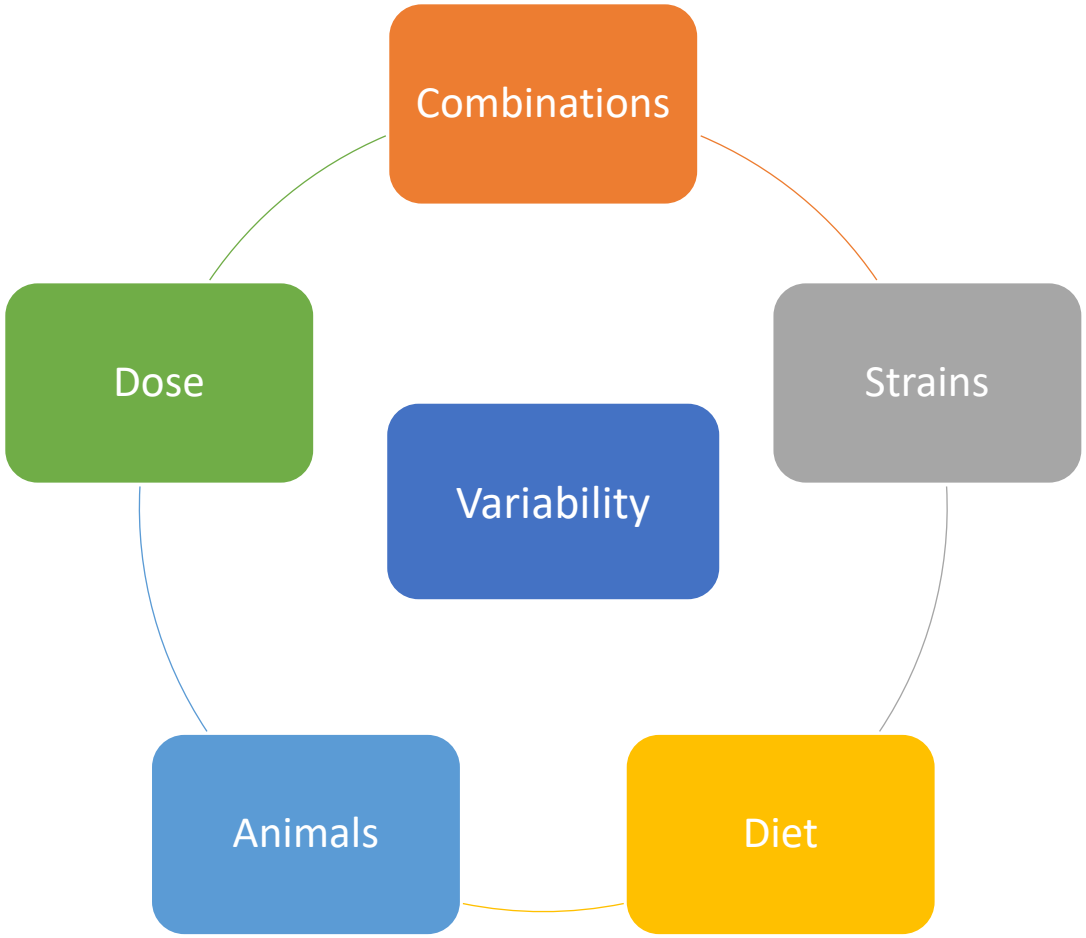
Inconsistent results[9,10]

Finishing beef cattle[11,12]

Few studies

[1] Quiao et al., 2008; [2] Sun et al., 2013; [3] Peng et al., 2012; [4] Sun et al., 2016; [5]Kowalski et al., 2008; [6] Sun et al., 2010; [7] Peng et al., 2012; [8]Deng et al., (2018); [11] Smith et al., 2021; [12] Smock et al., 2020; [9]Calaca et al., 2022; [10] Dias et al., 2022

Previous research and questions



Objective

Evaluate the effects of a multi-strain *Bacillus* probiotic on beef heifers' performance, nutrient digestibility and methane emissions

Hypothesis

Probiotic inclusion would improve performance and feed efficiency by enhancing nutrient digestibility and would decrease enteric methane emissions

Materials and Methods

- 108 Angus-crossbreed replacement heifers on a general randomized block design

- Fed ad-libitum sorghum silage-based diet:

  63 % of sorghum silage, 25 % cotton burrs, 10% cottonseed meal, and 2% premix

- Treatments

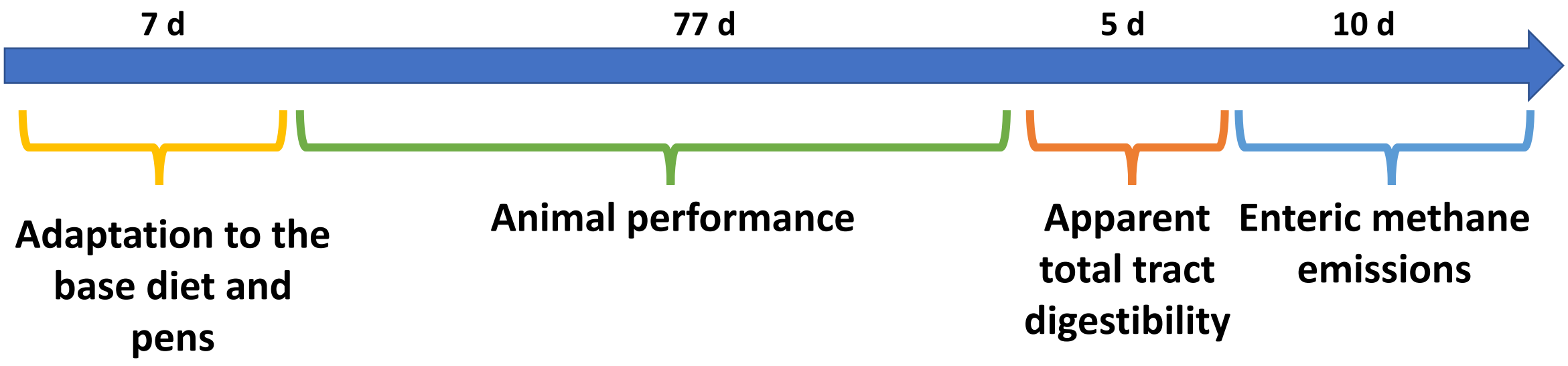
  1- Control (CTL, no additive)

  2- Bacillus spp. probiotic (BSL, 310 mg/kg of DM) to achieve a target dose of 2 g animal / day

  Probiotic → Mixture of *B. licheniformis* and *B. subtilis* at 3.2×10^9 CFU/g

Materials and Methods

Timeline

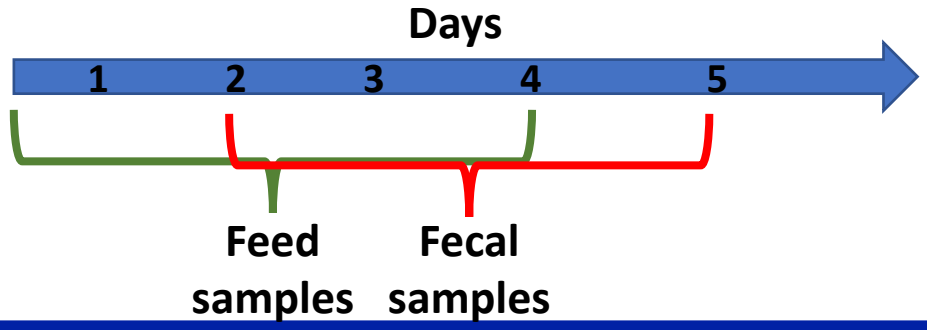


Animal performance

- 108 heifers → 54 per treatment
- Initial and final BW was obtained by double weight at the beginning and at the end of the performance phase
- Daily individual DM intake → GrowSafe feed bunks

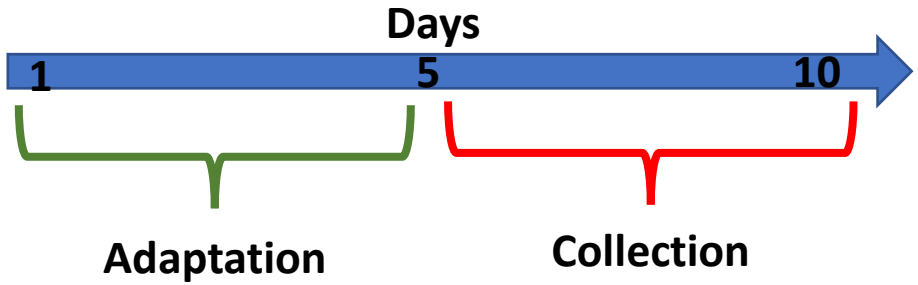
Apparent total tract nutrient digestibility

- Subsample of 80 heifers → 40 per treatment
- Using iNDF as an internal marker
- Feed and fecal samples collected twice a day, during 4-d each
- Analyzed for DM, OM, CP, NDF, ADF and starch digestibility



Enteric methane emissions

- Subsample of 42 heifers →21 per treatment
- Using the sulfur hexafluoride (SF_6) tracer technique
- 5 days of adaptation to the collection canisters
- 5 days of gas collection

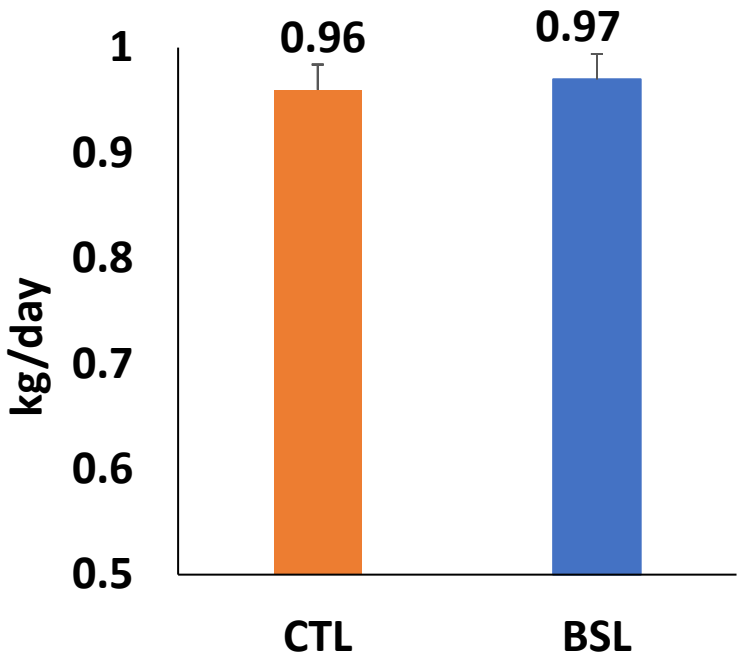


Statistical Analysis

- Data were analyzed by MIXED Procedure of SAS
- Generalized randomized block design
- Experimental unit : Heifer
- Fixed effect: Treatment and Pen (treatment)
- Significance $P \leq 0.05$
- Initial body weight was tested as a covariate and included when significant

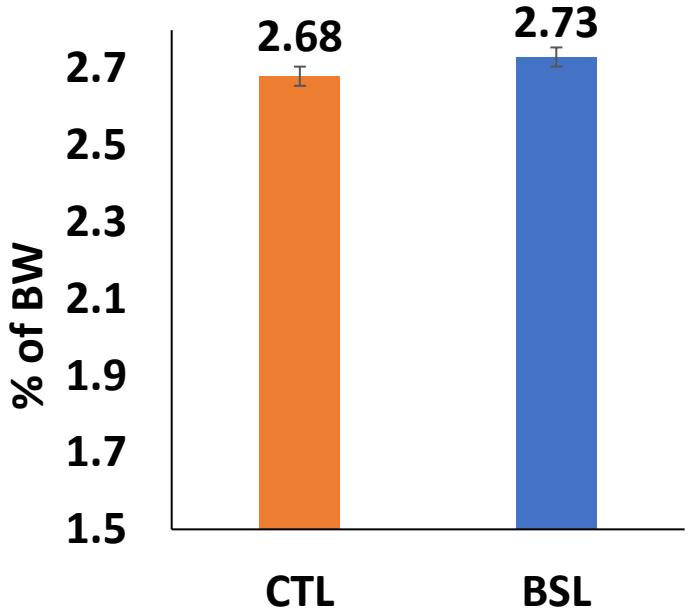
Performance results

Average daily gain (ADG)



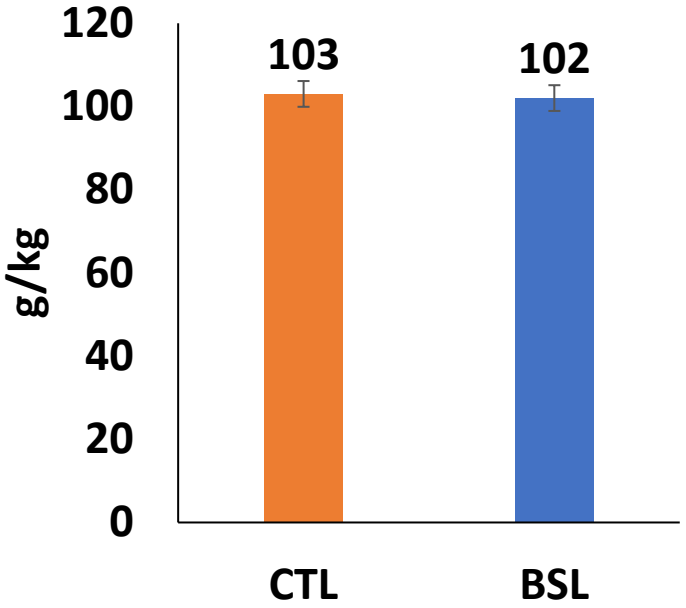
P = 0.841

DM Intake as a % of body weight (BW)



P = 0.444

Gain to feed ratio (G:F)



P = 0.653

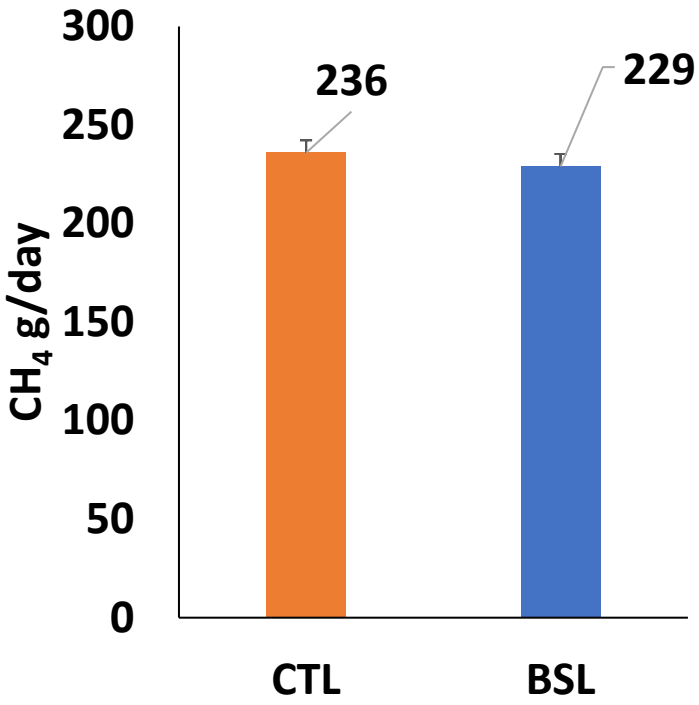
Apparent total tract digestibility results

	Treatment			
Item[1]	Control	*Bacillus* spp.	SEM[2]	*P*-value[3]
Intake, kg/d				
DM	8.64	8.68	0.289	0.940
OM	7.23	7.32	0.241	0.809
CP	1.55	1.55	0.053	0.987
NDF	5.53	5.47	0.188	0.819
ADF	3.25	3.03	0.105	0.144
Starch	1.71	1.71	0.069	0.970
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 = 40 heifers/treatment.
[3]Observed significance level for Treatment (n = 40 heifers/mean).

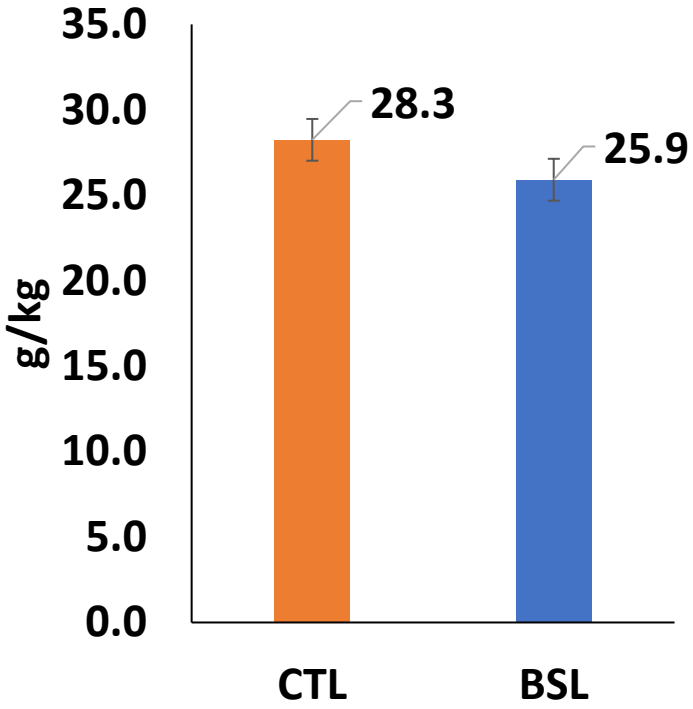
Enteric methane emissions results

Total CH_4 emissions



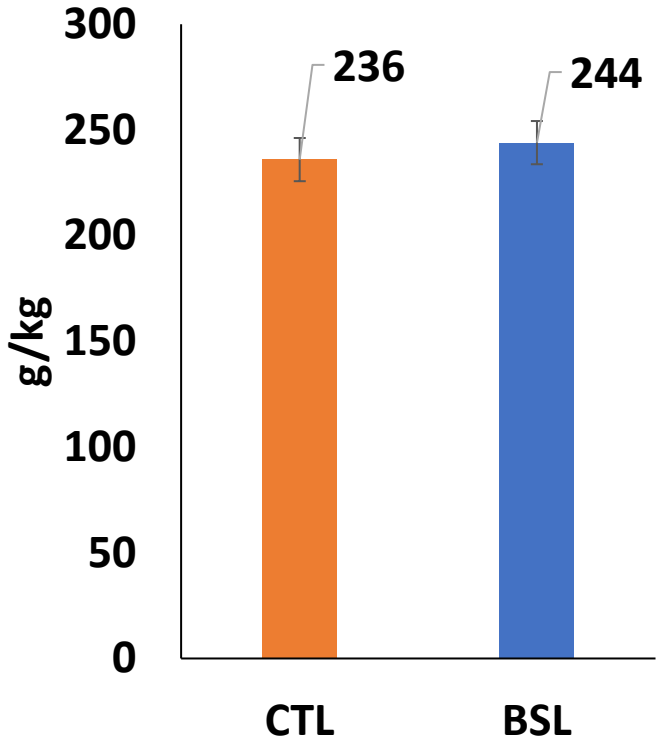
P = 0.402

CH_4 per kg of DM intake



P = 0.188

CH_4 per kg of ADG



P = 0.575

Summary and conclusions

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

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

Acknowledgements

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Thank you!