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Does processing of the straw have an effect on methane production from feedlot beef cattle?

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Introduction

Enteric methane from all ruminant species

Asia:	37%
S. America:	23%
Africa:	17%
Europe:	10%
N. America:	9%
Oceania:	3%

(FAOSTAT, 2020)

Annual enteric-methane emissions (CO_2-equiv; million tons) from cattle in Europe

Dairy:	81.1
Non-dairy:	101.1

(FAOSTAT, 2020)

Enteric CH_4 (*ca*. 3.5% of anthropogenic GHG)

Introduction

Feedlot beef cattle

Enteric CH_4

Million tons enteric CH_4/year from beef cattle in Western Europe

Grassland-based:	**21.89**	
Mixed systems:	**27.53**	(Opio et al., 2013)
Feedlot:	**0.73**	

Loss of energy

2-12% of gross energy intake

(Johnson and Johnson, 1995)

Introduction

Strategies to reduce enteric CH_4 production

Additives promoting the synthesis of propionate (malate, fumarate, crotonate)

Use of tannins and saponins

Use of linseed or rapeseed oils

Use of algae in the diet

Enteric CH_4

Use of probiotics

Vaccination against methanogenic microorganisms

Stimulation of acetogenic bacteria

Defaunation of determined species of protozoa

Genetic selection of animals with a more efficient microbiome

Inclusion of different cereals in the diet

Manipulation of ration's particle size

Free choice feeding

Introduction

Reduction of forage particle size

- **Increases ruminal passage rate**
- **Decreases organic matter degradation in the rumen**
- **Shifts fermentation toward propionate production with less CH_4 production**

(McAllister et al., 1996; Beauchemin et al., 2008, 2022)

Introduction

Reduction of forage particle size

However…

…very few papers directly measuring CH_4 production in cattle fed forages either in the long or in the ground and pelleted form:

Hironaka et al. (1996)

Benchaar et al. (2001)

Alfalfa hay as unique ingredient

>

Energy loss as methane

Introduction

Feedlots

Low quality forage (e.g. cereal straw)

Effect on CH_4 production ?

Objective

Assess the effect of straw processing on methane production from feedlot cattle

Materials and methods

18 cross-bred Montbéliarde males. Rumen cannulated and Individually housed

359 ± 2.7 kg
250 ± 0.4 days

Commercial concentrate

Group LS (n=9)

Group PS (n=9)

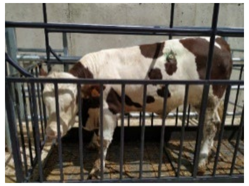
6 mm sieve
8 mm granule Ø

Ad libitum

Materials and methods

14d adaptation and recovery from surgery

112d trial



112d trial

d0 d28 d56 d84 d112

Daily intake: Concentrate and straw

LS

PS

Concentrate offered at 0800

Straw offered at 0900, 1200 and 1800

Materials and methods

14d adaptation and recovery from surgery

112d trial

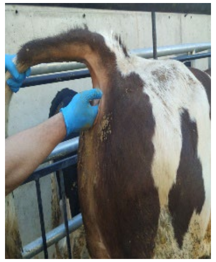
112d trial

d49 d57

Digestibility

Offer of Cr-labelled concentrate

Faeces sampling (0900 and 1700)



$4^{0}/_{00}$ Cr_2O_3 (as fed)

- Cr: labelled concentrates
  labelled concentrate refusals
  spot faeces samples

- DM, OM, CP and NDF:
  spot faeces samples
  refusals

Materials and methods

14d adaptation and recovery from surgery

112d trial

112d trial

d58 d86

Rumen fluid

0*, 3, 6 and 9 h after concentrate offer

pH, VFA, lactid acid and NH_3
* Abundance of bacteria, methanogens, protozoa and anaerobic fungi

Materials and methods

14d adaptation and recovery from surgery

112d trial

112d trial

d59 d87

Rumen gas

0, 4, 12 and 24 h after concentrate offer

CH_4 and CO_2 concentrations

Gas production for 6 min

Materials and methods

Statistical analysis: PROC MIXED of SAS v. 9.4

- **Final LW and ADG: treatment as fixed effect, and animal as random**

  Covariated with initial LW and age

- **Intake (straw and concentrate), digestibility and log-transformed microbial data: treatment as fixed effect and animal as random**

  Digestibility covariated with OM intake

- **Rumen variables: repeated measures**

  treatment, sampling time within a day (repeated measure), sampling day and all interactions as fixed effects, and animal as random

Materials and methods

Statistical analysis: PROC MIXED of SAS v. 9.4

- **Abundance of total bacteria, methanogens, protozoa and anaerobic fungi: repeated measures**

    treatment, sampling day (repeated measure) and all interactions as fixed effects, and animal as random

Results

Treatment (T)	LS	PS	SEM	P-value
ILW (kg)	361	363	10.8	0.82
FLW (kg)	497	512	10.2	0.50
ADG (kg/d)	1.51	1.64	0.104	0.78

LS: long straw

PS: ground and pelleted straw

Results

Treatment	LS	PS	SEM	P-value
Concentrate intake				
(kg/d)	7.74	8.07	0.620	0.61
(g/kg $LW^{0.75}$)	80.0	81.9	5.97	0.76
Straw intake				
(kg/d)	0.366	0.547	0.0984	0.09
(g/kg $LW^{0.75}$)	3.79	5.55	1.000	0.10
(% of total DM intake/d)	4.71	6.57	1.428	0.21
DMD	71.1	68.9	2.73	0.44
OMD	74.7	71.1	2.57	0.18
CPD	70.9	68.9	2.82	0.50
NDFD	45.5	42.1	8.38	0.69
DOMI				
(kg/d)	5.85	5.23	0.450	0.19
(g/kg $LW^{0.75}$)	60.4	53.0	4.37	0.12

LS: long straw

PS: ground and pelleted straw

Results

	LS	PS	SEM	P-value
% CH_4	21.7	21.2	1.85	0.79
% CO_2	62.0	64.1	2.45	0.40
L CH_4/h	8.79	8.49	1.303	0.82
L CO_2/h	26.7	26.7	4.98	1.00
L CH_4/d	211	210	29.9	0.98
L CO_2/d	648	663	123.3	0.90
L CH_4/ kg Δ weight	157	150	32.2	0.85
L CO_2/ kg Δ weight	467	454	84.8	0.88

LS: long straw

PS: ground and pelleted straw

Results

	LS	PS	SEM	P-value
Bacteria	9.63	9.58	0.123	0.67
Methanogens	6.23	6.26	0.159	0.87
Protozoa	8.49	7.22	0.682	0.08
Anaerobic fungi	5.12	4.65	0.789	0.55

LS: long straw

PS: ground and pelleted straw

Results

	LS	PS	SEM	P-value
pH	6.43	5.97	0.208	**0.04**
Total VFA	109	125	10.0	0.14
Ammonia	43.8	74.2	25.04	0.24
Lactic acid	97.7	120.0	16.58	0.20
Acetate	47.6	42.7	4.32	0.28
Propionate	33.7	37.4	4.58	0.44
Butyrate	13.1	14.8	2.19	0.46
Iso-butyrate	1.24	0.98	0.131	0.06
Valerate	1.93	2.61	0.423	0.13
Iso-valerate	2.36	1.50	0.452	0.08

LS: long straw

PS: ground and pelleted straw

Conclusion

Substitution of straw in the long form with a pelleted version does not seem to reduce CH_4 emissions from intensively reared beef cattle whereas it seems to increase the risk of acidosis.

The cost of straw processing would act against the profitability of the farms

Thank you