Effects of dietary nitrate and lipid on methane emissions from beef cattle are basal diet dependant

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Leading the way in Agriculture and Rural Research, Education and Consulting

Study part of larger project

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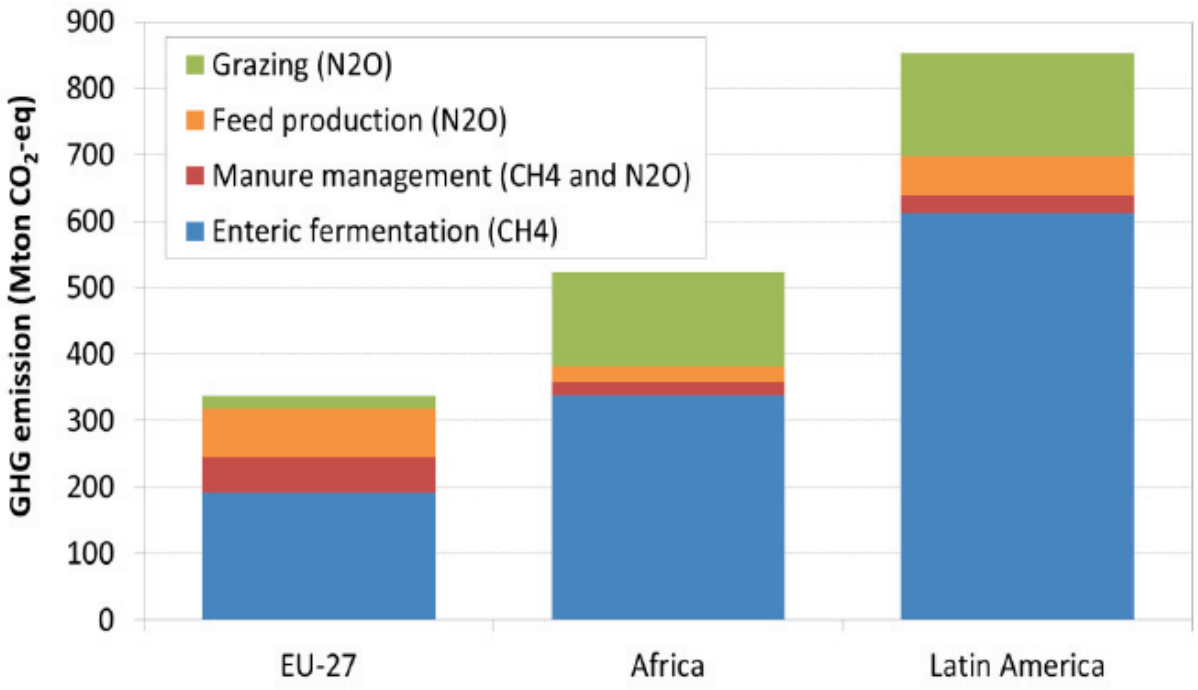
NUTRI-BEEF

"Nutritional improvements using diets and novel feed additives to enhance overall efficiency of beef production including meat quality and mitigation of greenhouse gas emissions as identified by characterisation of the rumen microbial population"

GHG from livestock



From: Lesschen 2012

Feed additives

Impact of feed additives on methane mitigation, feed efficiency and overall performance

To investigate

- Short and long-term effect of feed additives
- **Interactions between feed additives and diets**

Feed additives - criteria

- Sourced competitively – generic not proprietary
- Cost-effective
- Evidence for efficacy

Feed additive - nitrate

- *Reduction of enteric emissions*
  - NO_3^- ⟶ NO_2^- ⟶ NH_4^+
  - Alternative hydrogen sink / electron acceptor to methane
  - Thermodynamically more favourable

- Used successfully in previous experiments
- Can be sourced from different suppliers
- Issue of nitrite toxicity

Feed components based on lipids

- ***Reduction in enteric methane emissions***
  - **Non-fermentable feed component**
  - **Inhibition of protozoa**
  - **Biohydrogenation of unsaturated fatty acids**

- **Many different potential feeds for cattle**
- **Can be sourced from different suppliers**
- **Rapeseed oil in form of cold-pressed rapeseed cake used as UK produced.**

2 x 2 x 3 Factorial Design Experiment

	Diet type					
	Concentrate			Forage		
	Control	Nitrate	Rapeseed	Control	Nitrate	Rapeseed
Charolais x	7	7	7	7	7	7
Luing	7	7	7	7	7	7

•2 diet types
- Concentrate-straw (920:80 g/kg DM)
- Forage-concentrate (500:500 g/kg DM)

•3 treatment groups per diet type
- Control
- Nitrate
- Rapeseed cake

•2 breed types
- Charolais x
- Luing

Diet formulation

	Forage based diet (g/kg DM)		
	Control	Rapeseed Cake	Nitrate
Wholecrop Barley Silage	331	334	334
Grass Silage	189	192	193
Barley	328	287	374
Rapeseed Meal	123	16	45
Molasses	19	20	21
Minerals	9	9	10
Rapeseed Cake		142	
Calcinit			24

	Concentrate based diet (g/kg DM)		
	Control	Rapeseed Cake	Nitrate
Barley	740	700	797
Rapeseed Meal	145	21	64
Barley Straw	84	83	84
Molasses	21	21	21
Minerals	10	10	9
Rapeseed Cake		166	
Calcinit			25

Time line of the experiment

Adaptation phase A

- **4 weeks**
- **Adaptation to the basal diets**

Adaptation phase B

- **4 weeks**
- **Adaptation to feed additives, weekly increment of 25%**

Feed and productive efficiency

- **8 week test period**

Chamber based measurements

- **13 week period**

Carcass and meat quality based measurements

- **Animals slaughtered in batches**

Experimental procedure

Feed and productive efficiency → Chamber based measurements → Carcass and meat quality based measurements

- **13 week period**
- **6 respiration chambers**
- **Batches of 6 animals per week**
- **Animals acclimatised in training pens for 7 days pre-measurement**
- **Methane measured over 48 h period**
- **Ad libitum feeding**

Experimental records

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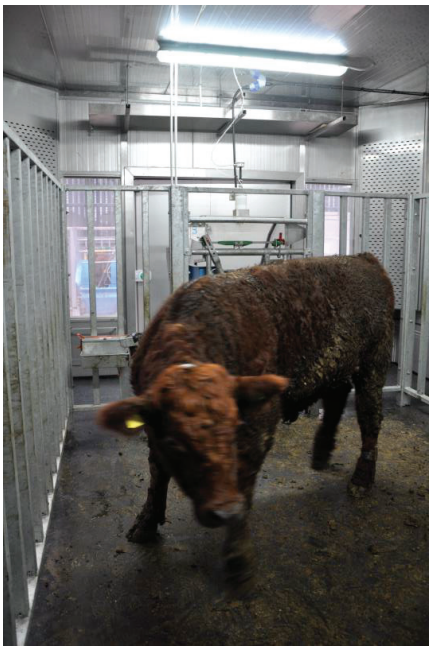
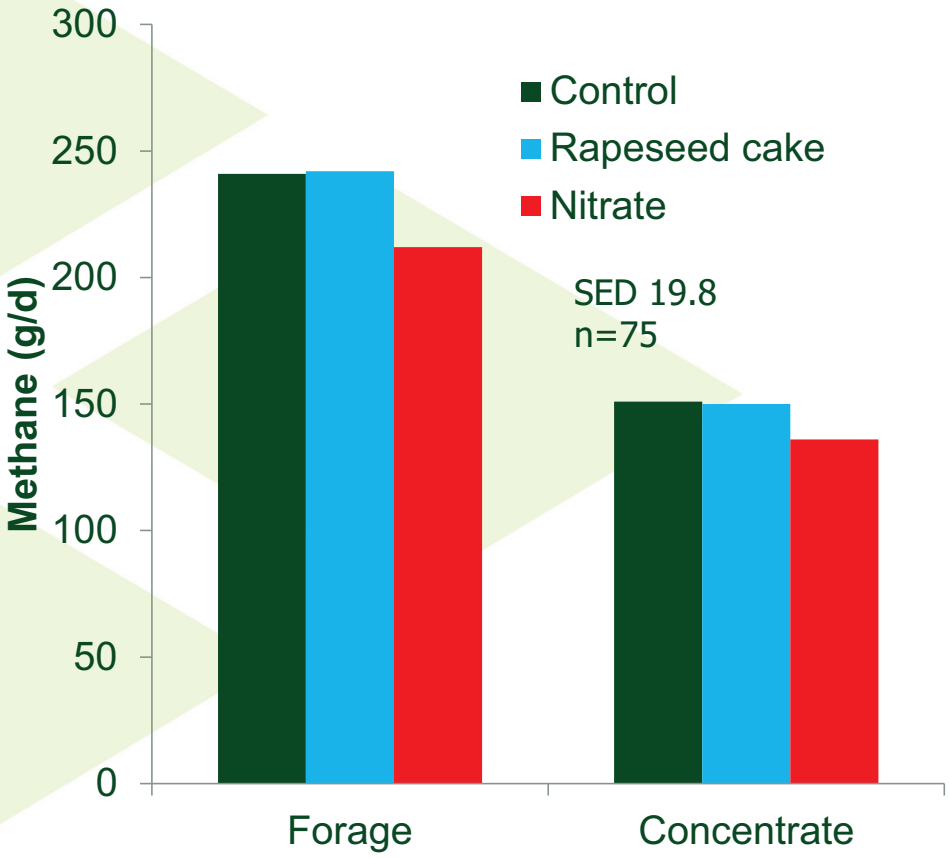
Feed and productive efficiency → Chamber based measurements → Carcass and meat quality based measurements

- **Methane**
- **Hydrogen**
- **VFA in rumen fluid**
- **Feed intake**
- **Live-weight**



Methane emissions – g/ day



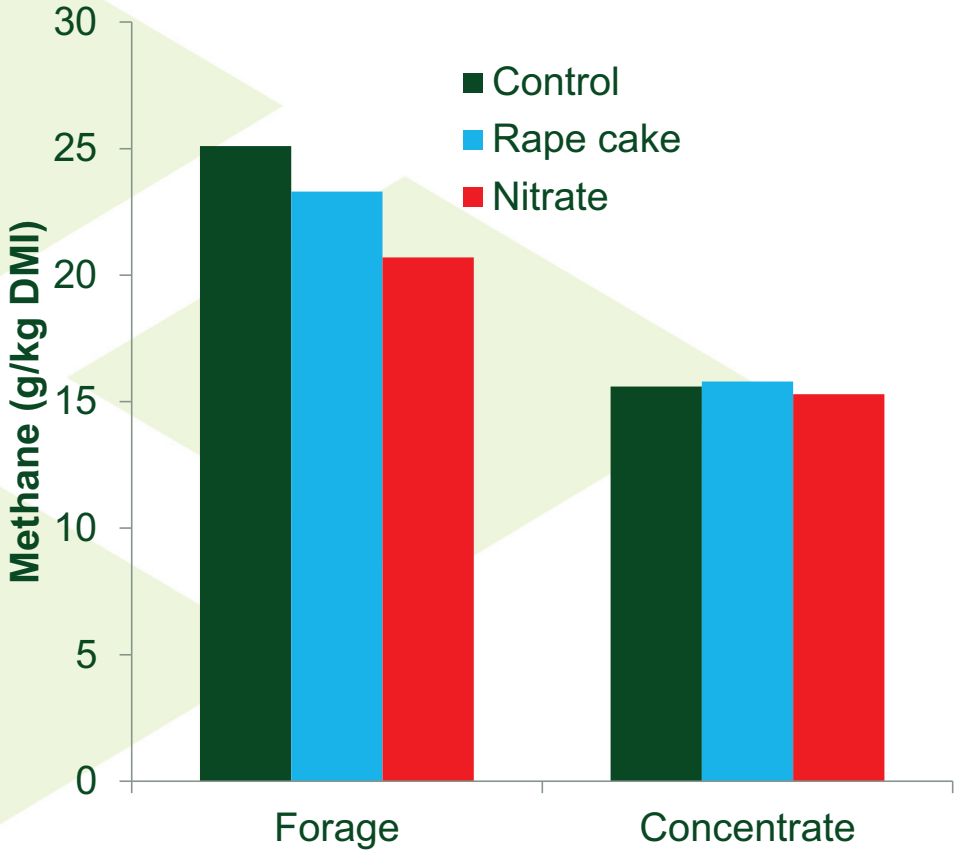
CH_4 from Concentrate less than Forage ($P<0.001$)

CH_4 from Nitrate overall less than Control ($P<0.05$)

No significant effect of rapeseed cake

No differences between breeds

Methane emissions – g/kg DM intake



Emissions from concentrate less than forage ($P<0.001$)

Significant reduction in CH_4 by nitrate on forage diet ($P<0.05$); no effect on Concentrate diet

No overall effect of rapeseed cake; non-significant reduction on forage diet

No effect of breed

Summary – forage diet

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Nitrate

- Methane emissions reduced by 17%
- 80% of maximum possible from stoichiometry
- In agreement with other studies

Rapeseed cake

- Methane reduced by 7.5%
- Equivalent to 3.3% reduction per 10 g/kg increase in dietary lipid
- Similar to average reduction (3.8%; Martin et al. 2010) across studies

Summary – concentrate diet

Nitrate

No reduction in methane outputs

	Forage	Concentrate
CH_4 reduction	17%	None
H_2 increase	2.6 x	2.0 x
Acetate:propionate	Con 3.1 → NO_3 4.0	Con 1.6 → NO_3 2.4

But other measurements change in similar fashion in response to nitrate in both diets.

Summary – concentrate diet

Nitrate

No reduction in methane outputs

Possible reasons

Nitrate is not reduced but absorbed

Nitrat sult in
metha

Nitrat umen
micro generated
from

.

Plasma nitrate (μM)	
Control	5
Forage – nitrate	56
Concentrate – nitrate	182

Conclusion

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Reductions in methane output from cattle fed nitrate and rapeseed cake are basal diet dependant

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