Combined effects of nitrate inclusion and increased lipid concentration within a silage-based diet on the performance of finishing steers

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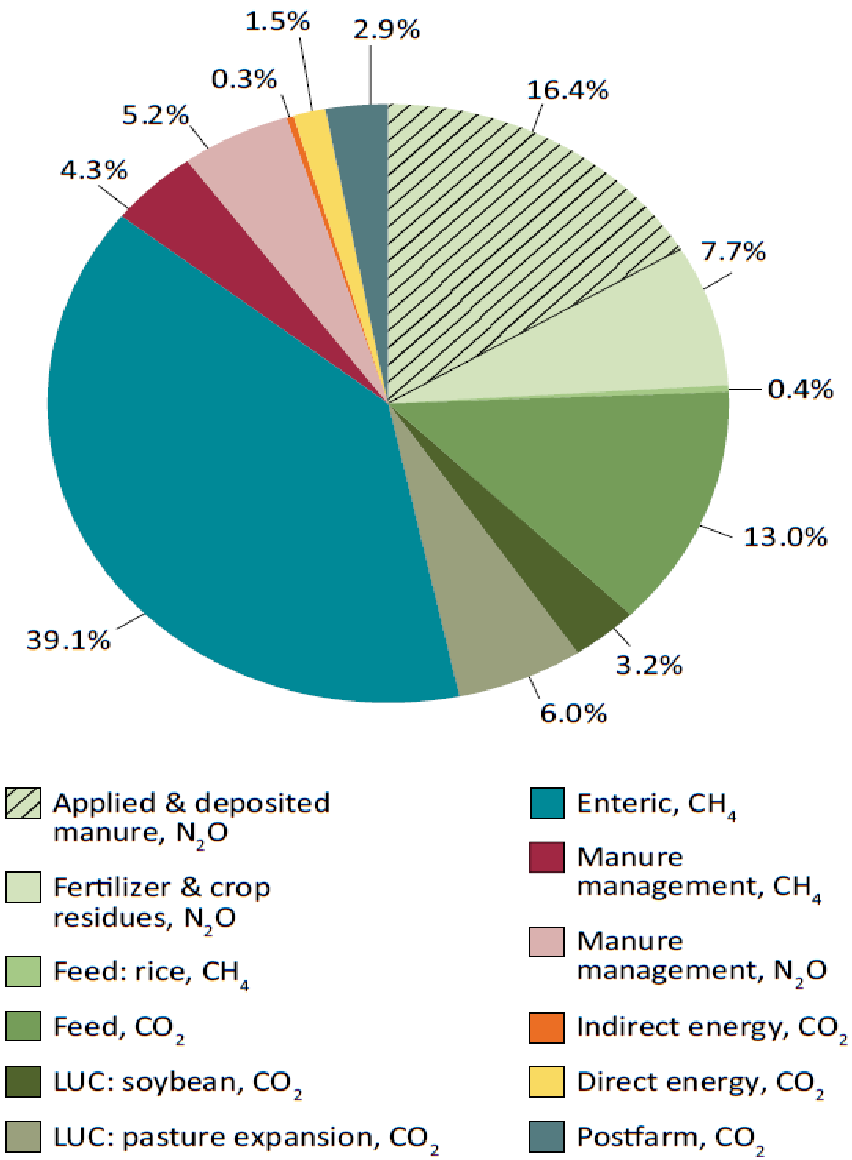
Study part of larger project

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”

Global issues



- World's population
  - 7.2 (mid 2013) to 10.9 billion by 2100
- Global meat production
  - projected to increase by more than 75% from 258 (2005/06) to 455 million t in 2050
- 39% total agriculture emissions from enteric CH_4
- Beef production – 43%.

Source: FAO 2013

Reducing CH_4 from beef production

- Considerable interest towards identifying appropriate GHG mitigation strategies
- Nutritional manipulation – practical and promising
- Based on one of the 3 following principles
  - Reducing hydrogen production during fermentation
  - Directly inhibiting methanogenesis
  - Providing alternative pathways for hydrogen use within the rumen

Criteria for selection of nutritional mitigation strategies

- Proven effectiveness
- Economic and practical in use
- No adverse effects on animal performance / health
- Persistent over time

Dietary Nitrate and Lipid

SRUC

- Effective at reducing methane in Mixed diets
  - Troy et al., 2015. Journal of Animal Science
- No adverse effects on performance or efficiency
  - Duthie et al., 2016. Animal

Objective

To investigate whether combining these strategies:

1. Were additive in their effects on reducing methane

2. Had adverse effects on performance, efficiency and carcass quality of steers

2 x 4Factorial Design

- 2 **breeds**
  - Crossbred Limousin (**LIMx**)
  - Crossbred Aberdeen Angus (**AAx**)

- 1 **basal diet**
- Forage:Concentrate ratio:
  - 520:480 (**Mixed)**

- 4 **treatments**
  - Control
  - Nitrate
  - Lipid
  - Combined (Nitrate + Lipid)

Ingredient composition (dry matter basis, g/kg)

Ingredient	Control	Nitrate	Lipid	Combined
Grass silage	210	211	209	210
Wholecrop barley	347	347	346	346
Bruised barley	336	388	289	263
Rapeseed meal	79	0	0	0
Calcinit	0	25	0	25
Maize dark grains	0	0	128	127
Molasses	19	20	19	19
Minerals	9	9	9	9

Experimental Design

- 80 finishing steers
- Group-housed in even numbers of each breed across 4 pens
- Each treatment allocated to 1 pen
- Treatments balanced for Age, LW and Sire

Treatments	Control	Nitrate	Lipid	Combined
No. AAx	10	10	10	10
No. LIMx	10	10	10	10

Time-line of the experiment

Adaptation phase

- **4 weeks**
- **Adaptation to diet treatments, weekly increment of 25%**

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

- **8 week test period**

- **13 week period**
- **Troy et al 2016 (EAAP)**
- ***Session 51 - Wed pm***

- **Animals slaughtered in 4 batches**

Experimental records

- Individual dry matter intake (DMI)
  - *32 electronic feeders*
  - *feed offered ad libitum*
- Weekly liveweight (LW)
- Ultrasonic fat depth at 12/13th rib (FD)

- 4 slaughter batches
- Commercial abattoir
- Preslaughter LW
- Net Carcass Weight
- EUROP classifications

Breed effects - growth

	AAx	LIMx	SEM	Significance
AgeSt (days)	417	411	5.3	NS
Mid-test LW (kg)	542	539	17.5	NS
Mid-test MLW (kg)	112	112	2.7	NS
LWG (kg/day)	1.74	1.56	0.076	**
FD (mm)	9.1	8.1	0.66	*

*<0.05, **<0.01, *** <0.001, NS = not significant (P>0.05).

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Breed effects – DMI and feed efficiency

	AAx	LIMx	SEM	Significance
DMI (kg/day)	12.15	11.07	0.425	***
DMI/LW(g/kg)	22.44	20.59	0.483	***
DMI/MLW(g/kg)	108.12	99.05	2.314	***
FCR (kg, kg)	7.02	7.20	0.269	NS
RFI (kg)	0.241	-0.235	0.2309	**

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Breed effects – carcass quality

	AAx	LIMx	SEM	Significance
SLW (kg)	689	667	13.9	**
NetCW (kg)	382	385	7.4	NS
KO (%)	55.5	57.7	0.45	***
EUROP conf	9.5	9.7	0.34	NS
EUROP fat	10.5	10.3	0.31	NS

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Treatment effects - growth

	Control	Nitrate	Lipid	Combined	SEM	Nitrate	Lipid
AgeSt (days)	413	414	413	414	5.3	NS	NS
Mid-test LW (kg)	546	543	538	534	17.5	NS	NS
Mid-test MLW (kg)	13	112	112	111	2.7	NS	NS
LWG (kg/day)	1.73	**1.53**	1.72	**1.62**	0.076	**	NS
FD (mm)	8.4	8.9	8.8	8.3	0.66	NS	NS

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Treatment effects – feed efficiency

	Control	Nitrate	Lipid	Combined	SEM	Nitrate	Lipid
DMI (kg/day)	11.78	11.43	11.75	11.44	0.425	NS	NS
DMI/LW(g/kg)	21.60	21.08	21.90	21.43	0.483	NS	NS
DMI/MLW(g/kg)	104.29	101.54	105.33	102.93	2.314	NS	NS
FCR (kg, kg)	6.85	**7.52**	6.89	**7.20**	0.269	*	NS
RFI (kg)	-0.078	**0.063**	-0.015	**0.030**	0.2309	NS	NS

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Treatment effects – KO

	Control	Nitrate	Lipid	Combined	SEM	Nitrate	Lipid
SLW (kg)	686	675	675	678	13.9	NS	NS
NetCW (kg)	391	380	383	380	7.4	NS	NS
KO (%)	57.0	**56.4**	56.7	**56.2**	0.45	0.07	NS
EUROP conf	10.1	**9.2**	9.6	**9.3**	0.34	NS	NS
EUROP fat	10.5	**10.1**	10.4	**10.7**	0.31	NS	NS

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Conclusions

- **In contrast to previous study (Duthie et al, 2016, Animal)**
- Addition of nitrate to the diet had a negative impact on growth and feed efficiency of finishing beef steers

- Increasing the dietary lipid concentration
  - Did not adversely affect steer performance or efficiency
  - Effectively reduces methane (Troy et al., 2016, EAAP)
  - Thus can be recommend for use within finishing cattle diets

Acknowledgements

AHDB BEEF & LAMB

The Scottish Government

- Excellent technical support at SRUC

Chemical composition

Treatment	Control	Nitrate	MDG	Combined
Chemical Composition, g/kg DM[4]				
DM, g/kg	533	531	533	533
Ash	52	48	51	51
CP	135	141	136	162
ADF	184	166	184	183
NDF	308	295	317	313
Starch	281	308	264	295
Lipid	25.0	23.4	36.7	35.9
GE, MJ/kg DM	18.1	17.6	18.5	18.0