Methane emissions and rumen fermentation in beef heifers differing in phenotypic residual feed intake

C. Fitzsimons[1,3], D.A. Kenny[1], M. Deighton[2], A.G. Fahey[3] and M. McGee[1]

Animal and Grassland Research and Innovation Centre, Teagasc, Grange[1], Co. Meath, Ireland, Moorepark[2], Co. Cork, Ireland, [3]School of Agriculture and Food Science, University College Dublin, Ireland

The Irish Agriculture and Food Development Authority

Introduction

- Enteric CH_4 production accounts for a significant proportion of anthropogenic CH_4 (Crosson *et al.*, 2011)

- CH_4 mitigation strategies:
  - Some affect animal performance / no lasting effect
  - Possibly, via selection of feed efficient animals by improved residual feed intake (RFI) (Hegarty *et al.*, 2007)

- RFI = animal's actual intake – predicted intake
  - Adjusted for maintenance + growth
  - Negative values = efficient
  - Positive values = inefficient

Introduction

- Some evidence that low RFI cattle produce less CH_4 than high RFI cattle

- Feed efficient cattle produced,
  - 25% less CH_4 on high conc. diets (Hegarty *et al.*, 2007)
  - 28% less CH_4 on high conc. diets (Nkrumah *et al.*, 2006)
  - 27% less CH_4 on high quality pasture but NO difference on low quality pasture (Jones *et al.*, 2011)

Objective of this study

- Characterise productivity-related variables, rumen fermentation and CH_4 emissions in beef heifers differing in phenotypic RFI

Materials and Methods

Animals: 22 Simmental/crossbred breeding beef heifers

- Individually tethered

Diet: 2nd harvest grass silage *ad libitum* (DMD 766 g/kg)

Experimental period: 120 d

Measurements:

- Individual feed intake
- Live weight
- Body condition score
- Ultrasonic fat & muscle depth
- Muscularity scores
- Skeletal

Materials and Methods

Measurements (cont'):

- Selected blood metabolites
- Total tract digestibility (AIA marker technique)
- Rumen fermentation (transeosophageal sampler)

Materials and Methods

Methane (CH_4) production:

- Measured two 5-day periods
- Weeks 3 and 11

Calibrated tracer gas - SF_6

Bolus administration

- 6 days prior to CH_4 measurement

SF_6 and CH_4 concentrations determined via gas chromatography (Johnson *et al.*, 2006)

Materials and Methods

- **RFI Calculation:**

  Predicted DMI
  - Regressed mean daily DMI on ADG and mid-test $BW^{0.75}$
  - PROC GLM, SAS

  RFI = Actual DMI – Predicted DMI

- Heifers ranked on RFI

- Assigned to high, medium or low RFI groupings

Materials and Methods

Statistical analysis:

- Data were analysed using PROC MIXED, SAS
- Model included
  - Fixed effects of RFI, period and RFI × period
  - Random effect – sire
  - Linear covariate – date of birth
- Also, regression analysis used to examine relationship between RFI and CH_4

Results

Trait	*RFI Group*			*SEM*	*P-value*
	High	Medium	Low		
DMI (kg/d)	8.4^{a}	7.7^{b}	7.4^{c}	0.24	*
RFI (kg DM/d)	0.52^{a}	-0.06^{b}	-0.49^{c}	0.092	***
Mid-test LW (kg)	483	482	490	18.3	NS
ADG (kg)	0.6	0.6	0.6	0.07	NS

Results

- No effect (P > 0.05) of RFI on:
  - Body composition traits
  - Visual muscularity scores
  - Skeletal measurements
  - Rumen fermentation parameters
  - Total tract digestibility

- Blood plasma metabolite concentrations
  - Glucose and urea higher (P < 0.05)
  - Creatinine lower (P < 0.05)

    in high RFI compared to low RFI heifers
  - Other metabolic variables did not differ (P > 0.05) between RFI groups

Results

Trait	*RFI Group*			*SEM*	*Sig.[1]*
	High	Medium	Low		
CH_4 (g/d)	297^{a}	275^{ab}	260^{b}	10.3	*
CH_4 (g/kg DMI)	35	35	36	1.3	NS
CH_4 (g/kg $LW^{0.75}$)	2.9^{a}	2.7^{ab}	2.5^{b}	0.08	*

[1]No RFI × Period interaction (P > 0.05)

Results

Trait	*CH_4 Production*		*SEM*	*P-value*
	Period 1	Period 2		
CH_4 (g/d)	334	220	10.6	***
CH_4 (g/kg DMI)	40	31	1.4	***
CH_4 (g/kg $LW^{0.75}$)	3.3	2.1	0.10	***

Results

Regression analysis:

Period 1:

- Relationship between RFI and CH_4 not significant ($P > 0.05$)

Period 2:

- 1-unit increase in RFI
  - 25 g/d increase ($P = 0.07$; $R^2 = 0.16$) in CH_4
  - 2.5 g/kg DMI decrease ($P = 0.06$; $R^2 = 0.17$) in CH_4

Summary

- Feed consumption was less ($P < 0.05$) in low compared to high RFI groups

- RFI – no effect ($P > 0.05$) on
  - Performance-related traits measured
  - Total tract digestibility
  - Rumen fermentation

- Daily CH_4 emissions were less ($P < 0.05$) on an absolute basis and relative to weight in low RFI heifers

Conclusion

This study provides evidence that improving feed efficiency in cattle, by way of improved RFI, will reduce CH_4 emissions while maintaining animal performance.