

Plasma natural ^{15}N abundance may predict both feed conversion efficiency and residual feed intake in beef cattle across different dietary conditions.

P. Guarnido¹, S. M. Nasrollahi¹, C. Chantelauze¹, G. Renand², C. Fossaert³, I. Ortigues-Marty¹, G. Cantalapiedra-Hijar¹

¹INRA, UMR Herbivores, F63122 Saint-Genès-Champanelle, France.

²INRA, UMR Génétique Animale et Biologie Intégrative, F78352 Jouy-en-Josas, France

³IDELE, Institut de l'Élevage, France

Abstract

Cheap and rapid methods to predict between-animal variability of feed efficiency (FE) are needed. We evaluated, by using a large dataset on beef cattle ($n = 355$) fed contrasting diets (grass vs corn based diets), the potential of plasma natural ^{15}N abundance ($\delta^{15}\text{N}$) as a biomarker of between-animal variation in FE, measured either as feed conversion efficiency (FCE) or residual feed intake (RFI). Data were analyzed by mixed models, with diet and $\delta^{15}\text{N}$ as a fixed effect and experimental farm, batch and pen as random effects. A negative and significant correlation was found between FCE and $\delta^{15}\text{N}$ within each contemporary group, with a lower response (slope) however in grass vs corn diets ($\delta^{15}\text{N} \times$ diet interaction; $P = 0.002$). Likewise, we found a significant but positive relationship between $\delta^{15}\text{N}$ and RFI, but without the influence of diet or any tested random effect. Our results indicate that $\delta^{15}\text{N}$ is a promising biomarker of between-animal variation of feed efficiency (FCE and RFI) in growing beef cattle.

Keywords: feed efficiency, ruminants, biomarker, $\delta^{15}\text{N}$

Introduction

To enhance the profitability and sustainability of the beef cattle sector, animal feed efficiency (FE) should be improved. FE is often measured as either feed conversion efficiency (FCE=daily gain/intake) or residual feed intake (RFI), the latter is considered to be more suitable for genetic selection programs. A major limitation to phenotype FE is the time and cost involved. Thus, easy-to-use biomarkers should be explored as indirect tools to evaluate the FE quickly and cheaper. We previously reported, with a limited number of beef cattle, the potential of the animal natural ^{15}N abundance ($\delta^{15}\text{N}$) to reflect between-animal variations in FCE (Meale et al., 2017). However, this promising biomarker failed to show any relationship with RFI. The aim of this study was to assess, using a large database, the potential of $\delta^{15}\text{N}$ to reflect between-animal variations of FE measured as either FCE or RFI. Since diet composition might have an impact on this relationship (Cantalapiedra-Hijar et al., 2018), an additional objective was to test whether the explored relationship was similar across two contrasting diets.

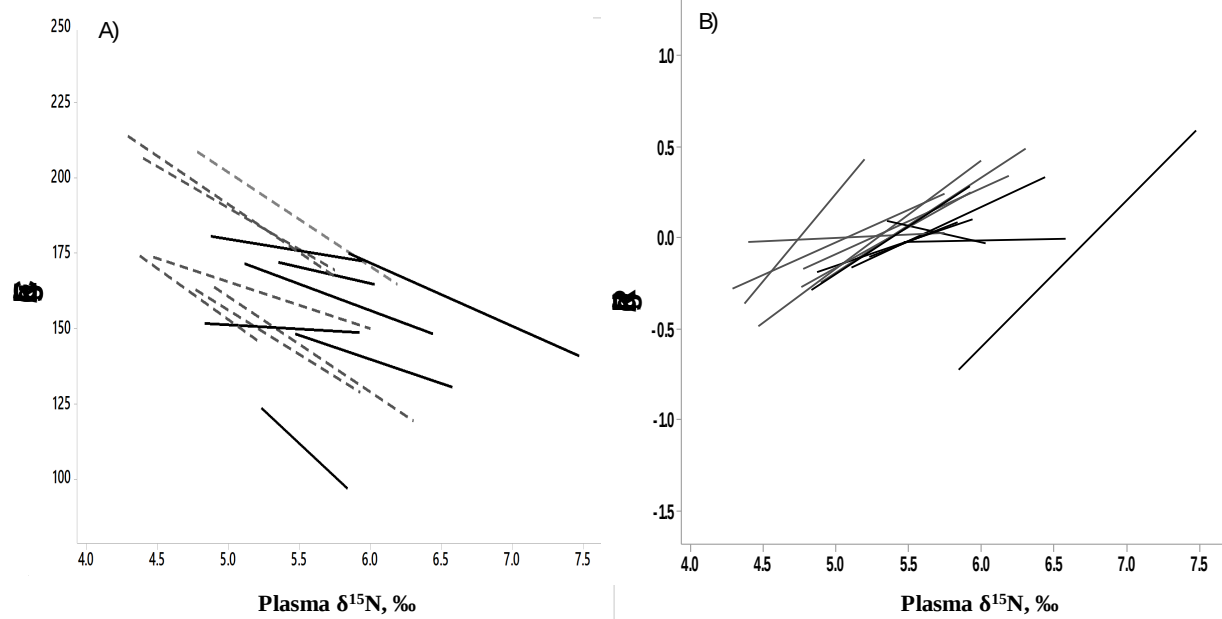
Material and methods

Seven independent RFI tests were conducted on 3 different experimental farms. Each RFI test was conducted on around 50 young Charolaise bulls with known genetic background. Animals from the same RFI test were evenly assigned to one of the two common experimental diets used across the three farms: grass silage diet (NE = 1.58 Mcal/kg DM and CP = 142 g/kg DM) vs corn silage diet (NE = 1.64 Mcal/kg DM and CP = 133 g/kg DM). The test lasted on average 6 months and all animals were recorded for daily feed intake and fortnightly body weight at least between 10 and 15 months old. Overall, 355 individual data on average daily gain and feed intake were used to calculate both feed conversion efficiency (FCE) and residual feed intake (RFI), the latter corrected by the effects of diet, farm, batch and pen. Blood was sampled 4 weeks before the end of each RFI test. Regression of FCE and RFI on $\delta^{15}\text{N}$ was analyzed by mixed-model regression analysis with diet as a fixed effect and farm, batch within farm and pen within batch and farm as random effects. The structure of the

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model was evaluated by testing the random effects on both the intercept and slope and keeping the one with the lowest AIC. The significance ($P < 0.05$) of the diet effect as well as its interaction with $\delta^{15}\text{N}$ was evaluated for each model.

Results and discussion

On average, a significant and negative correlation ($P < 0.001$) between FCE and $\delta^{15}\text{N}$ was found within each contemporary group (Figure 1). However, the slope of the model was significantly lower ($P = 0.002$) for grass diet (-10.92) compared to corn diets (-24.46). These results agree in considering that the response of $\delta^{15}\text{N}$ to changes in the N use efficiency may not be unique across diets (Cantalapiedra-Hijar et al., 2018). Because $\delta^{15}\text{N}$ in animal proteins results from isotopic discrimination at the rumen and metabolic levels (Cantalapiedra-Hijar et al., 2018), it can be argued that the N use with our experimental diets differs at these two levels. Unlike previous reports (Meale et al., 2017) we have found a significant and positive correlation ($P = 0.001$) between RFI and $\delta^{15}\text{N}$ not affected by any studied effect (diet, farm, batch and pen). We have demonstrated that $\delta^{15}\text{N}$ is significantly related to both FCE and RFI, and thus may be proposed in genetic selection programs assisted by biomarkers.

Figure 1. Within-contemporary group relationship between plasma $\delta^{15}\text{N}$ and either A) Feed Conversion Efficiency (FCE) or B) Residual Feed Intake (RFI). Corn diets are depicted as dashed lines and grass diets as thick lines. Model equations are: FCE (Grass) = $212.93(\pm 22.19; P < 0.001) - 10.92(\pm 3.25; P < 0.001) \times \delta^{15}\text{N}$; FCE (Corn) = $293.10(\pm 24.80; P < 0.001) - 24.46(\pm 4.44; P < 0.001) \times \delta^{15}\text{N}$ (RMSE=17.46) and RFI = $-0.70(\pm 0.22; P = 0.002) + 0.128(\pm 0.041; P = 0.002) \times \delta^{15}\text{N}$ (RMSE=0.43).

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