

Evaluation of compound-specific N isotope analysis in key amino acids to predict feed efficiency in growing lambs

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Abstract

To measure feed efficiency in growing ruminants we proposed an improved isotopic method based on natural ^{15}N abundance ($\delta^{15}\text{N}$). Individual feed conversion efficiency (FCE) was measured for 75 days in 48 growing lambs fed diets based on Lucerne and supplemented with either a high or low amount of barley. The $\delta^{15}\text{N}$ analysis was conducted in bulk N from feed ingredients and animal muscle to calculate the isotopic N fractionation ($\Delta^{15}\text{N}_{\text{animal-diet}}$, $\delta^{15}\text{N}_{\text{animal}} - \delta^{15}\text{N}_{\text{diet}}$) and by compound-specific isotopic analysis on amino acids to obtain the $\delta^{15}\text{N}$ of transaminating amino acids ($\delta^{15}\text{N}_{\text{TAAAs}}$). Isotopic values obtained with both approaches ($\Delta^{15}\text{N}_{\text{animal-diet}}$ and $\delta^{15}\text{N}_{\text{TAAAs}}$) were regressed against the observed FCE. We show an improvement in FCE prediction when analysis of ^{15}N natural abundances is conducted on transaminating amino acids rather than on bulk N.

Keywords: Feed efficiency, amino acids, natural abundance, ^{15}N

Introduction

Feed efficiency (FE) is a key factor in profitability of livestock farm systems. However, FE is costly, laborious and most times not possible to measure in field conditions. The difference in ^{15}N natural abundance ($\delta^{15}\text{N}$) between an animal and its diet ($\Delta^{15}\text{N}_{\text{animal-diet}} = \delta^{15}\text{N}_{\text{animal}} - \delta^{15}\text{N}_{\text{diet}}$) has been recently correlated to FE in ruminants (Cantalapiedra-Hijar *et al.*, 2015). However, bulk N isotopic values lack specificity, representing integrated isotopic values of various N-containing molecules in animal tissues. In this regard, the $\delta^{15}\text{N}$ in animals differs among individual amino acids according to their ability to be transaminated (Braun *et al.*, 2015). To refine the use of ^{15}N natural abundance to predict FE in ruminants we have conducted amino acid compound-specific N isotope analysis (AA-CSIA). The objective of this study was to assess in ruminants the improvement in FE prediction when shifting the isotopic analysis from bulk N to transaminating AAs.

Material and methods

Daily individual feed intake and fortnightly body weight gain were recorded for 48 growing Romane lambs fed for 75 days diets based on alfalfa dehydrated pellets supplemented with either 400g or 100 g of barley and with straw offered ad libitum. Muscle samples (*longissimus thoracis*) were obtained for all animals at the slaughterhouse while feeds were sampled weekly and pooled throughout the experiment. Muscle (n=48) and feed (n=3) samples were analyzed by EA-IRMS to obtain the ^{15}N natural abundance ($\delta^{15}\text{N}$) in bulk N. Eight muscle samples were randomly chosen within each dietary treatment (n = 16) for AA-CSIA by GC-C-IRMS. Average daily gain was determined for each lamb as the slope of the regression of live body weight against time. The FCE (%) was calculated as the average daily gain divided by dry matter intake (kg/d) and multiplied by 100. Linear regressions (XLStat v2015.2.02) were conducted to model FCE from isotopic natural abundances values in either bulk N or from the sum of transaminating AAs (alanine + valine + isoleucine + leucine + serine + aspartate + glutamate + glutamine; Braun *et al.*, 2015).

Results and discussion

As expected, a negative and significant ($P < 0.001$) relationship was found between FCE and $\Delta^{15}\text{N}_{\text{animal-diet}}$ in agreement with previous results in growing beef cattle (Cantalapiedra-Hijar *et al.*, 2015). This suggests a high correlation between FE and the efficiency of N utilization (N retained/N intake). Both diets were similar in isotopic N composition ($\delta^{15}\text{N} = -0.55$ and -0.30) and thus relationships between FCE and natural ^{15}N abundances were not different when using either $\Delta^{15}\text{N}$ (Fig. 1; $r^2 = 0.53$) or $\delta^{15}\text{N}$ ($r^2 = 0.44$; $P < 0.001$). This highlights the potential of this isotopic biomarker to predict between-animal variation of FCE in ruminants fed the same diet without the need to know the diet composition. When the isotopic analysis was shifted from bulk N (Fig. 1) to AA-CSIA (Fig. 2) the $\delta^{15}\text{N}$ values were better fitted to the observed FCE values ($r^2 = 0.80$ vs 0.53) and prediction error was less ($\text{RSE} = 1.85$ vs 2.74). The $\delta^{15}\text{N}$ values on transaminating AAs are more related to FCE compared to bulk N isotopic analysis since i) isotopic N fractionation occurs during transamination reactions (Macko *et al.*, 1986) and ii) higher AA catabolism and intensity of transamination reactions are usually associated with lower feed (N) efficiency. In conclusion, our results show that an improvement in the prediction of FCE can be achieved in ruminants when the analysis of $\delta^{15}\text{N}$ is conducted on specific AAs rather than on bulk N.

Figure 1. Relationship between feed conversion efficiency (%) and $\Delta^{15}\text{N}_{\text{animal-diet}}$ (bulk N) in growing lambs fed diets based on Luzerne supplemented with either low () or high () amounts of barley

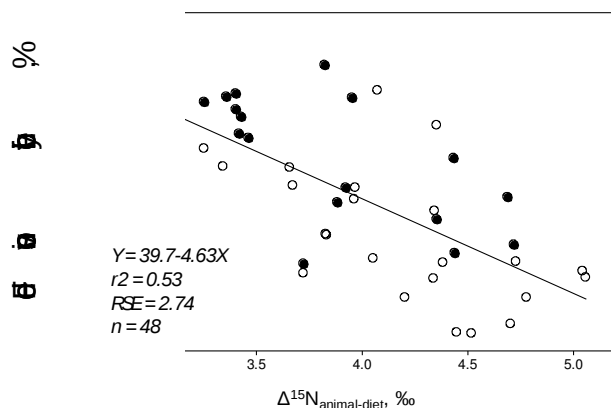
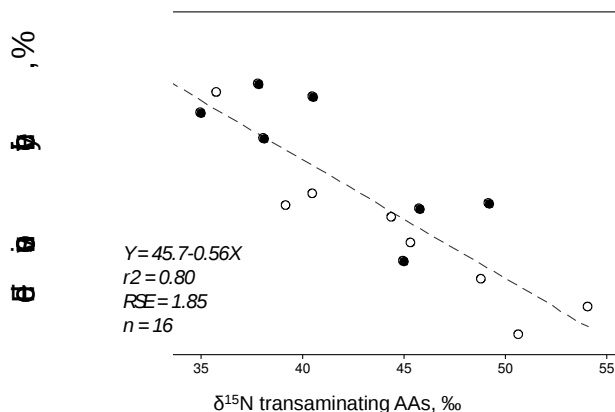


Figure 2. Relationship between feed conversion efficiency (%) and the $\delta^{15}\text{N}_{\text{TAAAs}}$ (AA-CSIA) in growing lambs fed diets based on Luzerne supplemented with either low () or high () amounts of barley



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