IMPROVED CATTLE GROWTH BY METHIONINE-BALANCED DIETS DOES NOT RESULT FROM LOWER PROTEIN DEGRADATION

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INTRODUCTION

• Improving N use efficiency (NUE) is currently an important issue in animal production

• From a metabolic point of view both the amount and nature of protein may impact NUE

• The dietary AA profile should be formulated according to animal requirements
  
  • Methionine is believed to be the first limiting AA in growing cattle fed forage-diets 
    (*Titgemeyer and Merche, 1990*)
  
  • Diets well balanced for Met improve performances of growing beef cattle 
    (*Veira et al., 1991; Bahloul et al., 2018*)
  
  • However, controversy exists about the metabolic pathways involved in this improvement
PROTEIN TURNOVER

IF THIS AMINO ACID LACKS:
1) PROTEIN SYNTHESIS MAY BE REDUCED
2) PROTEIN DEGRADATION MAY INCREASE

EXAMPLE OF PROTEIN TURNOVER
(Lobley, 2003)
• Protein intake = 1500 g/d
• Protein synthesis = 3000 g/d
• Protein degradation = 2750 g/d
• Protein gain = 250 g/d
PROTEIN TURNOVER: H1

EXAMPLE OF PROTEIN TURNOVER (Lobley, 2003)

- Protein intake = 1500 g/d
- Protein synthesis = 3000 g/d
- Protein degradation = 2750 g/d
- Protein gain = 250 g/d

Salter et al., 1990; Wessels et al., 1997; Saggau et al., 2000; Ren et al., 2007
Robinson et al., 2016
PROTEIN TURNOVER: H2

EXAMPLE OF PROTEIN TURNOVER (Lobley, 2003)

- Protein intake = 1500 g/d
- Protein synthesis = 3000 g/d
- Protein degradation = 2750 g/d
- Protein gain = 250 g/d

Nieto et al., 1994; Tesseraud et al., 1996
De la Higuera et al., 1998; Schadereit et al., 1999
Löhrke et al., 2001

IF THIS AMINO ACID IS SUPPLEMENTED
THE PROTEIN DEPOSITION MAY INCREASE THROUGH:

Nieto et al., 1994; Tesseraud et al., 1996
De la Higuera et al., 1998; Schadereit et al., 1999
Löhrke et al., 2001
Mechanisms responsible for the effect of Met (synthesis vs degradation) are not elucidated.

Available studies:

✓ monogastrics only (pigs, broilers, rats, fish)
✓ measurement of protein synthesis using a reference method (infusion or flooding dose of a labelled amino acid)
✓ but no measurement of protein degradation (→ calculated).

OBJECTIVE

To analyse the whole-body protein turnover rate of fattening young bulls fed diets balanced or unbalanced for methionine, at two dietary levels of metabolizable protein, using a new methodology to quantively assess protein degradation rate in vivo.
MATERIAL AND METHODS

- 36 Charolais young bulls (320 kg BW and 266 d old on average)
- 4 experimental diets, all based on grass silage (60%) and concentrate (40%)

2 x 2 Factorial design
[Normal vs High MP] x [Without vs with Smartamine®]
100 vs 120% requirements x 1.9 vs 2.4 %Met (Lys/Met ~ 4 vs 3)

The 2 experimental factors (MP and Met) significantly increased ADG (+16 and 9%, respectively) (Bahloul et al., 2018) and thus were supposed to impact the protein metabolism

Measurement of isotopic (¹⁵N) turnover
✓ After tissue enrichment in ¹⁵N, the rate of release of ¹⁵N from the whole body reflects WB protein degradation
✓ ≠ reference methods which target protein synthesis using tracers
ISOTOPIC $^{15}$N TURNOVER RATE

Measurement in urine following an isotopic diet switch

The rate at which WB proteins release $^{15}$N after accumulation reflects WB protein degradation rate. Protein synthesis rate evaluated by difference from ADG and protein degradation rate.
MODELING of ISOTOPIC TURNOVER RATE

\[ \delta^{15}N(t) = \delta^{15}N_{\infty} + (\delta^{15}N_0 - \delta^{15}N_{\infty}) \times [p \times \exp^{-k1 \times t} + (1-p) \times \exp^{-k2 \times t}] \]

Slope k1 = degradation rate of pool 1 (fast)
Slope k2 = degradation rate of pool 2 (slow)

- All individual data are used to adjust a non linear mixed-effect model (nlme in R)
- Mono or bi-exponential
- Fixed effects: MP level, Methionine content and their interaction
- Random effect: Animal
RESULTS

IMPROVED CATTLE GROWTH BY METHIONINE-BALANCED DIETS DOES NOT RESULT FROM LOWER PROTEIN DEGRADATION
Effect of DIETARY PROTEIN LEVEL

![Graph showing the effect of dietary protein level on urine δ15N% over time after a dietary isotopic switch.]

- Normal MP
- High MP

Time after dietary isotopic switch, d

Urine δ15N%, %
Effect of DIETARY PROTEIN LEVEL
High MP increases the whole body protein degradation rate

Degradation rate, %/d

<table>
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Time after dietary isotopic switch, d
Effect of Dietary Protein Level

High MP increases the whole body protein degradation rate

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Degradation rate, %/d

Time after dietary isotopic switch, d
Effect of DIETARY PROTEIN LEVEL
High MP increases the whole body protein degradation rate

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HIGH PROTEIN DIETS INCREASE BOTH PROTEIN DEGRADATION AND ANIMAL GROWTH, ⇒ THEY LIKELY INCREASE THE PROTEIN SYNTHESIS TO A GREATER EXTENT
Effect of DIETARY METHIONINE LEVEL

Unbalanced

Balanced

Time after dietary isotopic switch, d

Urinary δ¹⁵N, ‰
Effect of DIETARY METHIONINE LEVEL
No impact on whole body protein degradation

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Degradation rate, %/d
Effect of DIETARY METHIONINE LEVEL
No impact on whole body protein degradation

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**Urinary $\delta^{15}$N, ‰**

Time after dietary isotopic switch, d
**Effect of DIETARY METHIONINE LEVEL**

No impact on whole body protein degradation

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⇒ MET BALANCED DIETS IMPROVE ANIMAL GROWTH POSSIBLY BY INCREASING THE PROTEIN SYNTHESIS RATE
CONCLUSIONS

The improvement of animal growth with methionine balanced diets is not due to a decrease in whole-body protein degradation rate but more likely to an increase in protein synthesis.

As expected, increasing the protein content of diets increased the whole-body protein degradation rate, and may also have increased the protein synthesis rate.