

Estimating rumen undegradable crude protein from proximate nutrient, fiber fractions, and rumen *in-vitro* feed fermentation characteristics of tropical ruminant feedstuffs

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Application

Rumen undegradable crude protein (RUP) of tropical ruminant feedstuffs can be predicted from crude protein (CP) concentration and gas production (GP) from rumen *in-vitro* feed fermentation.

Introduction

Estimates of RUP are a prerequisite in feed evaluation and nutrient recommendation systems. The *in-situ* method is the reference method used for RUP determination. However, this method is expensive, time-consuming, and requires fistulated animals.

Objective

To predict RUP of tropical ruminant feedstuffs from proximate nutrients (e.g., organic matter (OM) and CP), fiber fractions (e.g., neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL)); and rumen *in-vitro* feed fermentation characteristics (digested OM, metabolizable energy (ME), and GP).

Materials and Methods

Independent variables

Dataset (n=46)

Feedstuffs commonly used to feed ruminants in (sub-)tropics:

- 6 concentrates and by-products
- 17 forage legumes
- 23 forage grasses

Proximate nutrient¹

(arithmetic mean ± standard deviation)

OM g/kg dry matter: 902 ± 38

CP g/kg dry matter: 159 ± 86

Fiber fractions¹

(arithmetic mean ± standard deviation)

NDF g/kg dry matter: 490 ± 131

ADF g/kg dry matter: 287 ± 85

ADL g/kg dry matter: 48 ± 28

In-vitro fermentation²

(arithmetic mean ± standard deviation)

Digested OM proportion: 0.6 ± 0.1

ME MJ/kg dry matter: 10 ± 2

GP ml/200 mg dry matter: 32 ± 8

¹The proximate nutrient and fiber fractions had been analyzed according to VDLUFA (2012).

²The GP had been measured and the ME (equation 12f) and digested OM (equation 43f) estimated from measured GP and CP, crude ash, and crude fat concentrations according to Menke and Steingäß (1988).

Dependent variable

In-situ RUP³

- incubation periods of 2, 4, 8, 16, 24, 48, and 72 hours
- during two periods with 3 cows per period
- effective CP degradability at a estimated rumen passage rate of 2, 5, and 8%/hour

In-situ corrections⁴

- losses of water soluble feed CP
- water insoluble feed CP escaping the bag in form of small particles
- microbial attachment to undegraded feed particles

³The *in-situ* RUP proportion had been determined following the protocol of Madsen and Hvelplund (1994).

⁴Corrections performed according Weisbjerg et al. (1990) and Krawielitzki et al. (2006).

Statistical evaluation

- stepwise multiple linear regression
- determination coefficient (R²) and root mean square error (RMSE) was calculated for identified RUP equations at rumen passage rates of 2, 5, and 8%/h.

Results

- The CP concentration and GP were good predictors of RUP across all feedstuffs (figure 1).
- The CP concentration accounted for 60, 72, and 77% and the GP for 14, 7, and 4% of the variability in the RUP at rumen passage rates of 2, 5, and 8%/h, respectively.

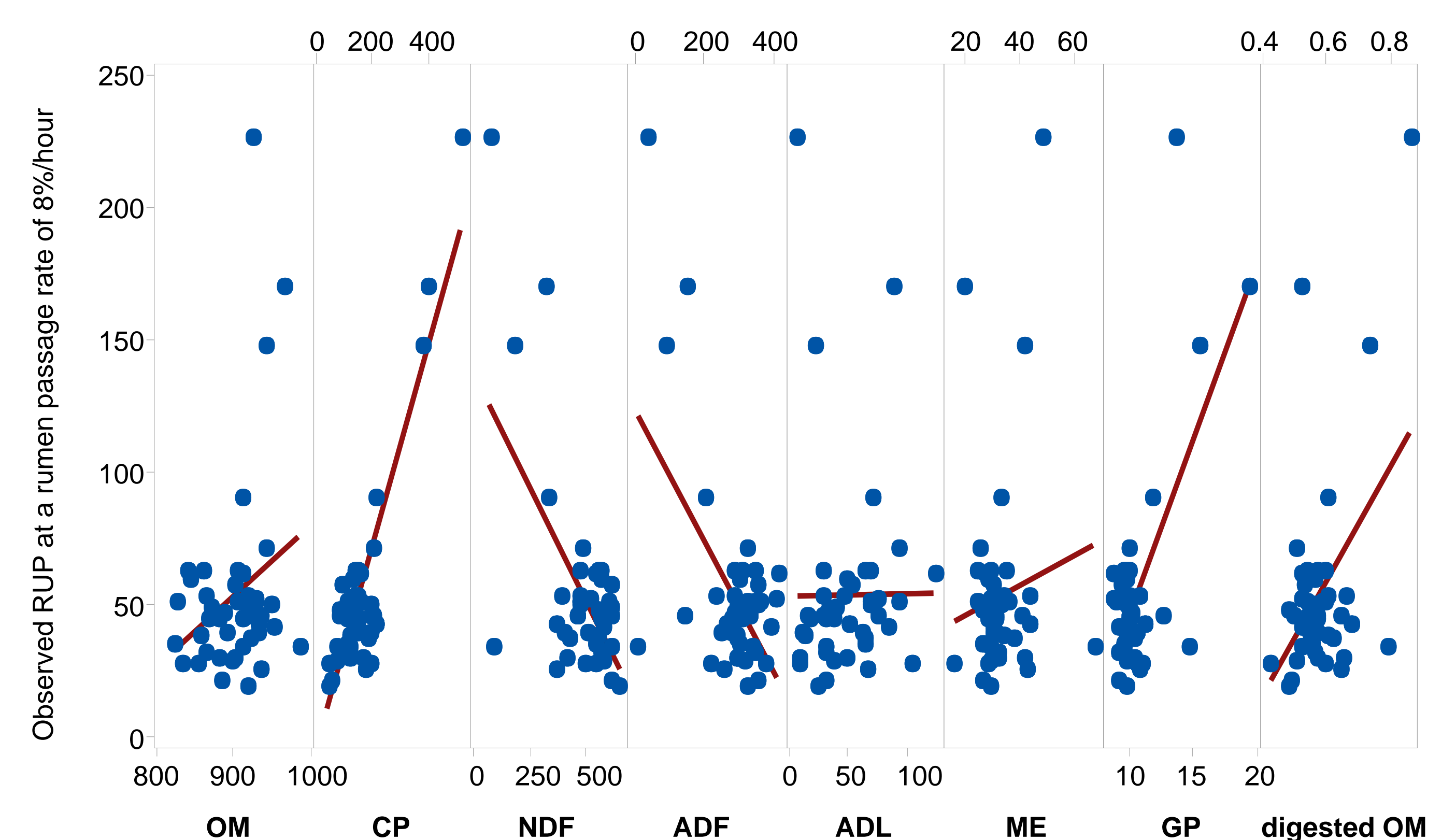


Figure 1. Relationship between observed RUP at a passage rate of 8%/hour (g/kg dry matter) and OM, CP, NDF, ADF, ADL (g/kg dry matter), ME (MJ/kg dry matter), GP (ml/200 mg dry matter), and digested OM (proportion).

Same relationship was observed for RUP at a passage rate of 2 and 5%/hour

The following equations were developed

(coefficient ± standard error)

$$\text{RUP 2\%/hour} = (40.9 \pm 8.5 + 0.3 \pm 0.1 \times \text{CP} - 1.5 \pm 0.3 \times \text{GP})$$

(R² = 0.74; RMSE = 11; P < 0.01),

$$\text{RUP 5\%/hour} = (34.1 \pm 10.6 + 0.4 \pm 0.1 \times \text{CP} - 1.4 \pm 0.4 \times \text{GP})$$

(R² = 0.80; RMSE = 14; P < 0.01), and

$$\text{RUP 8\%/hour} = (25.2 \pm 12.5 + 0.4 \pm 0.1 \times \text{CP} - 1.3 \pm 0.4 \times \text{GP})$$

(R² = 0.81; RMSE = 17; P < 0.01)

where RUP is in g/kg dry matter, CP is in g/kg dry matter, and GP is in ml/200 mg dry matter.

Conclusion

The RUP of common feedstuffs used to feed ruminants in (sub-)tropics can be estimate using CP concentration and GP, however a 20% of the observed mean should expected.

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