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Estimating Rumen Undegradable Protein from Proximate Nutrient, Fiber Fractions, and *in-vitro* Fermentation of Tropical Feedstuffs

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Abstract

Estimates of rumen undegradable crude protein (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. Therefore, this study aims to predict the RUP of tropical feedstuffs from proximate nutrients, fiber fractions, and rumen *in-vitro* feed fermentation characteristics.

A total of 46 tropical feedstuffs, namely, 6 concentrates and by-products, 17 forage legumes, and 23 forage grasses, were used to develop RUP prediction equations. With use of the software Minitab (2018), stepwise linear regression was performed and the determination coefficient (R^2) was calculated for identified RUP equations at rumen passage rates of 2, 5, and 8%/h.

The dataset included information on (arithmetic mean \pm standard deviation): concentrations (per kg of dry matter [DM]) of organic matter (OM; 902 ± 38.9 g), crude protein (CP; 160 ± 87.3 g), neutral detergent fiber (490 ± 132.1 g), acid detergent fiber (287 ± 86.3 g), acid detergent lignin (48 ± 28.8 g), digested OM (0.6 ± 0.1 g kg^{-1} OM), and metabolisable energy (10 ± 1.9 MJ kg^{-1} DM), as well as cumulative gas production (GP) during 24h of *in-vitro* incubation (32 ± 8.3 ml/200 mg DM) and *in-situ* RUP proportion (per kg CP) at rumen passage rates of 2%/h (228 ± 90.8 g), 5%/h (299 ± 104.0 g), and 8%/h (342 ± 110.6 g).

The CP concentration and GP were good predictors of the proportion of RUP across all feedstuffs. The CP concentration accounted for 60, 72, and 77 % and the GP for 14, 7, and 4 % of the variability in the RUP proportion at rumen passage rates of 2, 5, and 8%/h, respectively. The following models were developed (coefficient \pm mean standard error):

$$\text{RUP } 2\%/h = (40.9 \pm 8.5 + 0.3 \pm 0.1 \times \text{CP} - 1.5 \pm 0.3 \times \text{GP}) \times 1000/\text{CP} \quad (R^2=0.74; p < 0.01),$$

$$\text{RUP } 5\%/h = (34.1 \pm 10.6 + 0.4 \pm 0.1 \times \text{CP} - 1.4 \pm 0.4 \times \text{GP}) \times 1000/\text{CP} \quad (R^2=0.80; p < 0.01), \text{ and}$$

$$\text{RUP } 8\%/h = (25.2 \pm 12.5 + 0.4 \pm 0.1 \times \text{CP} - 1.3 \pm 0.4 \times \text{GP}) \times 1000/\text{CP} \quad (R^2=0.81; p < 0.01),$$

where RUP is in g kg^{-1} CP, CP is in g kg^{-1} DM, and GP is in ml/200 mg DM.

In conclusion, the RUP proportions of tropical ruminant feedstuffs can be predicted from CP concentration and GP.

Keywords: *In-vitro* fermentation, tropical feedstuffs, undegradable crude protein