Prediction of feed metabolizable energy and metabolizable protein contents from their chemical constituents

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Abstract

This research aimed to predict feed ME and MP contents by their chemical composition. A total of 134 feeds from various categories (dry forage, fresh forage, silage, energetic concentrate, proteic concentrate and by-product) from BR-CORTE Brazil were integrated into a database.Values of TDN and CP were regressed against ME and MP, respectively. The value of ME was predicted from NDF, NFC, EE and CP whereas MP was predicted from RDP and RUP. The RDP to RUP ratio was regressed to MP in order to obtain optimum value of the ratio. Results showed that TDN and CP could predict quite accurately ME and MP by explaining 78.2% and 92.7% of their total variations, respectively. ME was accurately predicted by NFC, NDF, EE and CP, whereas MP was accurately predicted by RDP and RUP.Lower RDP/RUP led to a higher MP percentage to CP.

Key words: *metabolizable energy, metabolizable protein, total digestible nutrient*

Introduction

Current feed formulation system for ruminant livestock in developed countries such as USA (NRC), UK (AFRC), Australia (CSIRO), France (INRA), Netherland (VEM-DVE) and Brazil (BR-CORTE) is based on metabolizable energy (ME) and metabolizable protein (MP) supply. In Indonesia, however, our feed formulation is still based on an old system, i.e. total digestible nutrient (TDN) and crude protein (CP) to represent feed energy and protein supply, respectively (Riswandi et al., 2015; Yantika et al., 2016). This system has to be evaluated against the current system to decide whether we need to improve our system or we keep the old one. An approach to evaluate the system is through predicting ME and MP by feed chemical constituent, i.e. TDN and CP, respectively. The accuracy of prediction may provide important information to make such decision. This research therefore aimed to predict feed ME and MP contents by their chemical composition.

Methodology

Data used in the present study were originated from the Brazil system BR-CORTE (Filho et al., 2010). A total of 134 feeds from various categories (dry forage, fresh forage, silage, energetic concentrate, proteic concentrate and by-product) were integrated into a database. The chemical constituents recorded were dry matter (DM), ash, organic matter (OM), lignin, neutral detergent fiber (NDF), ether extract (EE), non-fiber carbohydrate (NFC), TDN, ME, CP, rumen degradable protein (RDP), rumen undegradable protein (RUP) and MP.

Values of TDN and CP were regressed against ME and MP, respectively. Regression equations, P-values and coefficient of determinations (R2) were recorded for both relationships. Root mean square prediction error (RMSPE) was calculated between the observed and predicted valuesaccording to Jayanegara et al. (2015). The value of ME was predicted from NDF, NFC, EE and CP whereas MP was predicted from RDP and RUP. Additionally, RDP to RUP ratio was regressed to MP in order to obtain optimum value of the ratio.

Results and Discussions

It was observed that TDN and CP could predict quite accurately ME and MP; 78.2% and 92.7% total variations in ME and MP could be explained by TDN and CP, respectively (Figure 1). The RMSE between observed and predicted values of ME and MP were 0.31 and 2.83%, respectively. It may suggest that our old feed formulation system is sufficient and can be continued especially in the case of CP. However, it has to be noted that our TDN values are usually obtained by estimation from chemical composition (e.g. Zahera et al., 2015), and not by experimentation. This may create bias since to date such estimation has never been validated regarding its accuracy. Development towards a more sophisticated feed formulation system is advisable when adequate resources are available.

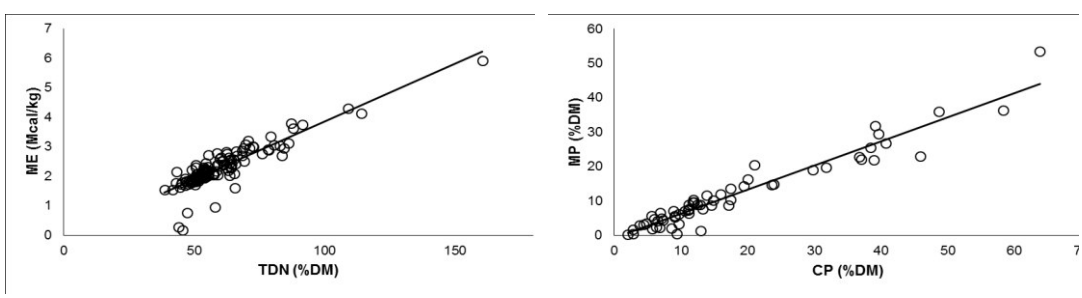

Figure 1. Relationships between total digestible nutrient (TDN) and metabolizable energy (ME) and between crude protein (CP) and metabolizable protein (MP).

ME = –0.057 (±0.111) + 0.039(±0.002) TDN (P<0.001; R^2 = 0.782)

MP = –0.711 (±0.589) + 0.701 (±0.026) CP (P<0.001; R^2 = 0.927)

Both ME and MP are accurately predicted by feed chemical constituents (Table 1). Carbohydrate, both structural (represented by NDF) and non-structural (represented by NFC), EE and CP contribute to energy supply for livestock. The MP is originated from microbial protein that use RDP and by-pass protein. Microbial protein and by-pass protein that can be digested and absorbed in the small intestine is regarded as MP (Pfeffer et al., 2016). Therefore RDP and RUP are very accurate predictors of MP.

Table 1. Regression equation of ME and MP prediction

Dependent	Equation	P-value	R^2
ME	–0.296 + 0.032 NFC + 0.018 NDF + 0.068 EE + 0.044 CP	<0.001	0.914
MP	–0.001 + 0.577 RDP + 0.880 RUP	<0.001	0.999

ME, metabolizable energy (Mcal/kg); NFC, non-fiber carbohydrate (%DM); NDF, neutral detergent fiber (%DM); EE, ether extract (%DM); CP, crude protein (%DM); MP, metabolizable protein (%DM); RDP, rumen degradable protein (%DM); RUP, rumen undegradable protein (%DM)

Relationship between RDPto RUP ratio and MP is presented in Figure 2.Lower RDP/RUP led to a higher MP percentage to CP. It is apparent that RDP/RUP ≤ 4.0 is important to maintain MP ≥ 60% CP, which is equal to maximum 80% RDP (or minimum 20% RUP).

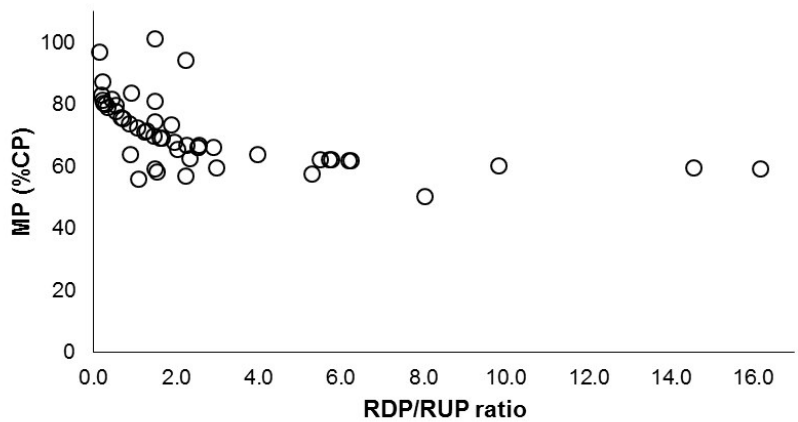

Figure 2. Relationship between rumen degradable protein (RDP) to rumen undegradable protein (RUP) ratio and metabolizable protein (MP).

Conclusion

The TDN and CP and other feed chemical constituentscould predict quite accurately ME and MP. Lower RDP/RUP led to a higher MP percentage to CP..

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