Nitrogen utilization of treated cocoa pod-based ration in steers and its prediction from metabolic parameters

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Introduction

Insufficient supply of forage such as grasses and legumes may limit the production potential of ruminant animals. Accordingly, various agro-industrial by-products are among potential sources of alternative feedstuffs to overcome such forage shortage, including cocoa pod. Cocoa pod is a by-product of cocoa (*Theobroma cacao*) plantation which is grown in some regions in Indonesia. However, high plant cell wall content limits its utilization and, therefore, needs further treatments prior to use (Saili *et al.*, 2010). So far studies have been focused on improving fiber digestibility of cocoa pod, but still limited studies observing on nitrogen (N)-related parameters. The aim of this study was to investigate N utilization of treated cocoa pod-based ration when being fed to steers. Further, several metabolic parameters were attempted to be used for predicting N utilization of the respective ration.

Materials and Methods

Cocoa pod was obtained from PTP XII Rajamandala, Bandung, West Java. Prior to inclusion in ration, the material was subjected to chemical or biological treatments, i.e. (A) control/no treatment, (B) ammoniation with 1.5% urea, (C) fermentation with 3% molasses, (D) fermentation with 3% rumen content, and (E) fermentation with 3% molasses and fungi *Phanerochaete chrysosporium*. The respective cocoa pods (both untreated and treated) were then formulated into total mixed rations at 35% inclusion level, in which the rations were formulated iso-energy and iso-protein, i.e. 65% total digestible nutrient and 17% crude protein, respectively. Five Friesian Holstein steers were fed the rations by following a 5 × 5 latin square design. Adaptation period was carried out for 20 d, and trial period was conducted for 10 d each. Parameters measured were ruminal NH_3 concentration, microbial protein synthesis (MPS), N digestibility (ND), urine allantoin (UA), N retention (NR), net protein utilization (NPU) and average daily gain (ADG). Data obtained were statistically analyzed by analysis of variance, followed by Duncan's multiple range test when the treatment ration differed significantly at $P<0.05$. Further, multiple linear regression method was applied to predict NR and NPU ($n = 25$ data).

Results and Discussion

Rations containing 35% of cocoa pods treated by ammoniation technique (B) and 3% molasses + *P. chrysosporium* (E) produced significantly higher NH_3 ($P<0.05$) in the rumen of steers compared to control (A) (Table 1). However, only the latter treatment increased MPS than that of control ($P<0.05$); the respective result was confirmed by the UA data since rumen microbial protein is excreted as allantoin in urine (Carro *et al.*, 2012). The patterns of ND, NR and NPU showed similarities; ration B and E were superior compared to the others in term of the respective N utilization-related parameters. The response was further reflected in ADG parameter, in which rations B and E resulted in higher ADG than those of other rations ($P<0.05$). Apparently, better access of rumen microbes on the plant cell wall of cocoa pods due to ammoniation or fungal treatment stimulates the microbes to proliferate, and, in turn, to utilize N more efficiently.

Table 1. Nitrogen utilization of cocoa pod (untreated or treated) when fed to steers at 35% inclusion level in a total mixed ration

Parameter	A	B	C	D	E
Rumen NH_3 (mM)	4.69^{a}	6.30^{b}	4.18^{a}	4.84^{a}	5.90^{b}
MPS (g/d)	253^{a}	299^{a}	318^{a}	331^{a}	520^{b}
UA (g/d)	3.32^{ab}	3.98^{b}	3.69^{ab}	2.85^{a}	5.10^{c}
ND (%)	41.8^{a}	51.9^{ab}	42.8^{a}	44.3^{a}	55.2^{b}
NR (g/kg $BW^{0.75}$/d)	1.06^{a}	1.45^{b}	1.12^{a}	1.16^{a}	1.60^{b}
NPU (%)	40.6^{a}	50.1^{ab}	41.4^{a}	43.0^{ab}	53.0^{b}
ADG (kg/d)	0.76^{a}	1.56^{b}	0.94^{a}	0.75^{a}	1.46^{b}

Various superscripts within the same row showed significantly different at $P<0.05$.
A, control; B, ammoniation with 1.5% urea; C, fermentation with 3% molasses; D, fermentation with 3% rumen content; E, fermentation with 3% molasses and fungi *Phanerochaete chrysosporium*.
MPS, microbial protein synthesis; UA, urine allantoin; ND, nitrogen digestibility; NR, nitrogen retention; NPU, net protein utilization; ADG, average daily gain.

In relation to predicting N utilization, i.e. NR and NPU, some parameters were sufficiently good; these parameters were ADG, metabolic body mass (MBM), rumen NH_3 concentration, ND and UA. Multiple regression equations for predicting NR and NPU showed high coefficient of determination (R^2), i.e. 0.99 and 0.85, respectively. The respective equations were presented as below:

$NR = 3.75 + 1.09\ ADG - 0.04\ MBM + 0.01\ NH_3 + 0.94\ ND + 0.54\ UA,\ R^2 = 0.99$
$NPU = 141.2 - 5.03\ ADG - 3.06\ MBM + 1.35\ NH_3 - 0.68\ ND - 1.01\ UA,\ R^2 = 0.85$

References

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