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Comparison of different models to estimate purine bases absorbed in goats

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Abstract

The purine bases absorbed (PBa) and microbial nitrogen flow (MNF) in the duodenum were estimated with five models proposed for sheep (1, 4), goats (2), cattle (5) and a goat-sheep mixed model (3). Data of purine derivatives excreted (PDe) in urine of eight digestibility trials were used. In these trials, eight adult male castrated Murciano-granadino goats (30.5 ± 4.95 kg of live weight) were used. Feed was offered as a total mixed ration and was based on alfalfa hay or barley straw and concentrates (50:50). The range in variation for daily DM intake, OM digestibility and nitrogen balance of the different rations were: 38 to 42 g/kg $LW^{0.75}$, 68 to 71% and 0.35 to -0.11 g/d respectively. The estimation to PBa, MNF and microbial yield, were different between equations. The estimation of PBa in equation 4 was underestimated by too high recovery of endogenous fraction of PDe in urine considered in this equation. The ratio between N content in the microbial population of the rumen (MNR) and PBa was lower in the equation 2 (0.55 mmol/day) than equations 1, 3, 4 and 5 (0.727 mmol/day). The variability of the factors used in the equations to estimate PDa and MNF within and among species limits its use.

Keywords: Endogenous purine derivative, digestible organic matter intake, microbial nitrogen synthesis, purine metabolism
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Introduction

The knowledge of the microbial nitrogen synthesis in the rumen is an important factor in the new protein evaluation systems. The purine derivatives excreted (PDe) through the urine, could be used to estimate the microbial protein produced in the rumen and digested in the lower tract (Chen & Gomes, 1992). The use of this method requires knowledge of purine metabolism and the relation of Pde : purine bases absorbed (PBa). The PDe is a function of the plasma concentration of purine derivatives (PD), rate of glomerular filtration and the metabolic activity of xanthine-oxidase. These factors are different among species (Chen & Gomes, 1992).

Chen & Gomes (1992) proposed a model for sheep that has been used in goats, since these two species have similar xanthine-oxidase activity (Lindberg, 1989; Stangassinger *et al*., 1995; Belenguer *et al*., 2002). Variations to the Chen & Gomes (1992) model for sheep have been proposed by Balcells *et al*. (1991) and for goats by Belenguer *et al*. (2002).

The objective of this work was to compare the use of five different models to calculate the PBa and the microbial nitrogen flow (MNF), by means of the excretion of PD in urine in Murciano-Granandino goats.

Materials and Methods

Data of PDe in urine of eight digestibility trials were used. In this trial, eight castrated adult males of Murciano-granadino goats (30.5 ± 4.95 kg of live weight) were used. Feeds were offered as a total mixed ration based on alfalfa hay or barley straw and concentrate (50:50). Rations were offered in a restricted form (40 g of dry matter (DM)/kg $BW^{0.75}$ per day; Van Es & Van der Meer 1980). Range of variation for daily intake, digestibility and nitrogen balance of the different rations is shown in Table 1.

Urine excretion was collected daily for 5 days and it was preserved with 100 mL of 10% H_2SO_4. The urine was weighed and 50 mL/animal/day was sampled and frozen at –20 °C. The PDe in urine were analysed by the HPLC (Kontron Data System 450-MT) with a column Kromasil C_{18} column.

The references for the equations used for the estimation of PBa, MNF and microbial yield (microbial N g/kg of digestible organic matter fermented in the rumen (DOMR)) are shown in Table 2.

Table 1 Characteristics of the rations

	Means	Minimum	Maximum	s.e.m.
Daily Intake g/kg $BW^{0.75}$				
Dry matter	40.46	38.55	42.36	0.95
Digestible organic matter	27.01	25.57	28.45	0.72
Digestible protein	3.62	3.34	3.90	0.14
Digestibility (%)				
Organic matter	70.17	68.53	71.82	0.83
Nitrogen balance (g N/day)	0.58	-0.11	0.35	1.27

Table 2 Equations used to calculate PBa and microbial nitrogen flow (MNF)

Equation number	PBa (Species)	MNF (Species)
1	Chen & Gomes (1992) (Sheep)	Chen & Gomes (1992) (Sheep)
2	Belenguer *et al.* (2002) (Goats)	Belenguer *et al.* (2002) (Goats)
3	Belenguer *et al.* (2002) (Goats)	Chen & Gomes (1992) (Sheep)
4	Balcells *et al.* (1991) (Sheep)	Chen & Gomes (1992) (Sheep)
5	Chen & Gomes (1992) (Cattle)	Chen & Gomes (1992) (Cattle)

Pba - purine bases absorbed

Results and Discussion

The results of PD excretion and PBa, MNF and microbial nitrogen yield/kg of digestible organic matter fermented in the rumen (MNF g/kg DOMR) estimation are shown in Table 3. The PD excretion was similar to that observed by Belenguer *et al*. (2002) for goats fed with lucerne hay at a maintenance level. The PBa and MNF are different (P < 0.01) among equations. PBa values ranged from 12.6 (equation 4) to 16.3 (equations 2 and 3) mmol/d. The models proposed for sheep (4) or cattle (5) underestimated the PBa values predicted for goats (2,3). The estimation of PBa is affected by the recovery of PDe and the endogenous fraction of PD in urine. However, the recovery of urinary PD is variable within and among species. In sheep, it ranged from 84 to 93% (Balcells *et al*., 1991; Chen & Gomez, 1992), and in goats from 74 to 95% (Lindberg, 1991; Belenguer, 2002). On the other hand, goats and cattle have similar endogenous ratio PD excreted in urine (30% and 24-39%, respectively) but they are different to sheep (9-17%) (Mota *et al*., 2003).

Table 3 Results of PDe and PBa and microbial nitrogen flow (MNF) estimated by different equations

Equation	1	2	3	4	5	s.e.m.	Sig[2]
PDe mmol/d	12.39	12.39	12.39	12.39	12.39	0.68	NS
PBa mmol/d	14.64[a]	16.3[a]	16.3[a]	12.68[b]	13.99[b]	0.84	**
MNF g/d	10.64[a]	8.99[b]	11.85[a]	9.22[b]	10.17[ab]	0.58	***
MNF g/kg DOMR[1]	48.35[ab]	40.84[a]	53.82[b]	40.82[a]	46.2[ab]	2.89	**
MNF g/N intake g	1.03[ab]	0.87[a]	1.15[b]	0.89[a]	0.98[a]	0.05	

PDe - purine derivatives excreted; Pba - purine bases absorbed
[1]DOMR: Digestible organic matter fermented in the rumen = DOM*0.65 (ARC, 1980)
[2]Significance level: NS: P > 0.05; ** P < 0.01; *** P < 0.001
[a-b]Means between columns with different superscript are significantly different

The ratio between N content in the microbial population of the rumen and PBa was lower in the equation 2 (0.55 MNF g/PBa mmol) than equations 1, 3, 4 and 5 (0.727 MNF g/PBa mmol). Therefore, the Chen & Gomes (1992) models could have overestimated the MNF in goats. The estimation of MNF depends on the digestibility of duodenal PBa and the ratio between N content in microbial population of the rumen and PBa, this relation is not absolute and it can vary according to the experimental diet. Nevertheless, the range of change is not important (Chen & Gomes, 1992; Stangassinger *et al*., 1995; Sandoval-Castro & Herrera Gomez, 1999). On the other hand, the microbial yield was higher in equation 3, due to a greater ratio between PBa and PDe and to the ratio between MNR and PBa used in equations. Nevertheless, the estimates of microbial yield was similar to that reported by other authors, ranging from 25 - 45 g of MNF/kg DOMR (ARC, 1980; Ranilla *et al*., 2003). The ratio MNF g/g N intake was higher than 1 in Equations 1 and 3. The data suggest that these models could not be used for goats.

Conclusion

The results suggest that the enzymatic activity is similar between sheep and goats, but that the variability between the factors used in the equations to estimate PDa and MNF within and among species limits its use.

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