The INRA 2018 updated calculation of fermentable organic matter intake improves the prediction of net portal appearance of volatile fatty acids in ruminants

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Take home message The INRA 2018 updated calculation of fermented organic matter (FOM) in the rumen, which takes into account digestive interactions, improves the prediction of net portal flow of volatile fatty acids (VFA) in ruminants.

Introduction The FOM in the rumen is a key predictor of the production of VFA, the main energy nutrients for ruminants (Loncke *et al*., 2009). Until recently, two calculation methods were used in France (INRA, 1978, 2007). In 2016, the calculation was largely revised (Sauvant and Nozière, 2016). It now takes into account digestive interactions due to level of intake, proportion of concentrate and rumen protein balance. It also better integrates partition of digestion between rumen and intestines for protein and starch considering that the outflow rate of particles and liquid changes with level of intake and proportion of concentrate. This revised FOM is now included in the new INRA (2018) feeding system. The aim of the present study is to compare the ability of the three calculations to predict the net portal appearance of VFA.

Materials & methods Meta-analyses (Sauvant *et al*., 2008) were applied on published data compiled from the INRA Flora database (Vernet and Ortigues-Marty, 2006), which gathers published results on net portal appearance of nutrients in ruminants. The FOM of diets was calculated according to INRA 1978 (FOM_1978), INRA 2007 (FOM_2007) and INRA 2018 (FOM_2018) using the systoolweb.fr application (Chapoutot *et al*., 2015). The FLORA database is totally independent from databases used to establish the INRA 2018 feeding system. Relationships between NPA of total VFA and the three expressions of the FOM were studied by intra-experiment covariate models.

Results & discussion For a wide range of diets containing 25 ± 31% concentrate and ingested at a dry matter intake level of 1.86 ± 0.65 %BW, the net portal appearance of total VFA was significantly predicted by all of the three expressions of the FOM (Table 1). Adjustment was, however, better for the FOM_2018 model than for the other two models. Overall it had smaller RMSE and higher adjusted R^2. The standard error on the slope was also smaller (0.0338 = 13% of the slope, vs. 15% for FOM_2007 and 16% for FOM_1978). The intercept was not significantly different from 0, suggesting no VFA production at zero intake. Finally, level of intake and diet composition did not influence the parameters of the FOM_2018 model. By contrast, dietary starch content was an interfering factor on residues and individual slopes, and the proportion of concentrate was interfering on residues of the FOM_1978 model. Altogether, this suggests that the 2018 updated calculation of the FOM better reflects the outcomes of ruminal digestion. The slope of 0.265 corresponds to 6.36 mmol/d/kg BW, which is equal to 76% of total VFA produced in the rumen as calculated by the new INRA 2018 system (8.35 mol/d/kg FOM).

Table 1 Linear intra experiment response equations for the relationships between fermented organic matter intake (FOM, g/d/kg BW) calculated from INRA (1978, 2007 and 2018) and the net portal appearance of total volatile fatty acids (mmol/h/kg BW)

Variable	Mean ± SD	nexp	ntr	intercept	se	slope	se	RMSE	Adjusted R^2
FOM_1978	11.03 ± 3.98	24	54	0.734*	0.411	0.182***	0.0291	0.424	0.879
FOM_2007	9.68 ± 3.74	24	54	0.579*	0.333	0.225***	0.0341	0.411	0.886
FOM_2018	9.39 ± 3.14	24	54	0.256^{NS}	0.321	0.265***	0.0338	0.369	0.909

Probability of significance: ^{NS} P > 0.1 ; *P<0.05; ***P<0.001; nexp : number of experiments ; ntr : number of treatments

Conclusion The FOM of the new INRA system improves the prediction of net portal appearance of total VFA.

References

Chapoutot P, Martin O,Nozière P and Sauvant D. 2015. Annual Meeting of the European Federation of Animal Science
INRA 1978. Alimentation des Ruminants. INRA Publications, Versailles, 597 pp
INRA 2007. Tables INRA 2007, Versailles, 307 pp.
INRA 2018. INRA feeding system for ruminants. Wageningen Academic Publisher, Wageningen, 640 pp
Loncke C, Ortigues-Marty I, Vernet J, Lapierre H, Sauvant D and Nozière P 2009. Journal of Animal Science 87, 253-268.
Sauvant D and Nozière P 2016. Animal 10, 775-770
Sauvant D, Schmidely P, Daudin JJ and St-Pierre NR 2008. Animal 2, 1203-1214.
Vernet J and Ortigues-Marty I 2006. Reproduction Nutrition Development 5, 257-546