Interest and limits of the HFT method to evaluate the energy value of compound feeds for small ruminants

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SUMMARY – *In vivo* organic matter digestibility (OMD) of 34 compound feeds was measured on dairy goats or on male castrated sheep. *In vitro* gas production of these 34 compound feeds was calculated from gas production of ingredients. OMD was well predicted by gas production, but the coefficients of this new equation differed from those proposed previously by Menke and Steingass. The coefficients of the equation predicting OMD from gas production and protein content differed also from those of Menke and Steingass. The most precise prediction included gas production, crude protein and lignin percentages. This model was not previously tested. Residuals of the Menke and Steingass equations applied to our data are correlated to the percentage of cereals in the compound feeds, which limits their use. This was not the case for the equations proposed in this paper. These equations allowed to predict with a high degree of precision and close to what was observed *in vivo* the OMD of compound feeds for ruminants, and thus their energy value.

Key words: *In vitro*, gas method, prediction, energy value, compound feeds, small ruminants.

***RESUME –** "Intérêt et limite de la méthode HFT pour évaluer la valeur énergétique des aliments composés pour les petits ruminants". La digestibilité* in vivo *de la matière organique (dMO) de 34 aliments composés a été mesurée sur des chèvres laitières ou sur des moutons castrés standard. La production de gaz* in vitro *de ces 34 aliments a été calculée à partir de la production de gaz de leurs ingrédients. La prédiction de la dMO par la production de gaz est bonne. Les coefficients de l'équation obtenue sur cet ensemble diffèrent de ceux proposés par Menke et Steingass. La même remarque est valable pour les coefficients de l'équation incluant la production de gaz et la teneur en protéines brutes. La prédiction la plus précise est obtenue avec une équation incluant la production de gaz et les teneurs en lignine et en matières azotées totales des aliments. Ce modèle n'avait pas été testé dans l'étude précédente. Les résiduelles des équations de Menke et Steingass appliquées à nos données sont corrélées au pourcentage de céréales, ce qui en limite leur portée, contrairement aux résiduelles des équations issues de ce travail qui permettent de prédire avec une incertitude proche de celle observée* in vivo *la dMO des aliments composés pour ruminants, et donc leur valeur énergétique.*

***Mots-clés :** Production de gaz* in vitro*, modèle de prédiction, valeur énergétique, aliment composé, petits ruminants.*

Introduction

In 1979, Menke *et al.* proposed an estimation of the energy value of feedstuffs from their *in vitro* gas production associated with chemical parameters. The gas test (HFT or Hohenheimer Futterwert Test) method is based on the assumption that the accumulated 24 h gas production by a substrate, incubated in a syringe with rumen liquor and a nutritive solution, is proportional to the amount of digestible carbohydrates, and thus highly correlated to the energy value of feedstuffs or to the *in vivo* organic matter digestibility (OMD).

The aim of this work was to predict OMD of compound feedstuffs for sheep or goats estimated from the chemical composition associated with the gas production of their ingredients. The equations obtained in the present work are compared and discussed with those published by Menke and Steingass (1988).

Materials and methods

Thirty four compound feedstuffs were tested *in vivo* in 2 INRA laboratories: 18 on dairy goats at the Nutrition and Feeding Station (INA-PG, Paris, France), and 16 on castrated male sheep at the Research Station for Herbivorous Nutrition (Theix, France).

Gas production of ingredients similar to those used to formulate compound feeds was measured according to the Menke and Steingass (1988) procedure with rumen liquor obtained from fistulated dairy cows (about 200 mg DM of feed is incubated in a 100 ml glass syringe with 10 ml of rumen liquor and 20 ml of a buffer solution). Data are expressed as ml of gas produced after 24 h of incubation per 200 mg DM.

Gas production of compound feedstuffs was calculated with the assumption of additivity for gas production of ingredients.

Results

OMD was highly correlated with gas production, with a residual standard deviation (RSD) of 3.53 (Fig. 1):

$OMD_{(\%)}$ = 52.2 + 0.505 gas production (r^2 = 0.40, n = 34, RSD = 3.53)

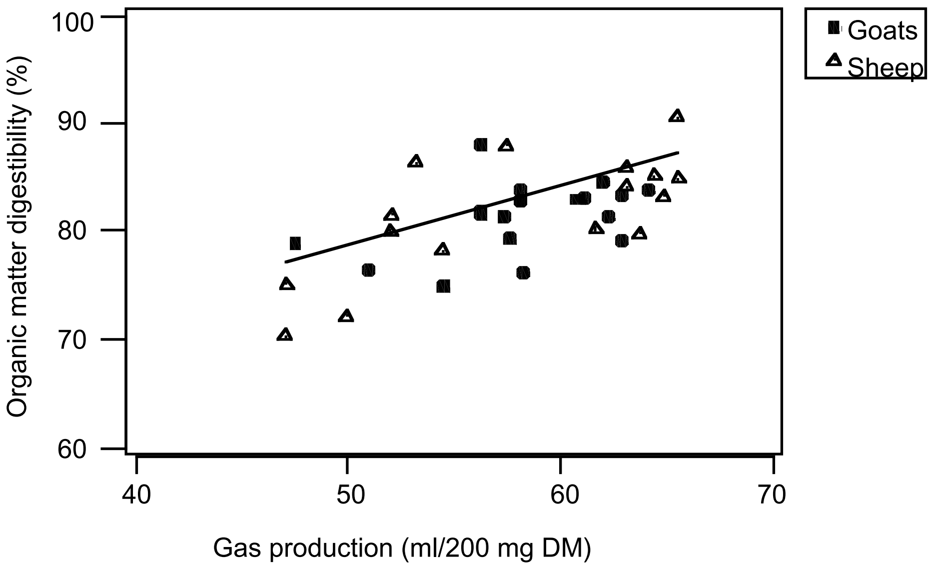

Fig. 1. Relationship between *in vivo* organic matter digestibility and *in vitro* gas production.

The slope of our regression line was smaller than that obtained by Menke and Steingass (1988) using 150 concentrates of similar chemical composition:

OMD (%) = 42.85 + 0.6766 gas production (r^2 = 0.72, n = 150, RSD = 2.37)

Another equation by Menke and Steingass (1988) using a second set of 200 feedstuffs (150 concentrates + 50 ingredients) produced an even higher slope compared to our equation:

OMD (%) = 37.59 + 0.7571 gas production (r^2 = 0.72, n = 200, RSD = 5.64)

The addition in the equation of crude protein content (CP) improves the accuracy of prediction:

OMD (%) = 33.3 + 0.648 gas production + 0.472 CP (r^2 = 0.63, n = 34, RSD = 2.75)

This is not surprising because the HFT method is based on carbohydrate degradation and does not take well into account crude protein.

Similar equations from Menke and Steingass can be used to estimate OMD:

OMD (%) = 28.49 + 0.7967 gas production + 0.0325 CP (r^2 = 0.78, n = 150, RSD = 2.13)

OMD (%) = 11.03 + 0.9860 gas production + 0.0606 CP (r^2 = 0.92, n = 200, RSD = 3.11)

Moreover, the residuals of the regressions applied to our data are significantly related to the percentage of cereals (and thus the kind of feedstuffs). The use of the above regression equations obtained either on 150 data (Fig. 2) or on 200 data (Fig. 3) do not accurately predict OMD.

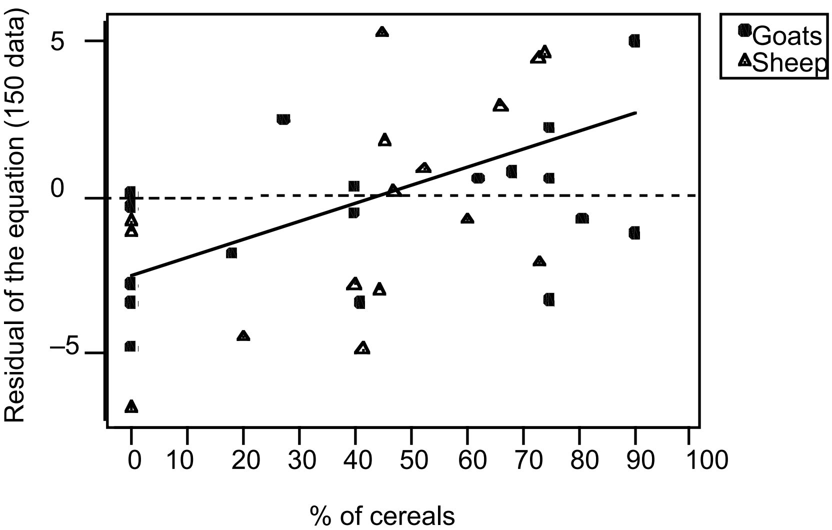

Fig. 2. Relationship between the residual of the equation of Menke and Steingass on 150 data and the percentage of cereals.

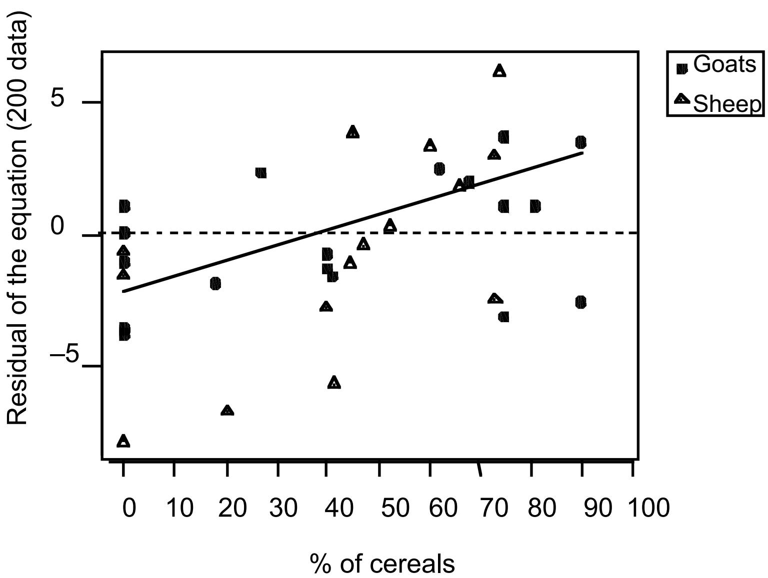

Fig. 3. Relationship between the residual of the equation of Menke and Steingass on 200 data and the percentage of cereals.

For both regressions that we obtained, percentage of cereals was not correlated with the residual.

Accuracy may be improved when lignin is associated with crude protein and gas production:

OMD = 57.2 + 0.365 gas production + 0.304 CP – 1.98 ADL (r^2 = 0.78, n = 34, RSD = 2.18)

The residual standard deviation is of the same order of magnitude (2.18) as the accuracy of the *in vivo* determination. The kind of animals (sheep vs goat) and the percentage of cereals of the compound feedstuffs had no significant effect on the residual of this last equation (Fig. 4). This model gives higher accuracy than the previous ones.

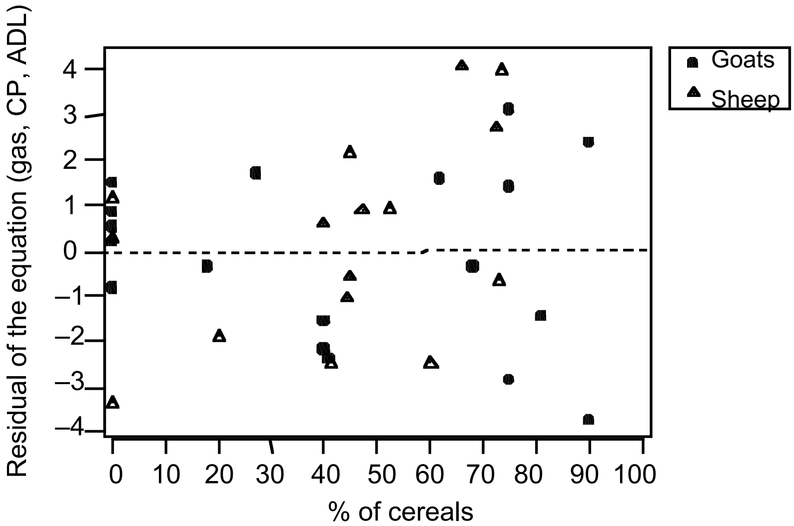

Fig. 4. Relationship between the residual of the equation including gas production crude protein content (CP) and lignin (ADL) and the percentage of cereals.

Conclusion

The HFT method is of interest in predicting OMD, and thus the energy value of compound feedstuffs for small ruminants, especially when combined with CP and ADL.

Moreover, the amount of feedstuff needed is low and the number of samples tested could be up to 24 in a batch.

Limits of the method are the cost of the device and the need to check the model carefully for poorly digestible feedstuffs, because equations depend on the data base and it must be stressed that the incubation medium is rich in nitrogen and this might overestimate the energy value.

References

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