Methane production in sheep in relation to concentrate feed composition from bibliographic data

Giger-Reverdin S., Sauvant D.

in

Ledin I. (ed.), Morand-Fehr P. (ed.).
Sheep and goat nutrition: Intake, digestion, quality of products and rangelands

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 52

2000
pages 43-46

Methane production in sheep in relation to concentrate feed composition from bibliographic data

S. Giger-Reverdin and D. Sauvant
Laboratoire de Nutrition et Alimentation (INRA) de l'INA-PG,
16 rue Claude Bernard, 75005 Paris, France

SUMMARY – Methane is one of the factors involved in the greenhouse effect. As ruminants produce methane in the rumen and eruct it, the aim of this study was to perform a global statistical approach on the data published by the Rowett Research Institute on male castrated sheep. This work underlined big variations between and within feeds for gross energy losses as methane. Lignin was the best predictor of methane losses, and a model including digestible energy and chemical parameters explained 90% of methane variation. This work agrees with previous reviews on gross energy losses as methane and gives new information about the intrinsic feed influence.

Key words: Methane production, sheep, feedstuffs, model of prediction.

RESUME – *"Production de méthane chez le mouton selon la composition des aliments concentrés à partir des données bibliographiques". Le méthane est l'un des facteurs impliqués dans l'effet de serre. Comme les ruminants en produisent dans le rumen et l'éructent dans l'atmosphère, l'objet de ce travail est d'analyser les résultats publiés par le Rowett Research Institute par une méthode statistique globale. Les résultats ont été obtenus sur des moutons castrés standard. Cette étude a souligné l'importance des variations inter et intra aliments pour la part d'énergie brute perdue sous forme de méthane. La lignine est le meilleur prédicteur chimique des pertes en méthane, et un modèle associant l'énergie digestible et les paramètres chimiques permet d'expliquer 90% des variations des pertes en méthane. Les résultats obtenus sont en accord avec les revues existantes sur ce sujet et les complètent sur la part de l'effet spécifique des aliments.*

Mots-clés : *Production de méthane, mouton, aliment concentré, modèle de prédiction.*

Introduction

Methane is one of the factors involved in the greenhouse effect. Digestive processes in ruminants produce methane in the rumen which is eructed. It is therefore of importance to estimate accurately methane production from ruminants. Several reviews have dealt with this topic (Crutzen *et al.*, 1986; Vermorel, 1995). Nevertheless, we have focused on the specific effects of feedstuffs.

Therefore, the aim of this study was to perform a global statistical approach on the data published by the Rowett Research Institute on male castrated sheep (RRI, 1975; Wainman *et al.*, 1978, 1984). The interest of this data base is that all the results have been obtained with a single methodology.

Materials and methods

The data base contains 535 individual observations which can be grouped into 22 feed classes: (i) wheat, wheat offals, barley, distillers grains, oats, maize, sorghum; (ii) peas, beans; (iii) sugar beet by-products, potatoes, rutabaga, cauliflower; (iv) soyabean meal, groundnut meal; (v) green gramineae, grass silages, artificially dried grasses, lucerne silage, lucerne hay, maize, silage and straw.

Results

Within each of the 22 classes of feedstuffs, gross energy (GE) losses as methane varied considerably (Fig. 1).

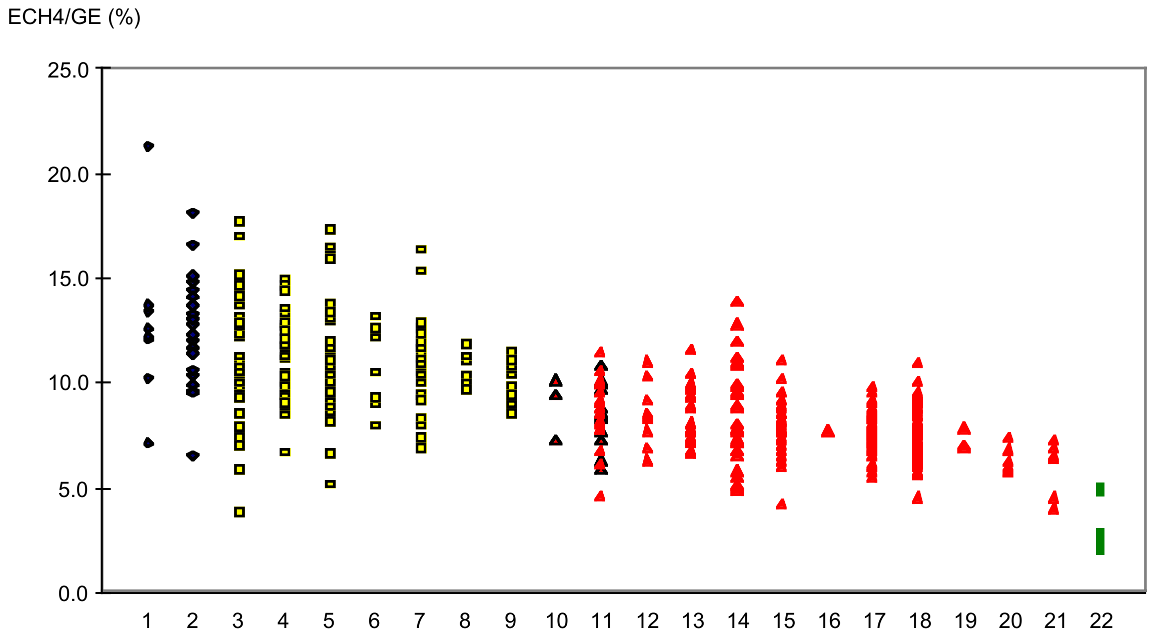

Fig. 1. Within feed variations of losses of gross energy as methane (ECH4/GE).

Mean values of gross energy as methane varied also between feeds from 3.8 (distillers grains) to 12.8 % (peas) (Fig. 2).

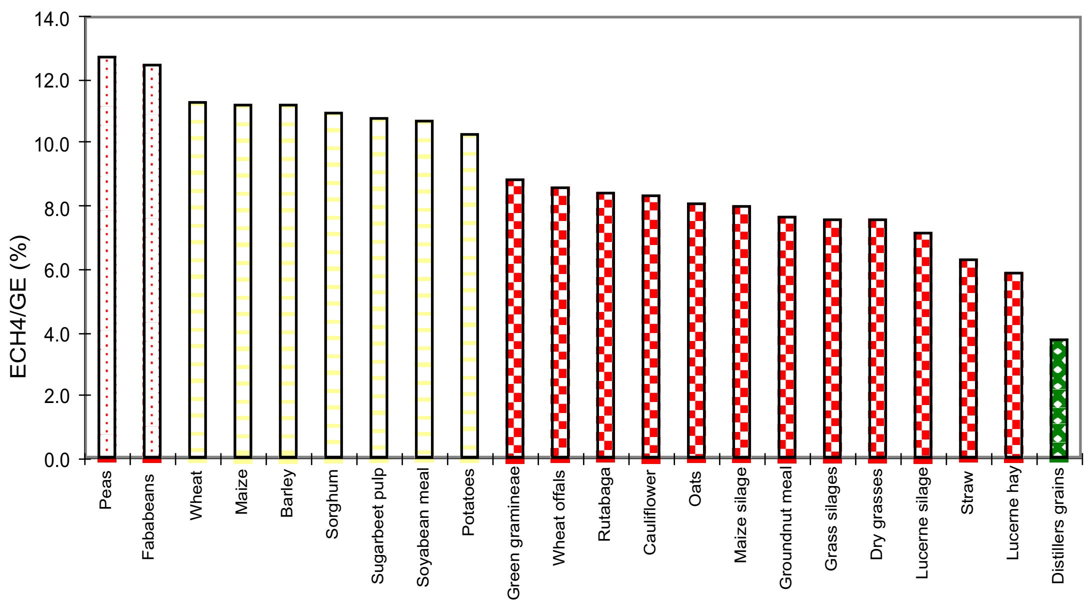

Fig. 2. Between feeds variations of losses of gross energy as methane.

A statistical approach of the whole set of 535 data divided the 22 classes of feedstuffs into 4 groups:

(i) High-producing methane feeds (>12%/GE): peas and fababeans.

(ii) Medium-producing methane feeds (10 to 12%/GE): wheat, maize, barley, sorghum, sugar beet pulp, soyabean meal, potatoes.

(iii) Low-producing methane feeds (5 to 9%/GE): green gramineae, wheat offals, rutabaga, cauliflower, oats, maize silage, groundnut meal, grass silages, dry grasses, lucerne silage, straw and lucerne hay.

(iv) Very low-producing methane feeds (<4%/GE): distillers grains.

The associated basal feedstuffs used may also influence this value. With dry forages, methane losses are a little higher (0.01%/GE) than with grass silages. No statistical difference appeared for peas, fababeans, sugar beet pulp and sorghum when tested with either gramineae hays or with maize silage. Kinds of concentrates do not seem to statistically modify the methane losses of the basal feed. In conclusion, reciprocal influence of feeds sometimes exists, but generally it might be smaller than the incertitude of measurements.

Methane variation losses were significantly decreased with the increase of ether extract or of one of the cell wall constituents (NDF, ADF or ADL). Lignin (ADL) was the best chemical predictor in methane variation losses and explained 61% of the variations of gross energy losses as methane (Fig. 3):

$ECH4/EB_{(\%)} = 11.7 – 0.0847\ ADL$ ($r^2 = 0.61$, n = 22, RSD = 1.45)

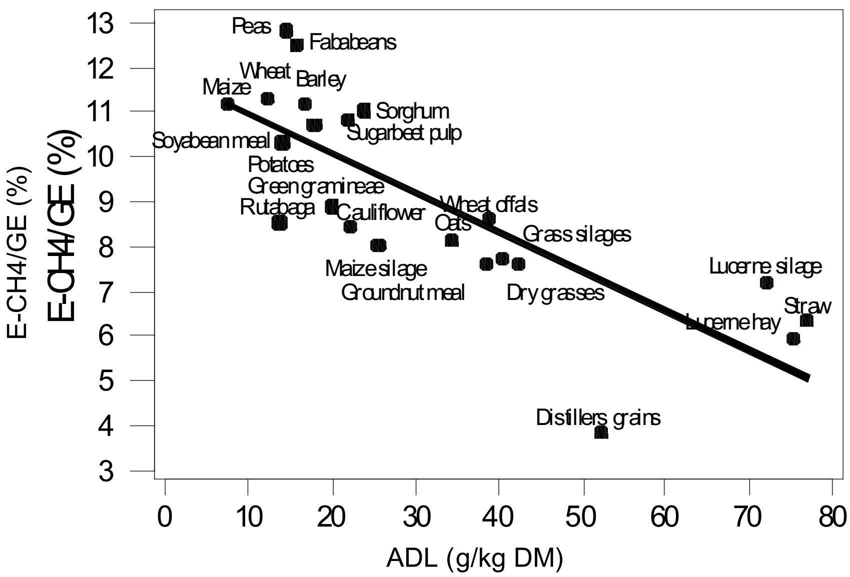

Fig. 3. Influence of lignin on gross energy losses asmethane.

According to its lignin content, distillers grains had a very low methane production.

About 90% of the variations in losses of gross energy as methane (ECH_4/EB) are explained by using the predictors of feed composition: lignin (ADL), ether extract (EE), starch (St) and protein (CP), expressed as g/kg DM:

$ECH_4/EB = 9.84 - 0.0461\ ADL – 0.0509\ EE + 0.00366\ St + 0.00648\ CP$
($r^2 = 0.88$, n = 22, RSD = 0.88)

Losses of gross energy as methane is directly proportional to digestible energy (Fig. 4):

$ECH4/EB = 0.116\ ED/EB$ ($r^2 = 0.56$, n = 22, RSD = 1.55)

About 11.6% of digestible energy is lost as methane, but straw had a large influence in the definition of regression coefficients, and distillers grains have low methane losses compared to the digestibility of energy.

Association of digestible energy with chemical variates improves the accuracy of prediction:

$$ECH_4/EB = -10.5 + 0.192\ ED/EB - 0.0567\ EE + 0.00651\ St + 0.00647\ CP + 0.0111\ NDF$$

$(r^2 = 0.92, n = 22, RSD = 0.70)$

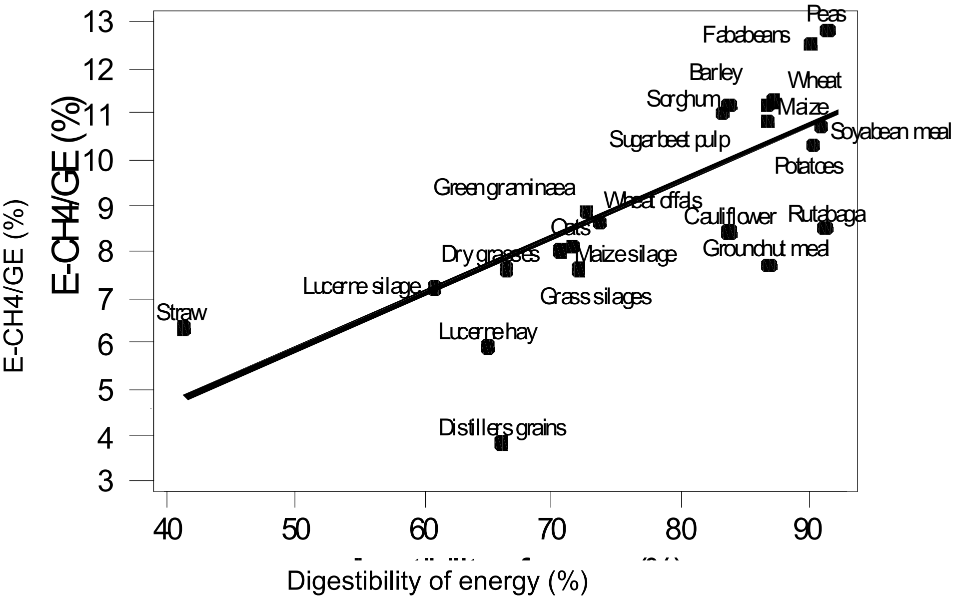

Fig. 4. Influence of digestibility of energy on gross energy losses as methane.

Conclusion

This statistical approach from the Rowett data on sheep makes clearer the effects of feedstuff composition on methanogenesis and is in agreement with previous papers on this topic.

Acknowledgments

The authors are indebted to Agriges for financial support.

References

Crutzen, P., Aselmann, I., Seiler, W., (1986). *Tellus*, 38B: 271-284.

RRI, Rowett Research Institute (1975). *Feedingstuffs evaluation unit*, First Report. Rowett Research Institute, Aberdeen.

Vermorel, M. (1995). *INRA Prod. Anim.*, 8: 265-272.

Wainman, F.W. and Dewey, P.J.S. (1984). *Feedingstuffs evaluation unit*, Fourth Report. Rowett Research Institute, Aberdeen.

Wainman, F.W., Dewey, P.J.S. and Boyne, A.W. (1978). *Feedingstuffs evaluation unit*, Second Report. Rowett Research Institute, Aberdeen.