Modelling variations in partition of carbon balance in lactating ruminants

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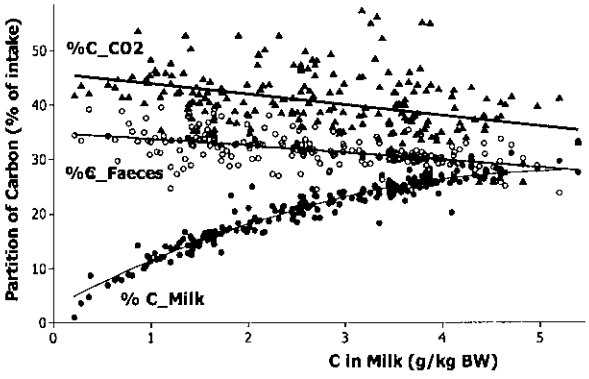
Take home message Carbon partition in lactating ruminants provides C flows of various significations in terms of environmental impact. Its major factor of variation is milk production level: when it increases, partition of C in faeces, CH_4, urine and CO_2 decrease.

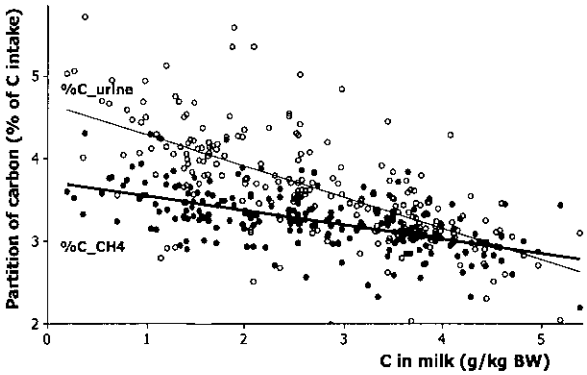
Introduction Knowledge on the variations of carbon (C) balance in dairy ruminants is necessary to accurately quantify C flows in farming systems, especially in life cycle analyses. Therefore, this study was performed to quantify the various inflows and outflows of C and their major variations in lactating cows and goats.

Material & methods For the current purpose, a database pooling results of calorimetric studies carried out on lactating ruminants (80 experiments, 227 treatments, trt, 180 on lactating cows, 47 on lactating goats) was developed. Calculations of the flows of C from the various flows of organic matter (diet, faeces, milk) consider that the proportions of C is, as classically assumed, of 0.45, 0.52 and 0.76 in carbohydrates, proteins and lipids respectively. The measured energy losses as CH_4 (75 g C/Mcal) and urine (105 g C/Mcal) were translated in terms of matter and then flows of C. Data on heat production (HP) were used to evaluate expired CO_2 (111 mgC/Mcal HP; Pedersen *et al.*, 2008).

Results& Discussion The dietary C content was of 446.2 ± 13.9 g/kg dry matter, for milk it was of 92.6±0.78 g C/Mcal. There was no significant difference between dairy cows and goats when C flows were expressed on a Body Weight (BW) basis. In these lactating ruminants, the flows of C expressed on a BW basis (g C/kg BW) associated with intake, faeces, CH_4, urine, CO_2, milk were respectively of 13.13 ± 3.43, 4.23 ± 1.33, 0.43 ± 0.13, 0.47 ± 0.19, 5.35 ± 1.35 and 2.70 ± 1.15 g/kg BW. Resulting body C balance is of 0.06 ± 0.82 g/kg BW. When reported on the basis of 100 for C intake, the partition of ingested C between %C_faeces, %C_CH_4, %C_urine, %C_CO_2, % C_milk were respectively of 31.7 ± 6.12, 3.28 ± 0.80, 3.65 ± 1.42, 40.69 ± 6.52 and 19.71± 6.32 %.

Milk production level is the 1st factor of variations in C partition. Figures 1 and 2 present the major intra-experiment trends. When C produced in milk increased, its coefficient of C partition increased curvilinearly (%C_Milk = 32.0 (1-exp$^{(-0.41\,C)}$) with a maximum asymptotic value of 32%. For the 4 other variables the trends were linear and they decrease at respective rates of -1.26, -0.17, -0.41 and -1.70 %/g C in milk/kg BW for %C_faeces, %C_CH_4, %C_urine and %C_CO_2. Beyond this factor, the residual variations around these relationships are partly caused by feeding factors.





Figures 1 and 2 Intra-experiment trends in partition of C intake in function of level of C produced in milk.

Conclusion Partitions of C are different according to the considered flows, in lactating ruminants partitions vary mainly in function of the level of milk production with a decrease of % of C lost in faeces, CH_4, urine and CO_2 when C in milk increases.

References

Pedersen S, Blanes-Vidal V, Joergensen H, Chwalibog A, Haeussermann A, Heetkamp MJW and Aarnink AJA 2008. Agricultural Engineering International 10, 1-19.