INNOVATIVE DATABASE AND ITS POTENTIAL TO REALISE LARGE SCALE STUDY TO QUANTIFY THE IMPACT OF DIET COMPONENT ON CH4 EMITTED DAILY BY DAIRY COWS

VANLIERDE, A.[1], BOULET, R.[2], COLINET, C.[3], GENGLER, N.[3], SOYEURT, H.[3], DEHARENG, F.[1], FROIDMONT, E.[1]

[1] Walloon Agricultural Research Centre (CRA-W), Belgium
[2] Dumoulin S.A., Belgium
[3] University of Liege, Gembloux Agro-Bio Tech (ULg – GxABT), Belgium

ABSTRACT: Diet composition (**DC**) is one of the main levers to reduce methane (**CH_4**) emissions from cattle. Anyway, neither DC nor individual CH_4 emissions are available in the classical performance recording databases. Through collaboration with the feed company Dumoulin S.A., a new type of database has been built including DC at herd level, zootechnical data, milk MIR spectra and through this last one, the individual CH_4 prediction. The objective was to realise a first exploratory analysis on this very novel database based on more than 6,800 records from 1,260 cows and 10 different Belgian farms. Correlations and models have been calculated to estimate the influence of diet components on the CH_4 emissions. The first conclusions highlighted that high fat, digestible proteins and “sugar and starch” levels in the diet permit to reduce CH_4 emissions through intensification. Fat seems to combine a great impact at ruminal level.

Keywords: CH_4, dairy cows, milk, mid infrared, diet composition

INTRODUCTION: Agriculture and more especially cattle breeding are notably concerned by the worldwide intent to reduce greenhouse gases (**GHG**) emissions. The main levers of action to reduce CH_4 emissions from cattle at the animal level are through breeding (de Haas *et al*., 2011) and adaptation of the DC (Beauchemin *et al*., 2008). Investigations on the impact of global DC on CH_4 emission are always complicated because of the small number of animals used during those trials and because of their specificities on some feeding parameters without considering the global diet. Moreover detailed DC is rarely available in the classical performance recording databases, as are daily CH_4 emission from dairy cows. Recent advances in the estimation of CH_4 from milk mid infrared (**MIR**) spectra (Vanlierde *et al*., 2016) make this data available in routine at least once every 6 weeks through milk recording in Walloon Region of Belgium allowing the organisation of large scale studies on dairy cows. Otherwise through collaboration with the feed company Dumoulin S.A., DC data were also available from 10 Walloon commercial farms between January 2014 and June 2015. Indeed the composition of the diet given to the herd has been recorded: feedstuff (%DM) included in the basal diet and average amount (kg/day) of production concentrate; and their composition: fat, proteins, energy, NDF, “sugar + starch” levels, *etc*. Moreover zootechnical data were also available (breed, days in milk (**DIM**), lactation number, milk yield, *etc*.). The DC of those farms differed mainly in terms of main forages types (grass silage *vs.* corn silage). The objective of this study was to use this novel and innovative database to evaluate the influence of the diet nutrient composition on the level of MIR CH_4 emissions.

1. MATERIAL AND METHODS

1.1. Creation of the database: The first important step was to assign the corresponding milk MIR spectra to each zootechnical and DC combination through the cow ID and the date of measurement. Then the equation developed by Vanlierde et al. (2016) has been applied to the MIR spectra to obtain an individual estimation of CH_4 emissions (g/day).

1.1.1. Cleaning regarding spectral and equation specifications: Regarding conditions of application of the CH_4 equation, only test-days from cows with a DIM between 5 and 365 (limits included) were kept in this study (779 discarded data). On another hand, only the spectra with a variability covered by the calibration set of the equation (estimated with standardized Mahalanobis distance, global H distance < 5) (863 discarded data) were considered. Around 6,800 records (predicted CH_4 linked with diet and zootechnical data) from 1,260 different cows were usable.

1.1.2. Cleaning regarding DC and zootechnical information: In this specific case, it has been decided to focus on data from November to March (around 3,450 data left) to remove the grazing data which are not easy to evaluate at nutritional level in terms of quantity and quality. Moreover, 3 herds have been removed because an automatic concentrate dispenser was used. Indeed a variation up to 6kg of concentrates between animals could occur and this information is not detailed even if this parameter influences deeply the individual level of CH_4 emission. The herds considered are fed with TMR. At the end, 2,498 data have been considered.

1.1.3. Estimation of the theoretical DMI: As the dry matter intake (**DMI**) is a significant information regarding the level of CH_4 emissions but was not recorded in this context, a theoretical DMI has been estimated by the amount of diet required to fulfill the digestible proteins (Tamminga et al., 1994) and net energy requirements for the observed milk production, according to the Dutch feeding standards. On the other hand cows at the beginning of the lactation are in negative energy balance (**NEB**) and so, do not cover those needs. This is why the percentage of cows under and above 70 DIM (supposed in NEB) is also considered.

1.2. Animal and herd levels: Regarding the DC, for each test-day (maximum once a month per farm) the same diet is allocated to all cows. The levels of each component of this DC are calculated for one theoretical animal which is representative of the herd at a precise time. It implies that DC information is at herd level and there is no distinction regarding the individual differences. However the CH_4 predictions to link with DC and zootechnical details are available on animal basis. To be as precise as possible regarding diet composition, only herd level will be detailed in this first approach. The zootechnical information has been averaged for the animals considered in each herd at each test-day (N=44).

1.3. Correlations and models: The units for CH_4 emissions vary in function of the general purpose. Three of them have been considered: g CH_4/day (i.e., reflecting the global GHG emission), g CH_4/kg of milk (i.e., economical production) and g CH_4/kg of theoretical DMI (i.e., animal's efficiency). Correlations have been calculated at herd level between CH_4 emissions and the main characteristics of the studied diets: "sugar and starch", fat, energy, digestible proteins and NDF levels, with the purpose to observe the influence of DC on CH_4 emissions.

2. RESULTS AND DISCUSSION: After the different cleaning processes, 2,498 records from 754 different cows observed in 7 distinct farms have been considered in this work.
Correlations observed at animal level (Figure 1) have mainly highlighted that digestible proteins, fat and "sugar and starch" contents of the diet could reduce methane emissions through intensification of milk production. Indeed a negative correlation was observed between those diet components and CH_4 in g/kg of milk. More than the intensification aspect, the important negative correlation observed between the fat level and CH_4 in g/day and more especially in g/kg of DMI shows that fat influences the CH_4 emissions through an impact at rumen level. Indeed, lipids are not fermented in the rumen so their addition reduces methane emissions per kg of DMI (Johnson and Johnson, 1995). Besides this general effect, some lipids like medium-chain fatty acids decrease methanogen numbers while polyunsaturated fatty acids have a toxic effect on cellulolytic bacteria that produce H^+ ions (Nagaraja et al., 1997), and protozoa (Doreau and Ferlay, 1995). These effects on the flora lead to a decrease of the acetate:propionate ratio and depend of the quantity of lipids used. Finally, to a less extent, biohydrogenation of the polyunsaturated fatty acids could impair methane emissions through hydrogen consumption (Martin et al., 2010).

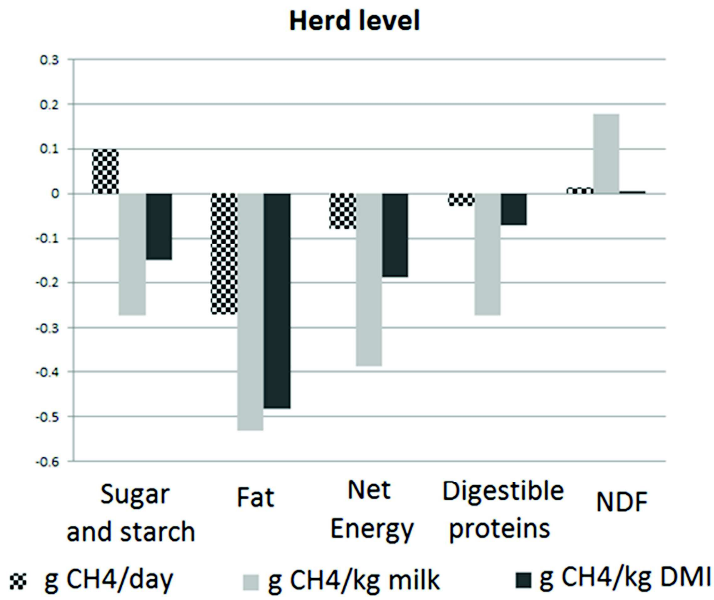

Figure 1. Correlations observed at herd (N=44) level between five characteristics of the diet (g/kg DM) and the CH_4 emissions in different units.

3. CONCLUSION: Because this dataset has not been collected for the study purpose, the analyse to assign a variation regarding CH_4 emissions to a variation of a specific diet component or a combination of diet components require beforehand a consequent cleaning of the dataset. Indeed several interdependencies existed between diet components. Anyway the first analyses permitted to conclude that high fat, digestible proteins and “sugar and starch” levels in the diet permit to reduce CH_4 emissions through intensification. Fat seemed to combine a great impact at ruminal level which makes this diet component particularly interesting in a global objective to reduce CH_4 emissions.

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