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F.L. de S.R. Mesquita[1,2,3,*], A. Farruggia[1,2], D. Andueza[1,2], F. Piccard[1,2], A. Le Morvan[1,2], A. Quereuil[1,2], P.C.F. Carvalho[3], F. Fournier[4] and D. Pomiès[1,2]

[1]INRA, UMR1213 Herbivores, F-63122 Saint-Genès Champanelle (France)
[2]Clermont Université, VetAgro Sup, UMR1213 Herbivores, BP 10448, F-63000 Clermont-Ferrand (France)
[3]Université Fédérale du Rio Grande do Sul, PPGZOO – Av. Bento Gonçalves, 7712
CEP 91540-000 – Porto Alegre – RS (Brésil)
[4]INRA, UE1414 Herbipôle, F-63820 Laqueuille (France)
*e-mail: franciscozoot@hotmail.com

Abstract. When animals graze swards at moderate or low stocking rate and hence have feeding choices to make within heterogeneous vegetation, the quality of their diet is difficult to assess. In such grazing conditions, the evaluation of the selected herbage digestibility through the analysis of the content of their faeces is a relevant alternative. The objective of this study was to examine the evolution of grazing animals' diet quality in two experimental grassland-based dairy systems (called "extensive" and "intensive"), using this indicator. About 800 faeces samples from cows and heifers have been collected by rectal sampling when animals were grazing during three periods (spring, summer, autumn) over 4 years in both systems. Each system was designed with 12 Holstein cows, 12 Montbéliarde and heifers for herd renewal, a short calving season at spring, a low (0.66 LU/ha), or moderate (1.09 LU/ha), stocking rate, no concentrate or a weak amount (4 kg/d during 200 days). A significant decrease in cows' diet digestibility (-4.9%) was observed in the "extensive" system in summer while a slight, regular but significant decrease was assessed in the "intensive" system (-2.2%). Significant difference of digestibility was found between breeds and between cows and heifers, within system. No positive relationship between digestibility and milk production was highlighted in the "intensive" system while significant correlations were found in summer and autumn in the "extensive" one, suggesting a limiting energy value of the diet at this period for this system.

Keywords. Dairy cow – Permanent grassland – Faeces – Organic matter digestibility – Milk production.

Qualité du régime alimentaire des animaux durant le pâturage dans deux systèmes laitiers bas intrants de montagne

Résumé. *Lorsque les animaux pâturent avec un chargement modéré ou faible et, par conséquent, choisissent l'herbe dans une végétation hétérogène, la qualité de l'alimentation est difficile à évaluer. Dans ces conditions de pâturage, l'évaluation de la digestibilité du fourrage sélectionné par l'analyse des fèces est une alternative pertinente. Dans cette étude, l'objectif était d'examiner l'évolution de la qualité de l'alimentation des animaux pendant le pâturage dans deux systèmes d'élevage laitiers expérimentaux (qualifiés d' "extensif" et d' "intensif"), en utilisant cet indicateur. Durant 4 ans, environ 800 échantillons de fèces provenant de vaches et génisses au pâturage ont été collectés par prélèvements rectaux au cours de trois périodes (printemps, été, automne) dans chacun des systèmes. Chaque système, composé de 12 vaches Holstein, 12 Montbéliarde et des génisses de renouvellement, est caractérisé par une saison de vêlage courte au printemps, un chargement faible ou modéré et pas ou peu de concentré (4 kg/j pendant 200 jours). Une diminution marquée de la digestibilité des régimes (-4,9%) a été observée dans le système "extensif" entre le printemps et l'été, alors qu'une diminution faible et régulière a été observée dans le système "intensif" (-2,2%). Des différences importantes de digestibilité ont été observées entre races et entre vaches et génisses, dans chaque système. Aucune relation entre digestibilité et production laitière n'a été trouvée dans le système "intensif" alors que des corrélations significatives ont été observées en été et à l'automne dans le système "extensif", ce qui suggère une valeur énergétique limitée de l'alimentation à cette période pour ce système.*

Mots-clés. *Vache laitière – Prairie permanente – Fèces – Digestibilité de la matière organique – Production laitière.*

I – Introduction

Grazing intensity determines the structural heterogeneity of grassland vegetation and consequently its quality for domestic herbivores. Grazing at high stocking rate allows maintaining homogeneous and leafy swards of high digestibility along the grazing season. By contrast, grazing at moderate or low stocking rate leads to the creation of a mosaic of short grazed patches that remain vegetative, and tall under-grazed patches composed of reproductive stems and dead leaves (Garcia *et al*., 2003). In such extensive grazing conditions, the major difficulty to estimate the diet nutritive value may be the accurate collection of representative herbage samples of the diet actually consumed by the animal (Lukas *et al*., 2005). Nutritive value of forage assessed with micro mower which cut the entirety of the sward does not match properly animal feeding selection. Furthermore, the technique of hand plucking of vegetation samples similar to those ingested by the animal seems to systematically underestimate diet digestibility especially when studying feed intake on multi-species swards (Mahler, 1991). Methods using oesophageal cannula are invasive for the animals, money and time-consuming, limiting therefore the number of samples. The estimation of herbage organic matter digestibility (**OMD**) from crude protein (**CP**) concentration in faecal samples using regression equations, offers opportunities to overcome these obstacles (Peyraud, 1998). In addition, these faecal methods, combined with near infrared reflectance spectroscopy (**NIRS**), allow analysing many samples.

In two experimental grassland-based dairy farming systems, with different levels of stocking rate, we used this faecal method as an indicator of the grazing management, allowing to give us the diet digestibility of grazing animals. Our aim was to examine the evolution of the quality of animals' diet according to the system, the grazing period, the type of animal, and the year. Moreover, we investigated the relationships between diet digestibility and milk production.

II – Materials and methods

1. Experimental design and animals

The experiment was conducted from 2011 to 2014 at an experimental farm of the INRA Herbipôle Unit (French Massif-central, 45.3046N, 2.8378E, 1100 m) where two grassland-based dairy farming systems were used. The first one called "Bota" (for Biodiversity, organolepsy, task load, autonomy) aims to preserve the herbage territory, to supply societal goods as biodiversity and high quality local cheeses, to use very low inputs, and to minimize farm labor. It was designed with a 59.6 ha area composed of 12 permanent diversified grassland plots, a low stocking rate (0.66 LU/ha), a short calving season in spring, first calving at 3-year-old, no mineral fertilization, no concentrates given to cows and a long rotation duration at pasture (4 grazing cycles of 51 days in average). The second system, called "Pepi" (for Production, efficiency, planet, innovations), is oriented towards milk production and herbage quality while minimizing environmental impacts. It was built with 29.2 ha of 7 old temporary and productive grassland plots, a moderate stocking rate (1.09 LU/ha, which is slightly higher than average in the surrounding area), a short spring calving season, 2-year-old heifers, a sharp adjustment of mineral fertilization (40 kg of nitrogen /ha) and concentrates (4 kg/d at pasture), rotational grazing (5 grazing cycles of 41 days in average), and early cutting. Each system used 24 cows and heifers for herd renewal, equally distributed among Holstein and Montbéliarde breeds. The two groups of cows and heifers have been paired at the beginning of the experiment and put on each system. All the 24 cows of each system grazed always together. Two-year-old and 3-year-old heifers of Bota grazed almost all the grazing season a diversified summer pasture far from the farm buildings while 2-year-old heifers of Pepi grazed with cows or remain into the plot after the grazing of the cows.

2. Measurements, sampling and laboratorial analysis

Each year, at 3 periods along the grazing season, faeces from all the animals of each system were simultaneously collected by rectal sampling at the farm building. The 3 periods were chosen according the state of the vegetation expected in Bota system: in spring when sward is expected to be mainly at vegetative phenological stage, in summer when sward heterogeneity is assumed to be at a maximum and at the beginning of autumn to account for cumulative grazing effects. Over the 4 years, they were positioned on average the June 1st (spring), July 12th (summer) and September 9th ('autumn'). A total of 792 faeces samples from cows and heifers were thus obtained (on average 33 faeces samples per period and per system). Once collected, samples were dried at 60°C for 72 hours and grinded at 1 mm size. Acid detergent fiber (**ADF**) and nitrogen (**N**) of fecal samples were predicted by NIRS using models characterized by the following statistics: for nitrogen, standard error of cross validation (**secv**) = 0.07; coefficient of determination in cross validation (r^2cv) = 0.98, and for ADF, (secv) = 1.42, (r^2cv) = 0.87. Chemical analyses for 80 samples were set up to validate the model.

Individual digestibility was calculated using the equation given by Peyraud *et al*. (unpublished):

OMD = 0.980 – 2.474/CP – 0.00276´ADF (r^2 = 0.87, rsd = 0.0123, CP expressed as % of OM)

Individual milk production was measured at each milking, allowing us to calculate, at each period, the mean daily milk production during the week following the fecal collection.

3. Statistical analysis

Data of individual OMD were analysed using the mixed procedure of SAS (version 9.4; SAS Institute, 2013). The model took into account the effects of year, system, period, breed, type of animal (cow or heifer) and the interactions of year*system, year*period, system*period, system*type and year*system*period. The analysis of variance was followed by the multiple comparison test of Tukey–Kramer. Discrepancies with P values less than 0.05 were considered significant. The relationship between individual milk production and OMD within period and system was analyzed using the regression procedure of SAS. The coefficients of variation of individual digestibility from animals grazing on a pasture in a particular date were also calculated.

III – Results and discussion

On average, diet digestibility of Pepi and Bota animals (0.77 and 0.74 respectively) were closed to those given in the INRA reference tables corresponding to grazing on mountain permanent grasslands at vegetative and reproductive stage, respectively (Agabriel, 2007). The quality of animals' diet was similar in spring (P1) in the two systems (Fig. 1; P = 0.076) before being significantly different in summer and in autumn. It highly decreased from spring (P1) to summer (P2) (-4.9%; P<0.0001) before being steady in autumn in Bota system while this decrease was very moderate and regular in Pepi along the grazing season (- 0.4% between P1 and P2; -1.8% between P2 and P3, P<0.001). This decrease in the quality of grass intake over the grazing season in extensive grazing system has already been shown by Farruggia *et al*. (2014). It reflects the increase of reproductive vegetation in Bota pastures along the grazing season due to the unbalance between herbage growth and animal intake. In Pepi, the relative stability of the diet digestibility from spring to summer clearly illustrated a good control of herbage quality by grazing management, as expected in the goals of this system. The concentrates distributed to Pepi cows can also influence the quality of the diet over the grazing season. Regarding the effect of breed, minor but significant differences were found between Holstein and Montbéliarde (0.75 *vs.* 0.76, respectively; P<0.0001) suggesting that Montbéliarde were a little more selective than Holstein when grazing, or that they have a higher digestion ability. Small differences were also observed between cows and heifers in Bota (P<0.0001) and in Pepi (P<0.001), reflecting that heifers grazed lower quality pasture, due to the grazing management of the young animals in the two systems.

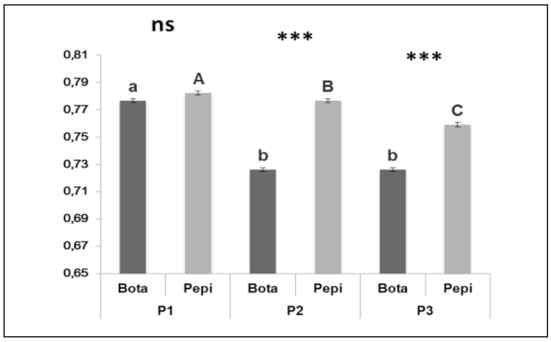

Fig. 1. Diet digestibility according to the dairy system (Bota or Pepi) and the grazing period (P1 to P3).

Letters in lowercase differ at P<0.05 between period within system Bota while letters in uppercase differ at P<0.05 between period within Pepi. For differences between systems: *ns* = non-significant; *** P < 0.001. Standard error is given.

The coefficient of variation of OMD varied from 0.2 to 3.6% in Bota and from 0.9 to 3.1% in Pepi. These quite low variations between animals could suggest that they selected similar range of patches within sward, which was unexpected in Bota heterogeneous pastures. Such results suggest also that the pasture digestibility could be evaluated in routine with this method by gathering feces from animals grazing within same pasture.

Finally, no significant relationship between individual diet digestibility and individual daily milk production was highlighted in Pepi whereas significant correlations were found in Bota system in summer (r = 0.28; P<0.04) and in autumn (r = 0.45; P<0.0001), suggesting a limiting energy value of the diet in these periods in this system.

IV – Conclusions

The forage OMD, estimated from fecal CP and ADF by NIRS associated with a predictive model, allows to characterize the quality of the animals' diet and to follow its evolution over the pasture season in mountain low-input systems. It is an operational technique, especially for dairy cows when they return to the milking parlour.

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