# Dairy cow grazing selection on upland pasture affects milk fatty acid concentrations

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**Abstract.** The aim of this work was to explore the variations in milk FA concentration according to the rate of pasture utilisation and the cows grazing selection. Two equivalent groups of nine dairy cows were assigned to a long duration (LD) of paddock utilisation (17 days) on heterogeneous pasture, common on extensive rotational grazing systems, or to a medium duration (MD) of paddock utilisation (7-10 days) on a more intensively managed pasture, usual on intensive rotational grazing systems. Grazing selection was characterized at the beginning and at the end of each MD paddock utilisation and at the same dates for LD. Individual milk samples were collected the first three days and the last two days of grazing on each MD paddock for both systems. A principal component analysis (PCA) was performed on milk fatty acid (FA) concentrations and grazing selection data, aiming to highlight their relationships. The LD samples were poorly separated by the PCA according to the day of paddock utilisation, because of small variations in LD milk FA composition. The free-grazing selection allowed the LD cows to ingest herbage with a quite constant nutritional value throughout the experiment. In contrast, the PCA showed a marked separation between samples from the beginning and from the end of each MD paddock utilisation. The MD cows grazed "by layers" inducing a rapid decrease in the nutritive quality of ingested patches during paddock utilisation, with consequently important variations in milk FA composition. Furthermore, an abrupt change in milk FA composition was observed in MD milk when cows were moved to a new paddock. The more stable milk FA concentrations across the LD paddock utilisation could be more favourable for farmhouse cheese making management.

**Keywords.** Grazing selection – Grazing system – Milk fatty acids – Upland pasture.

***La sélection alimentaire des vaches laitières au pâturage sur des prairies de montagne influence les concentrations des acides gras du lait***

***Résumé.*** *Deux groupes équivalents de 9 vaches laitières ont été soumis : soit à un pâturage de longue durée (LD) sur une parcelle de prairie hétérogène (17 jours), typique des systèmes de pâturage continu ; soit à un pâturage de durée moyenne (MD) sur des parcelles de prairie gérée de façon plus intensive (7-10 jours), typique des systèmes de pâturage tournant. La sélection alimentaire au pâturage a été caractérisée aux dates de début et fin d'utilisation de chaque parcelle de MD, sur les deux systèmes. Des échantillons individuels de lait ont été collectés les 3 premiers et les 2 derniers jours d'utilisation de chaque parcelle de MD, sur les deux systèmes. Une analyse en composante principale (PCA) a été faite sur les données de concentrations des acides gras (FA) du lait et de sélection alimentaire au pâturage, pour mettre en évidence leurs relations. Les échantillons de LD ont été mal discriminés par la PCA selon les jours d'utilisation de la parcelle. Par contre, pour MD, la PCA a montré une nette séparation des échantillons de début et de fin d'utilisation de chaque parcelle. Les vaches sur MD ont pâturé par horizons, avec pour conséquence une diminution rapide de la qualité nutritive de l'herbe ingérée au cours de l'utilisation de la parcelle et des variations importantes de la composition en FA du lait. De plus, un changement brusque des concentrations des FA du lait a été observé pour MD lors du changement de parcelle. Le profil en FA du lait de LD au cours de l'utilisation de la parcelle peut être plus favorable pour des fabrications fromagères fermières.*

***Mots-clés.*** *Sélection alimentaire au pâturage – Systèmes de pâturage – Acides gras du lait – Prairies de montagne.*

## I – Introduction

In the upland farming systems, considerable day-by-day variations in milk yield and composition are frequently reported by farmers and cheese makers with rotational grazing systems, according to the rate of utilisation of each paddock. Among milk components, FA concentrations concur to determine nutritional value and sensory properties of dairy products (Martin et al., 2005). The FA composition of pasture-derived milk is affected by several factors, such as herbage proportion in cow diet, herbage botanical composition, phenological stage and nutritive value, all interacting with cow grazing selection and grazing system (Farruggia et al., 2014; Coppa et al., 2011b; Chilliard et al., 2007;). In this experiment, two rotational grazing systems on upland pasture were studied: a long duration of paddock utilisation (LD) on highly biodiversified pasture, which is typical of extensive rotational grazing systems, and a medium duration of paddock utilisation (MD) on a more intensively managed pasture, which is typical of intensive rotational grazing systems. The aim of this work was to highlight the link between the variations in milk FA composition and changes in grazing selection according to the duration of paddock utilisation on MD and LD systems.

## II – Materials and methods

The FA concentrations have been monitored in the milk of two equivalent groups of nine cows in June, during a period of 17 days, corresponding to the duration of the grazing rotation of the LD group. At the same time, the MD group cows grazed successively two paddocks for 7 and 10 days. The LD paddock (9.7 ha) was characterized by a highly diversified pasture (139 botanical species) managed under a low stocking rate, while MD paddocks (6.4 ha) were characterized by a moderately diversified (62 species) and more intensively managed pasture. As usual in the intensive rotational grazing systems, the MD cows were supplemented with 4 kg of concentrate/cow × day. Grazing selection was characterized through direct observations and simulated bites (Farruggia et al., 2008) collected at the beginning and at the end of the utilisation of two subsequent MD paddocks, and at the same days for LD. Simulated bites were analysed for botanical composition and nutritive value. Individual milk was sampled the first three days and last two days of grazing on each MD paddock, and simultaneously also on LD system. Milk samples were analysed for FA analysis by gas-chromatography. A principal component analysis (PCA) was performed on the main milk FA, parameters of grazing selection and composition of simulated bites, aiming to show the relationships between the milk FA concentrations and grazing selection of cows in the two grazing systems.

## III – Results and discussion

On the plot of PCA individual distribution, samples were separated according to the day of paddock utilisation for principal component (PC) 1 and according to the grazing system for both PC1 and PC2 (Fig. 1). On plot of PCA variable distribution, PC1 was positively highly correlated to the neutral detergent fiber (NDF) content of the simulated bites, short vegetative (SV) patches, milk branched chain FA (BCFA) and monounsaturated FA (MUFA) concentrations, and C18:1c9 to C16:0 ratio. The PC1 was also negatively and closely correlated to the organic matter digestibility (OMD) value of simulated bites, total high vegetative (HV) patches, milk saturated FA (SFA) concentration, and C18:1t10 to C18.1t11 ratio. The PC2 was correlated to the crude protein (CP) content, the OMD values, the Legumes proportion and the leaf to stem ratio (L/S) of simulated bites, the HV patches and milk CLAc9t11, sum C18:1t isomers and polyunsaturated FA (PUFA) concentrations and negatively correlated to the NDF content and Grasses proportion of simulated bites, high mature (HM) patches, and milk C18:2n-6/C18:3n-3 and C18:1t10/C18:1t11 ratios.

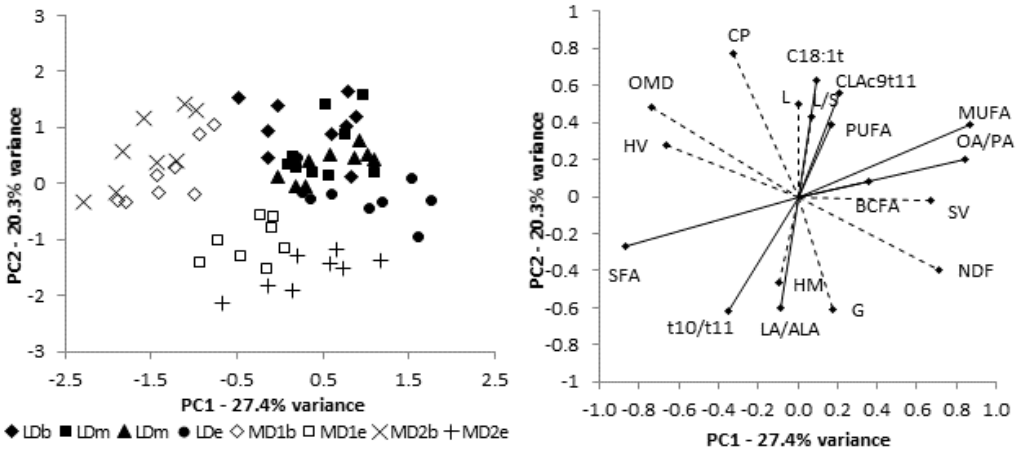


**Fig. 1. Principal component analysis (PCA) performed on the main milk fatty acid concentrations, the grazing selection and composition of simulated bites. Plot of sample and variable distribution according to grazing system and day of paddock utilisation, projected on the two principal components (PC1 and PC2).**

The variations in LD milk FA composition were small from the beginning to the end of LD paddock utilisation. The free-grazing selection allowed the LD cows to ingest herbage with a nutritional value that was quite constant throughout the experiment (Coppa et al., 2011a; Dumont et al., 2007). Indeed, the CP content and OMD value of the LD simulated bites slightly decreased, and the NDF content only slightly increased from the beginning to the end of paddock utilization. In contrast, important changes in the MD milk FA composition were observed during MD paddocks utilisation. The PCA results showed a clear separation between the samples derived from the beginning and from end of each MD paddock utilisation. The grazing “by layers” of the MD cows could cause a rapid decrease in the nutritional quality of ingested patches (i.e., decreasing the L/S and CP content and increasing the NDF and ADF contents of the simulated bites) from the beginning to the end of paddock utilisation (Abrahamse et al., 2008). As herbage C18:3n-3 concentration decreased linearly as the herbage total nitrogen content decreased (Revello Chion et al., 2011), it is possible to suggest that the C18:3n-3 concentration of simulated bites reduced with CP content decrease during MD paddock utilisation. As a consequence, a decrease in the amount of ingested herbage C81:3n-3 (being biohydrogenated) could have reduced the ruminal production of intermediate products and, thus, their milk concentrations, including C18:1t11 (Chilliard et al., 2007). Moreover, due to a higher proportion of stems, the increased herbage fiber content at the end of MD paddock utilisation could favor the development of cellulolytic bacteria in the rumen. As these bacteria are implicated in the production of BCFA (Vlaemink et al., 2006), this can explain the higher milk concentration of BCFA at the end of utilisation of each MD paddock utilisation. A higher C18:1c9 content in stems (Elgesma et al 2006) compared to leaves could be partly at the origin of the higher milk concentration of this FA at the end of each MD paddock utilisation.

## IV – Conclusions

The long duration of paddock utilisation on heterogeneous pastures, which is typical of a extensive rotational grazing systems, allows the cows to maintain a rather stable nutritive quality of the selected patches, resulting in only slight day-by-day variations in milk FA concentrations. In contrast, the nutritive quality of the selected patches with a medium duration of paddock utilisation on intensively managed pastures, which is typical of a rotational grazing system, varied strongly during each paddock utilisation, resulting in abrupt changes in milk FA concentrations. Our results confirmed the observations reported by farmers and cheese makers on the day-by-day variations in milk characteristic and could explain why a longer duration of paddock utilisation could be more favourable for farmhouse cheese making management.

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