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Influence of different alpine farming systems on animal activities, heart rate, and milk yield of primiparous cows

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Abstract. Over the past decades, different alpine farming systems have been adopted in order to use and valorise the available alpine pastures: in traditional systems cows were typically sheltered and milked in the barn (TP), but to reduce cost, on many alpine farms dairy cattle remain outdoors during the entire summer period and are milked on pasture in a mobile milking parlour (EP). The findings reported here are based on a study which aimed at comparing cows kept under these two conditions. Heart rate, milking characteristics and daily activities were recorded from five Aosta Red Pied primiparous cows under TP-management and eight under EP-management. Data were collected also before the alpine transhumance in order to assess the ability of the animals to adapt. As soon as the EP-cows had free access to the pasture, they had a longer eating time compared with TP-cows (treatment × time; P<0.01). Average heart rate was higher in EP-cows compared with TP-cows especially in the idling phase (72.3 *vs* 67.0 beats/min; P<0.05). In conclusion, these results suggest that, although average milk yield remained unaffected, EP-cows spent more time for feed intake, but probably also consumed more energy, as is indicated by the higher heart rate.

Keywords. Dairy cattle – Animal activity – Heart rate – Milking yield – Alpine pasture system.

Influence de différents systèmes de gestion des alpages sur l'activité des animaux, le rythme cardiaque et la production de lait des vaches primipares

Résumé. *Au cours des dernières décennies, différents systèmes de gestion des alpages ont été adoptés afin d'utiliser et de valoriser les ressources fourragères de haute montagne : dans les conditions traditionnelles, les vaches sont abritées et traites à l'étable (TP), mais pour réduire les coûts, dans de nombreux alpages, les vaches laitières restent à l'extérieur durant la période estivale et elles sont traites à l'aide d'un chariot de traite mobile (EP). Les résultats présentés ici sont basés sur une étude qui visait à comparer les vaches gardées dans ces deux conditions. La fréquence cardiaque, les caractéristiques de traite et l'activité journalière ont été enregistrées sur cinq primipares de race Pie Rouge Valdôtaine (gestion TP) et sur huit primipares en gestion EP. Les données ont été recueillies aussi avant la montée en alpage afin d'estimer la capacité d'adaptation des animaux. Dès que les vaches EP avaient libre accès à la pâture, elles ont eu un temps d'ingestion supérieur par rapport aux vaches TP (traitement×temps; p<0,01). La fréquence cardiaque moyenne était plus élevée chez les vaches EP par rapport aux vaches TP en particulier dans la phase de repos (72,3* vs *67,0 battements/min; p<0,05). Ces résultats suggèrent que, bien que la production de lait moyenne soit demeurée inchangée, les vaches EP pâturait plus longtemps, mais consommaient aussi probablement plus d'énergie, comme l'indique la fréquence cardiaque plus élevée.*

Mots-clés. *Vaches laitières – Activités journalières – Fréquence cardiaque – Production laitière – Gestion d'alpage.*

I – Introduction

The Aosta Valley comprises an alpine region in the very North-West part of Italy, situated at the borders with Switzerland and France. Surrounded by the highest Alpine peaks, it is characterized by an average altitude of 2100 meters (Cerutti, 2006). Although the economy of the region is based on tourism, agriculture contributes and supports it directly through very high quality food products and indirectly by playing a crucial role on the landscape maintenance. Nevertheless, agro-pastoralism is a real challenge for the valley. The livestock systems are characterised by dairy farms: the animals spend the winter in lowland farms fed with hay until the summer transhumance, called *inalpe*, starts. On the alpine pastures, traditionally cows are sheltered and milked in the barn twice a day (TP). However, to reduce costs, on some alpine farms dairy cattle now remain outdoors during the entire summer period and are milked on pasture in a mobile milking parlour (EP), a practice also applied in Switzerland and France (Berard *et al.*, 2013). In the Aosta Valley, because of the very strong link with traditions and cultural heritages, this fully outdoor system was not accepted by the livestock keepers. Because the restoration of the alpine barn is often too expensive, agro-pastoralism is progressively abandoned and the number of cattle farms is decreasing. The Institut Agricole Régional (IAR) set itself the goal to rehabilitate an abandoned mountain pasture using a fully outdoor management system as a demonstration project. A second aim was to investigate productive and physiological parameters of indigenous cows kept under traditional and experimental conditions.

II – Materials and methods

From two herds comprising more than 60 Aosta Red Pied cows, 13 primiparous cows, five under TP-management and eight under EP-management, were selected and equipped with Polar Equine Science® (Polar Electro, Italy) cardio belts for recording heart rate and a MSR Electronics (Henggart, Switzerland) chewing sensor. The latter device records and discriminates between rumination, eating and idling activities during 24 hours (Nydegger *et al.*, 2011). The number of animals used in the TP condition was smaller compared with the EP condition because a previous experiment conducted in the same management systems has revealed a larger variance of the data of EP compared with the TP cows (Berard *et al.,* 2013). On the experimental animals, also a Lactocorder® (WMB AG, Balgach, Switzerland) was applied during milking to record milking characteristics. Data were collected, on a representative day every 3 weeks from April to August 2013, a period which included the time before the alpine transhumance in order to determine the ability of the animals to adapt (cf. Fig. 1).

After the transition period where the animals still were in the lowland barns, cows kept under TP were sheltered and milked in the barn twice a day and had free access to fresh highland alpine grass, approximately 4 h in the morning and 2 h in the evening. Conversely, in EP cows remained outdoors during the entire day and night and were milked on pasture in a mobile milking parlour. Hay, fresh grass and pastures were chosen to offer similar forage quality to the two groups. Representative forage samples were taken every 3 weeks at the general sampling days and were analysed by near-infrared spectroscopy for contents of dry matter, crude protein, ether extract, neutral detergent fibre, acid detergent fibre and acid detergent lignin. Data were subjected to analysis of variance using the MIXED procedure of SAS (version 9.1 Inst. Inc., Cary, NC) by including treatment (EP and TP), time (A to G) and their interaction as fixed effects. Time was considered as repeated factor, with animals nested within treatment as subject.

<table>
<tr><td colspan="2"></td><td colspan="7">Sampling time</td></tr>
<tr><td colspan="2"></td><td colspan="2">Barn</td><td colspan="2">Transition</td><td colspan="3">Alp</td></tr>
<tr><td>EXP</td><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td rowspan="2">TP</td><td>feeding</td><td colspan="2" rowspan="2">Barn (hay)</td><td colspan="2" rowspan="2">Barn (fresh grass)</td><td colspan="3">Pasture</td></tr>
<tr><td>milking</td><td colspan="3">Barn</td></tr>
<tr><td rowspan="2">EP</td><td>feeding</td><td colspan="2" rowspan="2">Barn (hay)</td><td colspan="2">Pasture</td><td colspan="3">Pasture</td></tr>
<tr><td>milking</td><td>Barn</td><td colspan="4">Mobile milking parloir</td></tr>
</table>

Fig. 1. Sampling schedule applied for the primiparous cows in the two experimental treatments (EXP), the traditional management system (TP) and the experimental management system (EP). Samplings A and B correspond to the lowland farm when animals were fed with hay; samplings C and D correspond to the lowland farm when animals were in a transition period and fed with hay and fresh grass/pasture; samplings E, F and G correspond to alpine pasture systems.

III – Results and discussion

The quality of the forage offered (in the barn or on the pasture) to both groups did not differ (P>0.2) in any of the parameters analysed. This aspect allowed a direct comparison of the two management systems, albeit they were located in two different places. No differences in eating time were observed when both groups were feed in the barn with hay (average data at time points A and B: EP-cows 253 *vs* TP-cows 294 min/day; P> 0.10). As soon as the EP-cows had free access to the pasture, from the morning until the evening milking time, during times C and D and day and night during times E, F and G, they ate for a longer time compared with the TP-cows (time C: 358 *vs* 268 min/day; time D: 373 *vs* 303 min/day; treatment × time; P<0.01). This was also true in the alpine management system (time E: 304 vs 229 min/day; time F: 370 *vs* 294 min/day; treatment × time; P<0.01). Troxler and Jans (1992) reported that cattle in a full outdoor management system are able to optimise their intake by alternating periods of grazing and rest depending on pasture forage supply and weather conditions; this much better than cows with restricted access to pasture. However, this difference in ingestion did not find a correspondence in the daily rumination time or the rumination time per bolus (respectively P>0.52 and P>0.35) in the present experiment.

Milk yield did not significantly differ between the two management systems (effect of treatment; P>0.10), maybe because of the small number of animals observed. Yield progressively decreased as cows were approaching the end of lactation (effect of time; P<0.01). Nevertheless, the average milk yield fluctuation over time was larger in EP-cows compared with TP-cows (Fig. 2).

The differences in the ingestion time and the lack of difference in milk yield suggest that the energy expenditure of EP-cows, caused by the efforts of thermoregulation, but also by external factors (insects, noise and environmental stress) was higher compared with that of the TP-cows. Costa *et al.* (1990) reported that milk production remains unchanged when dairy cattle are driven in a permanent pasture, despite a longer duration of ingestion and restricted transfer. This hypothesis was confirmed for the present study by the average heart rate that did not differ when both groups were sheltered and milked in the barn (average data on the times A and B: EP-cows 65.6 *vs* TP-cows 65.3 beats/min; P>0.36), but was later significantly higher in EP-cows compared with TP-cows, especially in the idling phase (74.5 *vs* 67.8 beats/min; P<0.05).

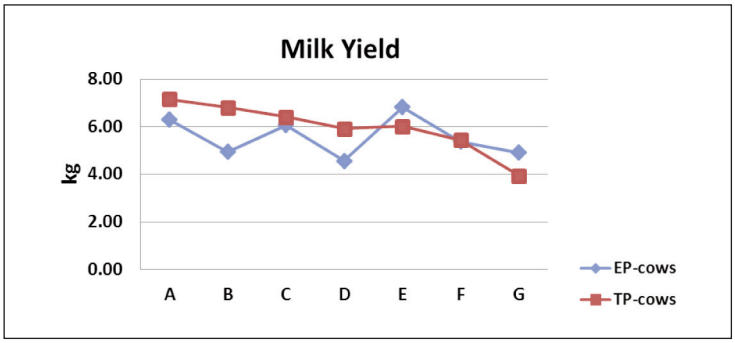

Fig. 2. Effect of management system (EP-cows: blue; TP-cows: red) and time (A, B: lowland farm, fed with hay; C, D: transition period in lowland farm, fed with hay and fresh grass/pasture; E, F, G: alpine pasture systems) on milk yield per milking time.

IV – Conclusions

In conclusion, these results suggest that, despite the small number of animals used in this study, the full outdoor system significantly influenced the cows. They ate more, and probably also consumed more energy, as is indicated by the higher heart rate, than cows in the traditional management system. Nevertheless, average milk yield was only marginally affected, showing a higher fluctuation in the full outdoor system compared to the traditional one. Further investigation on the heart rate variability will be carried out to better understand the adaptive capacity and the potentially higher stress of the animals in this production system.

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