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Milk production and grazing behaviour responses of Alpine dairy goats to daily access time to pasture or to daily pasture allowance on temperate pastures in spring

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ABSTRACT

In a context of price volatility and low feed self-sufficiency of goat farms in Western Europe, grazing may play an important role. Knowledge about the impact of grazing management – particularly daily access time to pasture or pasture allowance – on dairy goats' performance is scarce. Two 3-week trials were carried out in spring with 36 Alpine goats in mid-lactation. In Trial 1, 3 access times to pasture during daytime (AT: 4, 6 or 8 h/day, from 08:00 to 12:00, from 10:00 to 16:00 and from 08:00 to 16:00, respectively) were compared. In each treatment, goats individually received 370 g DM of dehydrated forage (lucerne and maize) after the evening milking, 278 g DM of concentrate twice daily, at each milking, and a daily pasture allowance of 2.0 kg DM/goat, measured at 4 cm above ground level. In Trial 2, 3 daily pasture allowances (PA: 1.6, 2.3 or 3.0 kg DM/goat, measured at 4 cm above ground level) were compared. Goats individually received 278 g DM of concentrate twice daily, at each milking, and access time to pasture was of 13 h/d (from 07:30 to 16:00 and from 17:00 to 21:30). Milk production was similar between medium and high levels of AT or PA, and was lower for the lowest level of AT or PA (−300 g/d at the lowest AT and −500 g/d at the lowest PA). Milk fat and protein concentrations only slightly varied between the different levels of AT or PA. In both trials, goats maintained an intense grazing activity. Grazing time (from 240 to 540 min/d) and proportion of time spent grazing (from 66 to 99%) were mainly affected by AT, and only marginally by PA.

1. Introduction

Grazing in intensive dairy goat systems is known to improve feed self-sufficiency, while reducing production costs and environmental issues (Nahed et al., 2006; Ruiz et al., 2009). However, in temperate regions of Western Europe, the number of farms using grazing to feed goats significantly decreased over several decades, due to the development of large herds (Brocard et al., 2016), high parasitism occurrence and anthelmintic resistance (Hoste et al., 2002), and difficulty of grazing management (Lefrileux et al., 2008). Nowadays, with the increase in input prices, the specifications required for a protected designation of origin, the development of organic farming and consumers' demands for natural products, grazing can reclaim an important place in goat's feeding systems. To do so, more knowledge about the relationship between grazing management and goat performance is required. Sward structure (sward height, pasture mass, leaf:stem ratio), grazing pressure (stocking rate, pasture allowance, post-grazing sward height), and daily access time to pasture, are known to be important factors affecting pasture intake and milk production of lactating ruminants (Poppi et al., 1987; Penning et al., 1994; Delagarde et al., 2011). Very few studies have been carried out on the impact of grazing management on dairy goats (Lefrileux et al., 2008). The effects of daily access time to pasture or daily pasture allowance on milk production and behaviour of dairy goats grazing on improved temperate pastures are unknown, although there have potentially important practical implications for herd and grazing management on farms. It has been shown that increasing stocking rate (indirectly decreasing pasture allowance) negatively affects pasture intake (Bonanno et al., 2007) and diet selection behaviour (Animut et al., 2005). With decreasing pasture availability during the grazing down process under rotational grazing, goats' daily intake seems to decrease faster than in sheep or cows, suggesting goats may be more sensitive than other ruminants to sward structure and physical constraints (Collins and Nicol, 1986, 1987). Meat goats seem able to adapt to short access times (4 h *vs* 8 h/d) to pasture by increasing their pasture intake rate by 25–30% (Berhan et al., 2005; Romney et al., 1996), but the ability of lactating dairy goats to overcome time constraints and to maintain milk production under short access times to pasture is unknown.

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This study aims to quantify milk production responses as well as the behavioural adaptation of dairy goats to variations of daily access time to pasture or daily pasture allowance while grazing improved temperate pastures in spring.

2. Materials and methods

2.1. Experiments, treatments and experimental design

Two 3-week trials were carried out in spring 2015, from 16 April to 6 May (Trial 1), and from 27 May to 17 June (Trial 2), at the INRA experimental dairy farm of Méjusseaume (1.71°W, 48.11°N, Le Rheu, Brittany, France). Procedures relating to care and management of animals for these trials were approved by an animal care committee of the French Ministry of Agriculture, in accordance with French regulations (decree-law 2001–464, 29 May 2001).

In Trial 1, 3 daily access times to pasture (4, 6 or 8 h/d, namely AT4, AT6 and AT8, respectively) were compared. Goats had access to the pasture between both milkings, from 08:00 to 12:00 (AT4), from 10:00 to 16:00 (AT6) or from 08:00 to 16:00 (AT8). The hours of access to pasture for each level of AT were decided as a compromise between several factors to be considered, with the main objectives being to avoid large variations in the chemical composition of the diet selected between treatments, and to limit any possible behavioural disturbance of the goats upon the arrival or departure of groups of goats at pasture. Regardless of the selected hours, the first main meal started in the morning in all treatments, preventing large variations of soluble carbohydrates concentration in leaves (Delagarde et al., 2000), and there were always at least two groups of goats grazing simultaneously. For each treatment, the daily pasture allowance was 2.0 kg DM/goat. Each goat received 278 g DM of a commercial concentrate through an automatic feeder in the milking parlour twice daily (*i.e.* 556 g DM/d). Because goats had no access to pasture between PM and AM milkings, they individually received 400 g/d of dehydrated forage (300 g of maize and 100 g of lucerne, *i.e.* 370 g DM/d) after the PM milking (Table 1).

In Trial 2, 3 daily pasture allowances (1.6, 2.3 or 3.0 kg DM/goat, namely Low, Medium and High, respectively) were compared. Treatments were chosen to test the adaptability of goats to restrictions of pasture allowance, considering that goats are fed *ad libitum* in High (INRA, 2010). For all treatments, the daily access time to pasture was 13 h. Goats had access to pasture in 2 sessions, 8.5 h between AM and PM milkings (from 07:30 to 16:00) and 4.5 h after PM milking (from 17:00 to 21:30). Each goat received individually 556 g DM/d of a commercial concentrate fed twice daily at milking times, as in Trial 1 (Table 1). Goats received no forage supplementation during Trial 2 because of the access to pasture after PM milking.

For both trials, the concentrate consisted of the following ingredients on a dry matter basis: barley, 28%; sugar beet pulp, 24%; soyabean meal, 23%; lucerne, 11.5%; wheat bran, 6%; molasses, 3%; linseed, 2%; vegetable oils, 1%; sodium chloride, 0.5%.

In both trials, goats were penned at night inside, divided per treatment, on deep litter.

Table 1
Chemical composition and nutritive value of supplements used during Trial 1 and Trial 2.

Variable	Trial 1 (AT)			Trial 2 (PA)
	Concentrate	Maize	Lucerne	Concentrate
Chemical composition (g/kg DM)				
DM (g/kg)	905	927	918	906
OM	927	968	884	930
CP	202	73	183	218
NDF	319	388	434	298
ADF	152	190	300	147
ADL	26	22	77	25
Nutritive value				
PDIN (g/kg DM)[1]	132	51	120	132
PDIE (g/kg DM)[2]	119	76	104	119
UFL (/kg DM)[3]	0.92	0.93	0.70	0.92

AT: Access time to pasture; PA: Pasture allowance.
[1,2]Protein truly Digested in the small Intestine when Nitrogen (PDIN) or Energy (PDIE) is limiting for microbial protein synthesis in the rumen (INRA, 2010).
[3]UFL: Unité Fourragère Lait, 1 UFL = 7.115 MJ of Net Energy (INRA, 2010).

2.2. Goats

The same 36 Alpine goats were used in both trials, including 33 multiparous and 3 primiparous goats. Their average kidding date was 11 February 2015. Goats were fed with *ad libitum* grass hay plus concentrate from kidding until the turnout to pasture, on 16 March 2015. During the 15 days following turnout, the daily access time to pasture was progressively increased from 2 h to 8 h. The forage supplementation was progressively adapted to replace hay by 400 g/goat/d of dehydrated forage.

2.2.1. Trial 1

During the pre-experimental period from 4 April to 15 April, all goats grazed as a single herd on non-experimental pastures during 8 h/d between AM and PM milkings, and were indoors for the rest of the day. They were individually supplemented with 600 g/d of concentrate and 400 g/d of dehydrated forage. Individual goats' characteristics were measured from 4 to 10 April to split them into 3 homogenous groups according to their parity (1 primiparous per group), lactation number (3.1 ± 1.5 lactations), stage of lactation (53 ± 7.2 days in milk), milk production (3.0 ± 0.5 kg/d), milk fat concentration (37.7 ± 3.3 g/kg), milk protein concentration (30.7 ± 2.4 g/kg), and body weight (47.7 ± 5.1 kg). Difference between groups did not exceed 2% for any of these variables. Each group was then assigned to 1 of the 3 treatments from the first to the last day of the trial.

2.2.2. Trial 2

After Trial 1, during a 1-week transition period, the 36 goats grazed together as a single herd, with daily access time to pasture increasing from 8 to 13 h/d and dehydrated forage supplementation decreasing from 400 to 0 g/d. Then, a pre-experimental period was carried out from 12 May to 26 May, with 13 h/d of access time to pasture, 600 g/d of concentrate, and no forage supplementation. Three new homogenous groups of 12 goats were formed according to parity (1 primiparous per group; 3.1 ± 1.5 lactations), stage of lactation (97 ± 7.2 days in milk), milk production (3.1 ± 0.4 kg/d), milk fat concentration (34.7 ± 3.4 g/kg), milk protein concentration (30.0 ± 2.3 g/kg), and body weight (48.4 ± 5.1 kg), measured from 12 May to 19 May. Groups were also balanced based on treatments in Trial 1. Difference between groups did not exceed 3% for any of these variables. Each new group was then assigned to 1 of the 3 treatments from the first to the last day of the trial.

2.3. Pastures and grazing management

The pasture used was sown in autumn 2011 as a multispecies sward with perennial ryegrass (*Lolium perenne* L. cv Tryskal, 10 kg/ha), tall fescue (*Festuca arundinacea* Schreb cv Callina, 10 kg/ha), inoculated lucerne (*Medicago sativa* L. cv Prunelle, 10 kg/ha), white clover (*Trifolium repens* L. cv Trissid, 3 kg/ha), and chicory (*Cichorium intybus* L. cv Puna, 1 kg/ha).

The pasture was divided into 2 experimental plots of 6000 m^2 each, the second having been mowed on 15 April to control sward height during the second part of Trial 1. Goats successively grazed the first and the second plot during Trial 1. In each plot, as soon as grazing stopped, refusals and ungrazed areas were mowed to 5 cm from ground level and removed for homogenous pasture regrowth for Trial 2. The average age