J. Dairy Sci. 99:1–18
http://dx.doi.org/10.3168/jds.2015-9873


# The effects of a ration change from a total mixed ration to pasture on health and production of dairy cows

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## ABSTRACT

In pasture-based dairy production systems, dairy cows often receive a silage- and concentrate-based ration [total mixed ration (TMR)] during wintertime and are gradually introduced to fresh herbage in spring. The present study aimed to investigate how the transition to this new nutritional situation influenced different production and health indicators. A 10-wk trial was performed in spring 2014, including 60 dairy cows of the German Holstein breed (166 ± 23 d in milk, 23.5 ± 3.7 kg of milk/d; means ± SD). The cows were divided into a pasture and a confinement group (PG and CG, respectively). The CG stayed on a TMR-based diet (35% corn silage, 35% grass silage, 30% concentrate; DM basis), whereas the PG was gradually transitioned from a TMR- to a pasture-based ration (wk 1 = TMR-only, wk 2 = 3 h/d on pasture, wk 3 and 4 = 12 h/d on pasture, wk 5–10 = pasture-only). A continuous grazing system was implemented on a ryegrass dominated pasture and temperature humidity indices were assessed based on continuous recording of temperature and humidity indoors as well as outdoors. Dry matter intake (DMI) from TMR, milk production, body weight (BW), and body condition score decreased as soon as the PG had partial access to pasture. Milk production and BW decreased even further in the first week on a full grazing ration, but thereafter BW increased again and milk production stabilized. The DMI estimation using the n-alkane method in wk 7 and 9 revealed an increase in DMI from pasture between the 2 time points and indicates an adaptation of grazing behavior and metabolism over several weeks. Increased serum β-hydroxybutyrate and fatty acids concentrations at several time points, as well as a continuous body condition score decrease during the whole course of the trial, indicate an energy deficit in the PG. A significant correlation between serum glucose concentrations and the temperature humidity indices was observed. An increase in serum and milk urea concentrations as well as an increase in the urine total N to creatinine ratio occurred in the PG. To assess possible negative effects of the ration change on metabolic and liver health, different clinical chemistry variables and complete blood counts were assessed. No biologically relevant changes were observed for serum albumin, total protein, cholesterol, aspartate transaminase, γ-glutamyltransferase, and glutamate dehydrogenase concentrations, as well as for white and red blood cell counts.

**Key words:** pasture, confinement, ration change, health

## INTRODUCTION

In temperate climate zones, dairy cows are often fed a TMR during winter and are gradually transitioned to a pasture-based ration in spring. Especially for farms with a seasonal calving pattern, milk production from pasture can be economically beneficial due to lower production costs. Also, larger demand for pasture-based milk products, higher feed costs, and volatile milk prices have made grazing dairy systems more attractive in recent years (Dillon et al., 2005). Pasture-based rations generally exhibit a higher CP and lower ME content. Due to this imbalance in available nutrients, a lower DMI, and a higher energy demand, grazing dairy cows generally have a lower milk production when no dietary attempts are made for counterbalancing (Osuji, 1974; Kolver, 2003; Roca-Fernandez et al., 2013). Milk production can be supported by a pasture-based ration up

Received May 17, 2015.
Accepted October 3, 2015.
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to 25 to 30 kg of milk/d, whereas a TMR can support milk production of more than 40 kg of milk/d (Kolver and Muller, 1998; Bargo et al., 2002).

Different studies have shown that in a grazing- compared with a TMR-based system cows of high-yielding breeds with similar production potential, in particular, are subjected to a more pronounced negative energy balance after calving; as a consequence, these cows undergo a more extensive loss of BW (Washburn et al., 2002; Fontaneli et al., 2005; O'Neill et al., 2011) and exhibit higher serum BHB and fatty acids concentrations postpartum (Kolver and Muller, 1998; Bargo et al., 2002). However, until now no clear evidence has been found that this inferior metabolic and nutritional status is related to an increased incidence of health or reproductive problems (Olmos et al., 2009b; Alawneh et al., 2012; Ribeiro et al., 2013). Further, different studies suggest that pasture-based compared with confinement systems are more beneficial regarding different general health related traits, such as mortality (Burow et al., 2011), udder health (Goldberg et al., 1992; Washburn et al., 2002), and lameness incidence (Haskell et al., 2006; Olmos et al., 2009a), but elaborate studies are lacking.

Due to the limitations of ME supply and a high CP intake, the nitrogen efficiency of grazing dairy cows is generally lower (Kolver, 2003). Excess N is converted into urea by the liver and excreted mainly via milk and urine. Urea synthesis incurs a metabolic energy cost which imposes an additional metabolic effort on a system already limited by energy supply (Kolver, 2003). Several studies indicate that $NH_3$ in high metabolic concentrations has a toxic effect and incriminates different organs in their function (Rajala-Schultz et al., 2001; Pacheco and Waghorn, 2008; Keim and Anrique, 2011). It has been shown in confinement systems that high metabolic urea concentrations are associated with reduced fertility (summarized in Pfeffer and Hristov, 2005). Moller et al. (1993) confirmed this correlation in a study including several pasture-based dairy farms. Contrary to this conclusion, Smith et al. (2001) could not find any relationship between milk urea N content and reproductive performance of pasture-fed New Zealand dairy herds.

In a pasture-based system, in contrast to a confinement TMR-based system, the chemical composition of the ration as well as the cows themselves are much more subjected to the influence of weather. Grazing dairy cows have to deal with changes in protein and energy availability not only seasonally, but sometimes also daily and weekly (Parker and Edwards, 1996; Smit et al., 2004; Abrahamse et al., 2009), and are often more exposed to certain weather conditions, such as rain, wind, and heat (Legrand et al., 2009).

Thus, in pasture-based as well as confinement systems, different management aspects form challenges regarding cow performance as well as welfare. However, no studies that we know of have been published focusing on the effect of the transition from a TMR to a pasture-based ration on dairy cow production and health. It is generally accepted that animal behavior and metabolism, as well as the rumen microbiota, need to adapt to a new nutritional situation; therefore, farmers are advised to introduce cows to pasture gradually over several weeks. But data illustrating the effect of this nutritional change and duration of adaption are lacking.

Thus, we hypothesized that the change from a confinement to a pasture-based system involves complex nutritional and metabolic adaptations with consequences on health and performance. Therefore, the objective of our study was to investigate the influence of a ration change from TMR to pasture on DMI, body condition, milk production, N metabolism, and health. A 10-wk trial with 2 groups (TMR only vs. gradual transition from TMR to pasture) with repeated measurements was conducted to assess the effect and duration of the adaption period.

## MATERIALS AND METHODS

Experimental work was conducted from April until June 2014 at the experimental station of the Friedrich Loeffler Institute (FLI) in Brunswick, Germany. The experiment was carried out according to the German Animal Welfare Act approved by the Lower Saxony State Office for Consumer Protection and Food Safety (LAVES, Oldenburg, Germany).

### *Experimental Design and Treatments*

Sixty primi- and pluriparous German Holstein cows (166 ± 23 DIM; mean ± SD) were randomly assigned to either a pasture group (**PG**; n = 29) or a confinement group (**CG**; n = 31). Each group contained 5 rumen- and duodenum-fistulated animals. Cows had been exposed to intensive grazing before their first calving and during dry periods in previous seasons. Treatments were balanced for milk production (23.5 ± 3.7 kg of milk/cow per day), BW (613 ± 48 kg), BCS (3.1 ± 0.6; 5-point scale; Edmonson et al., 1989), and mean number of lactations (1.9 ± 1.6). The experimental period lasted 10 wk from April 21 until June 27, 2014. In the months preceding the trial, a TMR (similar components as fed during the trial) and additional concentrate to match individual milk production (available at an automated feeding station) were fed. Two weeks before the trial, all cows were switched to the trial TMR and individual