Coagulation properties and composition of milk from cows fed grass with different amounts of concentrates

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Abstract

Grasslands represent an important resource for milk production in many alpine European regions. Therefore, the aim of this study was to evaluate (1) the impact on milk composition and cheese-making properties of feeding regimes based on high but different dietary proportions of fresh grass during the vegetation period, and (2) to quantify changes due to seasonal variation. Three feeding regimes were tested: (C-0) full-time grazing plus mineral supplementation only, (C-low) partial grazing, fresh grass fed indoors with low concentrate level across the lactation, and (C-high) partial grazing, fresh grass fed indoors with a higher level of concentrate across the lactation. Milk from four, three and four cows (regimes C-0, C-low and C-high, respectively) was sampled during four periods in 2015 and analysed with a Lattodinamografo for various traits describing cheese-making properties. Gross constituent composition and cell counts in the milk were measured via mid-infrared spectroscopy. Milk composition and cheese-making properties were not affected by the feeding regime. However, there were significant interactions of sampling month and regime in the measured traits.

Keywords: grazing, fresh grass fed indoors, concentrate level, milk composition, cheese making properties

Introduction

A large share of the milk produced in many alpine European regions is transformed into cheese. In Switzerland 41% of marketed milk is sold in the form of cheese (BLW, 2016). As cheese is a highly valued product it is important to ensure its quality and milk-use efficiency (solids recovery) by regimes enhancing the contents of gross constituents and the coagulation properties of the milk. Cheese-making properties are influenced by several livestock-related factors including stage of lactation, nutrition, animal health, breed and genotype (Kreuzer *et al.*, 1996). As grassland represents the main feed source in alpine regions, it was the aim of the present study to evaluate (1) the impact of three different fresh-grass based regimes on milk composition and cheese-making properties, and (2) to quantify changes due to seasonal variation.

Materials and methods

The experiment was performed at the experimental farm of the Vocational Education and Training Centre for Nature and Nutrition in Hohenrain (Lucerne, Switzerland). In total 11 selected cows were monitored which originated from three separate herds consisting of 21 to 27 members each. Each herd was subjected to a different feeding regime: full-time grazing plus mineral supplementation only (C-0); partial grazing, fresh grass fed indoors with low concentrate level (C-low); and partial grazing, fresh grass fed indoors with a high concentrate level (C-high). Concentrate intake and milk yield are summarized in Table 1. At the beginning of the experiment the cows were 64±23 d, 64±9 and 37±8 days in milk in groups C-0, C-low and C-high, respectively.

Milk was sampled on three days during four successive periods in April, July, October and November (indoor period) in 2015. Milk samples obtained in the evening were immediately cooled and mixed with the milk from the morning for each cow proportional to the respective milk amounts produced. A

Table 1. Concentrate intake, days in milk and milk yield of the cows subjected to the three feeding regimes.[1]

	Regime[2]	April		July		October		November (indoor period)	
		Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD
Concentrate (kg DM/day/cow)	C-high	3.5	0.5	2.8	0.7	1.0	0.7	0.0	0.0
	C-low	3.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
	C-0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ECM (kg/day)	C-high	27	1.9	21	2.4	20	3.3	20	6.2
	C-low	27	5.8	19	3.2	19	3.5	16	3.2
	C-0	22	3.3	16	2.9	17	3.4	13	2.7

[1] ECM = energy corrected milk; SD = standard deviation.

[2] C-high (n=4); C-low (n=3); C-0 (n=4).

subsample of the milk was stabilised with Bronopol for mid-infrared analysis (Foss Milkoscan FT 6000) to determine contents of fat, protein, casein and lactose. Non-stabilised samples were transferred to the lab and analysed for milk coagulation properties within 24 h after sampling using a Lattodinamografo (Foss, Italy). Rennet coagulation time (RCT), curd firmness (A_{30}, amplitude measured after 30 min) and coagulation rate (k_{20}, time measured from starting point of coagulation until the amplitude measured reached 20 mm) were analysed. To do so, 10 ml of milk were warmed to 35 °C during 30 min, before adding 200 µl of diluted (1:50) rennet (Clerici Standard liquid, 1:19,000). Data were analysed using the MIXED procedure of SAS (version 9.1 Inst. Inc., Cary, NC, USA). The statistical model included sampling month, feeding regime and their interaction as fixed factors. Sampling month was considered as repeated factor, with cows as a random factor nested within feeding regime. Differences with probability levels of $P<0.01$ were considered significant.

Results and discussion

Milk constituents (fat) were not affected by the different feeding regimes but showed a typical increase with progressing lactation and sampling month over the seasons. Interactions were significant, thus regimes responded differently to sampling month. In July, contents of fat, protein, casein and lactose were lowest. Cell counts showed an increase with progressing sampling month over the year for regime C-0 and C-low, whereas in regime C-high a maximum was reached in July. Cell counts remained stable in April, October and during the indoor period in November (data not shown). Milk coagulation properties were not significantly affected by the different feeding regimes (Table 2), but by sampling month and regime×sampling month interaction. This is in accordance with other findings, where sampling month and stage of lactation had a strong impact on the coagulation properties (Auldist *et al.*, 1998; Jõudu *et al.*, 2008). Feeding regimes were affected differently during the sampling months. Under feeding regime C-high and C-low the RCT was lowest in April and reached the maximum in July. RCT was constantly shorter in C-0 during all sampling months. Coagulation rate was highest in July, where it took 3.5 min (average over all systems) to get the amplitude of 20 mm Curd firmness measured as A_{30} was lowest in July, whereas it recovered in October and November especially under regime C-low and C-0.

Conclusions

The findings demonstrate that, under our conditions, milk coagulation properties were not affected by the regimes investigated. However, sampling month had a major effect on milk composition and milk coagulation properties, affecting the properties differently in the three regimes. Milk coagulation properties and major milk components were unfavourable in July. This was most pronounced in regime C-high. Further evaluation of the data is needed to determine the cause for the decreased content of the major milk constituents during summer period.

Table 2. Milk coagulation properties during the four sampling months as measured in cows subjected to the three feeding regimes.[1,2]

	Regime	Month				SE	P-values		
		April	July	October	November (indoor period)		Regime	Month	Regime×month
RCT (s)	C-high	869 ^{def}	1,371 ^{ab}	1,145 ^{ce}	1,205 ^{abc}				
	C-low	805 ^{bef}	1,146 ^{acd}	1,080 ^{abcd}	1,004 ^{abcd}				
	C-0	792 ^{cde}	956 ^{abcd}	976 ^{acd}	954 ^{abcd}	121	ns	<0.001	0.002
Coagulation rate (k_{20}, s)	C-high	85.0 ^{c}	188 ^{ab}	142 ^{bc}	132 ^{bc}				
	C-low	83.9 ^{bc}	294 ^{a}	92.1 ^{bc}	115 ^{bc}				
	C-0	89.4 ^{bc}	147 ^{abc}	85.6 ^{bc}	96.1 ^{bc}	29.2	ns	<0.001	<0.001
Curd firmness (A_{30}, mm)	C-high	56.5 ^{ace}	26.5 ^{dg}	42.4 ^{bf}	40.8 ^{bf}				
	C-low	57.3 ^{abde}	29.5 ^{cfg}	44.9 ^{abcde}	49.9 ^{abde}				
	C-0	57.7 ^{abcd}	42.3 ^{efg}	58.0 ^{abcd}	50.3 ^{abcde}	6.96	ns	<0.001	0.011

[1] RCT = rennet coagulation time; SE = standard error.

[2] Within the same measured trait, least square means without a common superscript differ ($P<0.01$); ns = not significant ($P>0.05$).

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