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Seasonal and group effects on dairy cow behavior in large yards

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Abstract: In mechanized modern dairy facilities with competitive environments, monitoring behavior provides opportunities to manipulate and optimize the nutritional, health, and social status of high-merit cows. The objective of the current study was to determine seasonal and cow group effects on the eating, ruminating, standing, and lying behaviors of dairy cows in large yards. Seasonal data on various behaviors of lactating cows in different production and lactation stages were collected continuously for 26 months, from December 2006 through February 2008. The herd had approximately 3000 dairy cattle housed in groups within specific yards. A total of 415 multiparous high-producing cows (MH), 166 multiparous medium-producing cows (MM), 166 multiparous low-producing cows (ML), 165 primiparous high-producing cows (PH), 83 fresh cows (FC), 82 fresh heifers (FH), and 82 cows with high milk somatic cell count (HSCC) were monitored. Seasonal eating, ruminating, standing, and lying behaviors were recorded by 4 trained individuals at 1000 hours every week, on 4 days per week. Each activity was expressed as the proportion of cows exhibiting the activity relative to the total number of cows in the yard. Feed was delivered 6 times daily, 4 times as TMR at 0600, 1030, 1300, and 1800, just after milking and twice as alfalfa hay at nighttime. Across all groups, a greater proportion of cows were observed eating during winter (25.7%) than during spring (17.1%), summer (15.4%), and autumn (14.5%). The proportion of cows neither eating nor ruminating was lower in winter (48.1%) than in summer (58.9%) and autumn (58.6%), but similar to spring (53.7%). A greater proportion of cows in the PH (24.6%) and ML (21.3%) groups were observed eating, compared with the MM (15.2%), MH (16.6%), and FC (12.6%) groups. Lying was observed significantly more often in the FC (71%), MM (69.6%), HSCC (65.3%), and MH (64%) groups than in FH (54%), ML (55.7%), and PH (55.7%) groups. A greater proportion of cows were observed ruminating in the MM (31.7%), FC (31.3%), HSCC (28.7%), PH (27.2%), and MH (26.7%) groups, when compared to the FH (20.5%) and ML (22.9%) groups. The HSCC cows were less active in eating and more active in lying than the PH and ML groups. With the remarkably large sample size and prolonged study period, these findings reveal the determining effects of season alongside age, lactation stage, productivity, and—to some extent—mastitis on the eating, ruminating, and resting behaviors of dairy cows in large yard houses. The data suggests future research aimed towards developing local and global programs for monitoring and optimizing cow health and welfare based on social and feeding behaviors.

Key words: Behavior, eating, ruminating, season, parity, yard

Introduction

In mechanized modern dairy facilities with competitive environments, monitoring behavior provides opportunities to manipulate and optimize nutritional, health, and social status of high-merit cows. Initial research on cattle social behavior (1-6), although insufficient, highlighted and, in some cases quantified, the association of cow physiology, social rank, immunity, and performance with environment (e.g., stall design and space, inter-group

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member changes, isolation, and other stressors). Later research shed light on how cow grouping strategies affect social and feeding behaviors (7-9). Most recently, renewed research interest in cow feed intake and social behavior promises improvements in health, metabolism, and production (10-13). Huzzey et al. (11) showed that DMI and eating time and engagement in social and aggressive interactions at feed bunk during precalving week decrease in cows that are at high risk of postpartum mastitis. Goldhawk et al. (13) found that cows with lowered DMI and frequency of feed bunk visits and shorter feed bunk visits during precalving week had subclinical ketosis for a few weeks peripartum. These studies suggest that social and feeding behaviors are determining factors in cow health and productivity. Thus, feeding behaviors can be monitored as a management tool to evaluate and improve cow health and longevity, especially in large herds. Data are lacking on how environmental factors, independently or in relation to cow factors (e.g., production level, parity, and lactation stage), affect social-feeding behaviors. It was hypothesized that lactating cows housed in large groups exhibit different eating, ruminating, and resting or social activities during different seasons. Another hypothesis was that such activities will depend on cow groups defined by lactation stage, milk production level, and cow parity. The objective was to conduct an observational study for a prolonged period (i.e. from December 2006 to February 2008) to determine seasonal and group effects on the eating, ruminating, resting, standing, and idle activities of lactating dairy cows.

Materials and methods

The observations were made in a commercial yard-based herd with approximately 3000 dairy cattle, including 1100 milking cows. Cows were housed and grouped in large yards (80-120 cows/yard) based on stage of lactation and milk production. Multiparous (minimum 0.7 m/head) and primiparous (minimum 0.6 m/head) cows were ensured to have adequate bunk space to avoid abnormal inter-cow interactions that could interfere with true, normal behavior expression (9). About one third of each yard was roofed to provide cows with a hygienic area for resting and ruminating that was protected from rain and direct sun. The dairy farm is located in the central Iranian province of Isfahan in about 25 km northwest of Isfahan city. The region has hot-dry summers and moderate winters, with an approximate annual precipitation of 150 mm. A total of 415 multiparous high-producing cows (MH), 166 multiparous medium-producing cows (MM), 166 multiparous low-producing cows (ML), 165 primiparous high-producing cows (PH), 83 fresh cows (FC), 82 fresh heifers (FH), and 82 cows with high milk somatic cell count (HSCC) were monitored in different seasons. The average daily air temperature and relative humidity were, respectively: 20.9 °C and 36% in spring, 26.8 °C and 17.3% in summer, 10.0 °C and 43.9% in autumn, and 2.53 °C and 55.8% in winter. The cows were monitored continuously by 4 individuals every week, 4 days per week for 26 months, from December of 2006 through February of 2008. In all seasons daily eating, ruminating, standing, and lying activities were recorded at 1000 hours. On each recording day, each activity was expressed as the proportion of the cows presently exhibiting the activity relative to the total number of cows in the yard at the time of observation. For instance, if 20 cows were eating in a yard with a total of 90 cows, the proportion of cows observed eating was calculated as: $20/90 \times 100$ or 22.22%. Cows were fed on a group basis. Their diets were based on corn silage, alfalfa hay, barley and corn grains, cottonseed, cottonseed and soybean meals, and wheat bran (Table 1). The average milk yield and milk fat content of the herd during the study were 37 kg/day and 3.4%, respectively. The dietary forage-to-concentrate ratio was 36:64 for high-producing cows, 63:37 for low-producing cows, and 43:57 for fresh cows. Feed was delivered 6 times daily, 4 times as TMR at 0600, 1030, 1300, and 1800, just after milking and twice as nighttime alfalfa hay. The recording procedures and feeding and housing conditions were in accordance with the guidelines of the Iranian Council on Animal Care (14). Data were analyzed as mixed models of SAS (15). Final models of transformed data consisted of fixed effects of cow group, season, and interaction, plus random effects of recording date (season), group (date), and residual errors. Least square means were estimated using the REML method, and denominator degrees of freedom were calculated using the Kenward-Roger method (15). The PDIFF option of SAS and

Table 1. Dietary feed ingredients and chemical composition of different concentrates (DM basis).

% of concentrate DM	Diet		
	Fresh	High-producing	Low-producing
Ground barley grain	35.0	43.0	33.0
Ground corn grain	10.3	4.5	0
Whole cottonseed	19.3	11.0	0
Cottonseed meal	4.2	3.5	3.5
Soybean meal	14.0	13.3	0
Wheat bran	0	4.0	30.0
Canola meal	4.2	11.0	11.0
Sunflower meal	0	0	16.4
Corn gluten	2.1	1.1	0
Fish meal	1.7	2.5	0
Limestone	1.4	1.1	1.4
Salt	0.2	0.5	0.5
Protected fat	2.1	1.1	0
Sodium bicarbonate	1.3	1.1	0
Magnesium oxide	0.2	0.2	0.2
Zeolite	0.7	0.9	2.0
Urea	0	0	0.7
Glycoline	1.4	0	0
Mineral and vit. supplement[1]	1.8	1.2	1.3
Forage:concentrate	43.2:56.8	36.2:63.8	62.6:37.4
Alfalfa hay	24.4	19.6	29.1
Corn silage	18.8	16.6	19.4
Wheat straw	0	0	14.1
Chemical composition			
CP, %	19.2	20.8	16.8
NE_L[2], Mcal/kg	1.8	1.7	1.4

[1]Contains: 196 g, Ca; 96 g, P; 71 g, Na; 19 g, Mg; 3 g, Fe; 0.3 g, Cu; 2 g, Mn; 3 g, Zn; 100 ppm, Co; 100 ppm, I; 0.1 ppm, Se; and 50 × 105 IU of vitamin A, 10 ×105 IU of vitamin D, and 0.1 g of vitamin E/kg.
[2]From NRC (2001).

Table 2. Seasonal eating, ruminating, lying, and idle standing behaviors of dairy cows at different ages and production levels.

	Cow group							Season				SEMc	SEMs	P-value	
Item	FC	FH	MH	MM	ML	PH	HSCC	Spring	Summer	Autumn	Winter			Cow group	Season
Eating %	12.6^{c}	20.4^{ab}	16.6^{bc}	15.2^{bc}	21.3^{a}	24.6^{a}	16.5^{bc}	17.1^{b}	15.4^{b}	14.5^{b}	25.7^{a}	2.0	2.7	<0.0001	<0.01
Lying %	71.0^{a}	54.0^{c}	64.0^{ab}	69.6^{a}	55.7^{c}	55.7^{c}	65.3^{ab}	66.2	62.5	62.4	57.7	3.0	4.6	<0.0001	0.32
Ruminating %	31.3^{ab}	20.5^{c}	26.7^{b}	31.7^{a}	22.9^{c}	27.2^{b}	28.7^{b}	29.2	25.7	26.9	26.2	1.8	2.7	<0.0001	0.72
Standing %	15.6^{cd}	27.0^{a}	18.3^{bc}	13.8^{d}	21.7^{b}	17.2^{c}	19.0^{bc}	13.8	21.7	22.5	18.0	1.8	2.9	<0.0001	0.12
Idle[1] %	56.1^{a}	59.1^{a}	56.7^{a}	53.1^{b}	55.8^{ab}	48.1^{c}	54.7^{ab}	53.7^{ab}	58.9^{a}	58.6^{a}	48.1^{b}	1.7	2.8	<0.0001	<0.02

FC = fresh cows; FH = fresh, high-producing cows; MH = multiparous, high-producing cows; MM = multiparous, medium-producing cows; ML = multiparous, low-producing cows; PH = primiparous, high-producing cows; HSCC = high somatic cell count cows.

^{a,b,c,d} Within each row under "cow group" and "season", means with different superscripts differ at $P < 0.05$.

[1]Percentage of cows neither eating nor ruminating.

SEMc = standard error of mean for cow group effect; SEMs = standard error of mean for season effect.

Tukey's test were used to separate treatment means. Multiple means comparisons adjustment showed no significant interactions of season and cow group. The significance effects were declared at $P < 0.05$.

Results and discussion

Across groups, a greater proportion of cows ($P < 0.01$) were observed eating during winter (25.7%) than during spring (17.1%), summer (15.4%), and autumn (14.5%). These findings were consistent with the lower proportion of idle cows during winter than during summer. This suggests a greater demand for warming activities, such as eating, during the cold seasons. Eating activity in cattle is known to entail expenditures equal to 10%-30% of ME intake (16). Winter time would logically require prolonged eating activities, when compared to warmer times of year. This would not necessarily mean reductions in nutrient use efficiency; increased heat production by increased eating can help to warm the cow body more effectively (17). The proportion of cows neither eating nor ruminating was lower ($P < 0.05$) in winter (48.1%) than in summer (58.9%) and autumn (58.6%), but similar to spring (53.7%). These results were in agreement with the increased proportion of cows eating in winter compared to other seasons.

More cows in the PH (24.6%) and ML (21.3%) groups were observed eating when compared with MM (15.2%), MH (16.6%), and FC (12.6%) groups. Fresh cows (FC) could be rationally less active in eating compared to cows in advanced stages of lactation, as DMI is lower in fresh cows and has not yet reached its peak (9,17). The fact that MH and MM were less active in eating than ML cows suggests that, with increased milk production, multiparous cows may eat faster to obtain a certain amount of nutrients. In addition, it is suggested that higher producing multiparous cows with high social rank may spend more time ruminating after rapidly consuming their meals, when compared with lower-producing multiparous cows (9). From a digestive physiology perspective, a slower eating rate in combination with prolonged eating contributes to greater ensalivation (18). Accordingly, forages cause much greater ensalivation than concentrates (e.g., 1.1 vs. 3.4-7.2 g saliva/g DM)(18). These findings could explain why rumen acidosis severity and incidence increases shortly postpartum (19). FC and early lactation cows are expected to have reduced opportunities for ensalivation. However, PH cows may be an exception, since after parturition they do not experience changes in their physiology, immune function, and DMI as dramatic as those of multiparous cows (17). The more stabilized metabolism of periparturient primiparous (vs. multiparous) cows would concur with the active eating behavior of PH cows in the current study. Accordingly, lying was observed more extensively ($P < 0.01$) in the FC (71%), MM (69.6%), and MH (64%) groups than in the FH (54%), ML (55.7%), and PH (55.7%) groups.

A greater proportion of cows were observed ruminating ($P < 0.01$) in the MM (31.7%), FC (31.3%), PH (27.2%), and MH (26.7%) groups than in the FH (20.5%) and ML (22.9%) groups. By evolutionary definition, rumination occurs when ruminants are superior in psychological status and feel socially secure; it usually takes place 1) between morning and midday meals and 2) after evening grazing, later in the night (20,21). Fresh high-producing cows undergo the most dramatic periparturient metabolic changes and suffer from inadequate DMI, lowered immunity, and negative nutrient balance (17). When considering rumination psychophysiology, diurnal rumination patterns, and the fact that rumination in the present study was monitored in the morning, a lower proportion of ruminating FH cows would be biologically evocative. In addition, resting saliva secretion is much lower (e.g., 50%-100%) than eating saliva secretion (18,22). Higher producing cows eat more DMI mainly because they eat for longer periods and probably at a faster rate (23), suggesting that reduced eating time in fresh cows may contribute to reduced rumen acidosis tolerance (19).

HSCC cows were less active in eating compared to other groups, such as PH and ML cows. Consistently, a greater proportion of HSCC cows were observed lying when compared to PH, ML, and FH groups. These results have health implications and suggest subclinical mastitis effects on cow lying and eating behavior. Feeding and social behaviors are being introduced as a prognosis for cows with an emerging risk of abnormalities, such as metritis and subclinical ketosis (11,13). Data from the present study underline the feasibility of monitoring cow

behavior in large herds as a management tool for tracking herd health. Considering the remarkably large sample size and prolonged period of the study, the findings reveal the determining effects of season and cow group (i.e. age, lactation stage, and production level) on the eating, ruminating, lying, standing, and idle behaviors of dairy cows in large yards. The observational data suggest future research aimed towards developing local and global guidelines based on social and feeding behaviors to monitor cow health and welfare. Accordingly, certain groups or individual cows with inconsistent and abnormal behavior could be monitored for disease prediction and prevention. Subsequently, optimum feeding and housing management programs can be practiced.

In summary, the eating, ruminating, lying, and standing behavior intensity of lactating cows housed in groups in large yards in a 3000-head Holstein farm was dependent on season and cow group. A greater proportion of cows were observed eating in winter than in spring, summer, or autumn. The proportion of cows neither eating nor ruminating was lower in winter than in summer and autumn. More cows in the PH and ML groups were observed eating, when compared with the MM, MH, and FC groups. Lying was observed less often in the FH, ML, and PH groups than in the FC, MM, HSCC, and MH groups. Cows were observed ruminating more often in the MM, FC, HSCC, PH, and MH groups than in the FH and ML groups. The HSCC cows were less active in eating and more active in lying than cows in the PH and ML groups. Varying behavior reflects varying cow physiology, seasonal factors, feeding strategies, and housing conditions. The findings suggest that these factors will require consideration for effective betterment of animal well-being and improved prediction and prevention of health issues.

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