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Dairy cow preference for outdoor access during winter under Eastern Canada climatic conditions

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Cows on 2 separate farms were submitted to a 6-d preference test, repeated 4 times, consisting of three 2-d phases (3 h/d/phase): forced-indoor, forced-outdoor and free-choice. A majority of cows on both farms chose to be outdoors for at least 1 h. Previous experience may have contributed to outdoor preference.

Keywords: Dairy cows, outdoor access, preferences test, winter conditions

The Canadian Code of practices (Dairy Farmers of Canada-National Farm Animal Care Council, 2009) and the Canadian organic standards (Canadian General Standard Board, 2011) recommend daily exercise for dairy cows. In addition, organic standards require at least bi-weekly access to exercise during winter for cows in tie-stalls and access to the outdoors. Apart from meeting these standards, periods of daily exercise or outdoor access can positively influence the expression of normal behaviours (Popescu et al., 2013) and increase hoof-health (Hernandez-Mendo et al., 2007, Loberg et al. 2004). While a plethora of literature is available on the topic of pasture management, information on what is optimal for winter outdoor access in climatic regions with harsh weather conditions is less prevalent. To better understand the welfare implications of pasture and other forms of outdoor access, past studies have looked at cow preference for pasture versus a free-stall barn (Legrand et al., 2009; Charlton et al., 2011), but were limited to summer weather conditions and did not measure preference under colder winter weather.

The objective of the current study was to investigate lactating cow preference provided the choice between an outdoor area and an indoor facility under Eastern Canada winter conditions. The study also sought to document cow activity while forced to remain outside to better determine how cow activity is impacted by being outdoors in the winter.

Alfred experiment: 32 lactating Holstein cows (annual milk production: 9,211 kg/cow) were selected from the University of Guelph Alfred organic dairy facility (Alfred, Ontario, Canada). Cows were housed in a free-stall barn with straw-bedding on rubber mat cubicles and slatted flooring. The free-stall barn was divided into two pens to facilitate the movement of test cows and two fields, located 50 m from the barn, were used for outdoor winter access. The same forage was provided, ad libitum, inside and outside and daily grain allowance was fed inside

prior to each observation period. All cows had previous experience with both free-stall housing and seasonal access to pasture or outdoor winter areas.

La Pocatière experiment: 22 lactating Canadienne (annual milk production: 5,356 kg/cow, 25 % of herd) and Jersey (annual milk production: 4,489 kg/cow, 75 % of herd) cows were selected from the La Pocatière organic dairy facility (Institut de technologie agroalimentaire, La Pocatière, Quebec, Canada). A barn with a loose-housing system using a deep-bedded composted pack was divided into two pens to facilitate the movement of test cows and a pasture adjacent (0 m) to the barn was used for outdoor access. The same forage was provided, ad libitum, inside and outside and daily grain allowance was accessible via an automatic feeding system inside the barn. All cows had previous experience with their indoor housing facility and pasture but no prior outdoor winter experience.

Cows from both experiments were randomly assigned to 4 groups balanced by stage of lactation and parity. All cows were exposed to the test pens in the barn and provided access to outdoor area for 30 min to 1 h for seven days prior to the start of the study to allow acclimation to both choices.

Cows were subjected to a 6-d cycle preference test repeated 4 times from January to March 2012 and February to April 2013 in Alfred and La Pocatière, respectively. Cows were provided one rest week in between each test week. Forced-indoor and -outdoor phases (d1-d4): Each week, two different groups were combined and assigned to one of the two forced-phases. A different combination of two groups was used in each of the four repetitions ($n = 4$) for both the forced-indoor and -outdoor phases. The 2-d forced-indoor phase restricted the treatment cows to the indoor area and the 2-d forced-outdoor phase restricted the cows to the outdoor area. Both phases were applied for 3 h after which the cows were restricted to indoors access only. Free-

choice phase (d5-d6): during the following 2-d period, all cows were combined ($n = 1$) and allowed to choose between staying inside the barn or going outside for 3 h after which they were restricted to indoors access only. Each 3-h period phase was carried out from 1300 to 1600 h in Alfred, and 800 to 1100 h in La Pocatière, coinciding with the peak hours of courtyard sun exposure at each location.

Observations of cow activities were performed by a trained observer every 2 min for the duration of the forced-outdoor and free-choice phases using scan sampling. Four behaviours were observed when cows were forced outdoors: feeding, lying down, standing at the gate, or other. Feeding was defined as when the cow was masticating while standing in front of the feeder. Lying was defined as when cow flank was in contact with the ground. Standing at the gate was defined as when the cow positioned herself within 5 m of the gate of the outdoor area. Other represented all previously undescribed activities, such as idling, socializing and allogrooming. One measure was taken during free-choice phase: number of cows outdoors. Inter-observer reliability as measured by percent agreement with the instructor was 92.4 % ($K_w = 0.96$) for all observed behaviours.

Analyses were run at the group level as animals can influence each other, which may impact the results if analysed at the individual level (Lee et al., 2013). A Friedman test followed by an Asymptotic General Independence test was used to analyse time spent doing each activity for the forced-outdoor and free-choice phases between weeks (1-4) and between hours (1-3). Additionally, preference during the free-choice phase was tested by determining whether the herd preference for the outdoors was statistically different from 0 %, 50 % and 100 % (choice to be indoors, indifference i.e. random choice, and choice to be outdoors, respectively) following

Charlton et al. (2011), with a separate t-test performed for each hour (1-3) across weeks with each week analyzed as an independent replicate.

Descriptions of weather conditions were recorded throughout the course of the study (Table 1). Temperature loggers (Hobo Pro Data loggers, Onset Computer Corp., Bourne, MA) were used to record air temperature and relative humidity. A severe snow storm occurred on week 2 during the free-choice phase in Alfred, resulting in colder weather conditions.

Forced-outdoors phase. When kept outdoors, cows spent most of their first hour feeding and gradually increased their time spent standing at the gate, which peaked at the third hour (Table 2). Additionally, cows were observed feeding consistently throughout the course of both experiments at a minimum of 15 % of their time, suggesting that feeding will be performed regardless of outdoor conditions. At lower critical temperatures, cows redirect energy to increase metabolic heat, a process facilitated by an increase in feed consumption (Young, 1983). This is possible explanation for the feeding results in this study and it suggests that feed should be offered when providing cows with open-air access in the winter.

In both locations, lying behaviour was infrequently observed in weeks 1 and 2. Additionally, La Pocatière cows spent less time lying in weeks 3 and 4 while Alfred cows displayed an increase. The differences seen between weeks with low lying time and those with higher lying time may have been due to the presence of snow coverage. A reduction in lying was found in beef cows and heifers (Graunke et al., 2011) and dairy cows (Schütz et al., 2010) as precipitation levels increased. The snowfall in the current study may have had less impact than sleet or rain at cold temperatures because snow is drier (Graunke et al., 2011). However, accumulation of snow melting on and around the cows will similarly reduce the thermal insulation of the cow (Young et al., 1989), leading to less lying as cows will avoid lying on wet

surfaces (Fregonesi et al., 2007). Temperatures between weeks 3 and 4 did not differ much from those in weeks 1 and 2 in the Alfred experiment, further suggesting that snow coverage may have led to a decrease in lying time.

Free-choice phase. A majority of the herd was outside during hour 1 in both Alfred (89.2 %) and La Pocatière (67.7 %), respectively (Table 2). Table 3 outlines the results for cow outdoor preference when tested against 0 %, 50 % and 100 % (choice to go inside, indifference i.e. random choice, and choice to go outside, respectively). A lack of significant difference from both 50 % and 100 %, but significant difference from 0% denoted partial preference for the outdoors. Cows in Alfred showed a preference to be outdoors on hour 1 and a partial preference to be outdoors on hour 2 and 3, whereas cows from La Pocatière shifted from partial preference for the outdoors in hour 1 to indifference in hour 2 and then showed a strong preference for indoors on hour 3. These findings suggest that cow preference for outdoor does not last or at least not consistently for more than 1 h. Interestingly, during the forced-outdoor phase, cows spent most of their first hour at the feeder, possibly contributing to their choice to stay outdoor for that period of time.

Weather conditions may have impacted cow preferences. The Alfred herd, which maintained high percentages (73.5 % - 100 %) for weeks 1, 3 and 4, had a drop in percentage of cows outdoors in week 2 to only 48 %. During this week there was a severe snow storm, which may have deterred cows from going outside. Krohn et al. (1992) also reported a decrease in cows outdoors when adverse winter conditions became more extreme with no cows choosing to be outdoors when the weather went below zero. However weather conditions in Alfred during weeks 1-2 did not vary greatly from weeks 1-4 in La Pocatière to an extent where observed differences in preferences between the two farms would be expected. Instead, it is possible that

external factors such as indoor housing comfort may explain discrepancies between cow preferences in the two experiments. Cows at the Alfred barn were housed in an older facility with slatted floors, which exposed cows to high level of ammonia, and stall configuration and stall base that may not fully maximize cow comfort, potentially resulting in an increased preference to stay outdoors. Conversely, the newly designed La Pocatière barn with a deep-bedded composted pack was more conducive to cow comfort exposing cows to lower ammonia levels, and allowing cows to rest more comfortably, potentially resulting in an increased preference to go back and stay inside the barn. However, cows in Krohn et al. (1992) were provided with an indoor environment designed for maximum comfort but yielded a considerable preference for at least partial daily outdoor access in similar winter conditions to those of the current study, opting to be utilize the outdoor yard for an average of 4.8 h/d. This suggests that additional factors may contribute to the level of preference displayed by the cow.

Previous exposure to outdoor access, especially with regard to winter access, could be one such factor. Similar studies conducted under warmer conditions by Legrand et al. (2009) and Charlton et al. (2011) found that 48 % and 66.2 %, respectively, of cows preferred to remain indoors, with both noting experience as having a possible impact on these results. Cows in Alfred were outdoors during rearing and had year-round access to the outdoors, contrasting these studies in which cows had no experience with pasture during rearing (Charlton et al., 2011) or during lactation (Legrand et al., 2009). Furthermore, the La Pocatière farm provided outdoors access only during the summer grazing season and cows had no experience with winter outdoor access. This suggests that an increasing level of past outdoor experience may result in a higher propensity for cows to remain outdoors. This could also explain the preference for indoors found in Charlton et al. (2011) and the shifting preferences found in La Pocatière.

This study found that, when given the choice, most cows chose to be outside and when outside, cows would display a normal range of activities such as lying and feeding, even under the harsh conditions of Eastern Ontario winter. A herd preference or partial preference for the outdoor area was seen in Alfred for all hours and, although less preference was found with that of La Pocatière, there was still a partial herd preference during hour 1, further supporting the assumption that cows show a preference for the outdoors. While this study looks to develop a baseline for possible management recommendations, further research into cow preference for the outdoors on both a herd and individual level as well as learning more about how the expression of normal behaviours are impacted by various weather conditions is needed. As time of outdoor access varied between the two farms in this study, research into the impact of time after milking and feed intake is warranted. Additional research is also important in furthering our understanding of the role played by prior experience in preference development and to determine best management practices for outdoor access during winter, such as maximum duration under extreme temperatures, and further environmental enrichment such as ground insulation.

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Shepley, Table 1

Table 1. Weather conditions (outdoor temperature, in °C; outdoor relative humidity RH, in %; complete snow coverage, Yes or No) for each week of Alfred and La Pocatière experiments.

Farm	Item	Week			
		1	2	3	4
Alfred	Temperature ¹	5.0 ± 2.34	2.3 ± 4.83	8.7 ± 3.44	6.8 ± 2.99
	RH ¹	64.1 ± 13.76	70.4 ± 14.35	80.4 ± 15.24	49.4 ± 22.74
	Snow coverage	Yes	Yes	No	No
La Pocatière	Temperature ¹	-4.4 ± 8.01	0.6 ± 7.71	2.0 ± 1.99	2.2 ± 5.26
	RH ¹	72.4 ± 18.38	70.0 ± 15.47	80.8 ± 12.76	67.5 ± 16.17
	Snow coverage	Yes	Yes	Yes	Yes

¹Values are average ± SD

Shepley, Table 2

Table 2. Effect of week (1-4) and effect of hour (1-3) on differences in percentage of time spent doing each activity (Forced-outdoor phase) and percentage of cows outdoors (Free-choice phase) for each experiment (Alfred and La Pocatière).¹

Experiment	Phase	Item	Hour					Week					
			1	2	3	SEM	P-value	1	2	3	4	SEM	P-value
Alfred	Forced-Outdoor	Feeding	56.9 ^a	33.1	20.2 ^b	3.25	0.04	48.6	29.5	41.4	27.3	3.25	0.12
		Lying	9.9	29.2	35.2	4.18	0.09	5.8	3.3	31.2	58.7	4.18	0.06
		Standing at Gate	7.4 ^a	11.5	19.5 ^b	4.07	0.05	10.3	39.8 ^a	0.0 ^b	1.0	4.07	0.04
		Other	25.8	26.3	25.2	2.50	0.76	35.3	27.3	27.4	13.0	2.50	0.12
	Free-choice	Cows outdoor	89.2	78.8	62.6	30.1	0.02	73.5	38.0 ^a	100.0 ^b	96.0	30.1	< 0.01
La Pocatière	Forced-Outdoor	Feeding	73.9 ^a	30.9	15.1 ^b	4.12	0.01	37.1	39.4	46.2	37.1	4.12	0.12
		Lying	0.1	0.8	1.2	0.40	0.15	0.0	2.3	0.4	0.0	0.40	0.18
		Standing at Gate	2.7 ^a	36.3	70.4 ^b	5.00	0.01	39.1	33.1	31.3	42.3	5.00	0.17
		Other	23.3	32.0 ^a	13.3 ^b	2.20	0.02	23.8	25.1	22.0	20.6	2.20	0.59
	Free-choice	Cows outdoor	66.7	33.5	14.6	27.6	0.06	43.3	50.6	25.6	33.5	27.6	0.60

¹Different superscripts within hours or within weeks denote significant differences at $P < 0.05$.

Shepley, Table 3

Table 3. Differences from 0 %, 50 % and 100 % (choice to be inside, indifference i.e. random chance, and choice to be outside, respectively) of the percent of cows, averaged by hour across weeks, choosing to be outside for each experiment (Alfred and La Pocatière).

Hour	Proportion	Alfred		La Pocatière	
		t	P-value	t	P-value
1	0	3.68	0.04	6.04	< 0.01
	50	3.68	0.04	1.51	0.23
	100	-1.01	0.39	-3.02	0.06
2	0	6.38	< 0.01	3.56	0.04
	50	2.34	0.10	-1.75	0.18
	100	-1.71	0.19	-7.05	< 0.01
3	0	2.97	0.06	2.85	0.07
	50	0.60	0.60	-6.91	< 0.01
	100	-1.77	0.17	-16.67	< 0.01