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Evaluation of The Dairy Cattle Resting Behavior and Stall Usage in Free Stall Housing Systems

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Abstract: *This study was conducted to evaluate resting and standing behavior and stall usage by cows for resting and standing and effect of environmental temperatures on these behaviors in free stall housing system. In a free stall commercial dairy farm in Golestan province, 60 lactating cows of two high producing or low producing groups were filmed for 20 continues 24 h periods in two different season (hot and cold). Data for standing in stalls, resting in stalls, standing in alleys, perching in stalls and resting in alleys were collected using 30 minutes' interval scanning the video records. Data were analyzed in a 2×2 factorial experiment using general linier model. Counteraction effects of season×group on behavioral variables were not significant. Also, there were no differences between high producing and low producing cows in resting or standing behaviors. Season has a considerable effect on resting behavior and stall usage. Cows rest more and spend more time resting in stalls in colder season than in hot season, and they spend more time resting in alleys in hot season ($p<0.05$). Based on these results, it can be concluded that many of the standards used for construction of this free stall barn are probably inadequate for care of animals and needs total revision based on cow natural behaviors.*

Keywords: Free Stall, Resting Behavior, Season

INTRODUCTION

The effect of housing system on welfare of animals is indisputable (Rushen, de Passille AMB, 1999). The extend to witch husbandry system take account of the needs of livestock can be established with the help of various complementary parameters, such as production indicators, veterinary approach, physiological parameters, and behavioral indexes. Behavior provide a more direct window on the animal's own perceptions of surrounding environment (Novak et al., 2005). Indexes based on the time spent by cow in different activities, specially resting and standing, have been used to assess animal welfare and comfort by several authors (Haley et al., 2000; Cook et al., 2004; Seyfi et al., 2015).

The way in which a barn is designed and constructed can allow or hinder animal's natural behaviors. There are several forms of dairy cow housing systems, among them free stall housing system has emerged as the dominant housing system in many different climates around the world (Cook et al., 2004). A free stall barn system is a barn plan that considered to improve the welfare of animals by providingcows' privetindividual space for resting and standing. Cows clearly prefer to rest on well cautioned surface and will spend more time resting in dry deep bedded stalls (Haley et al., 2001). However, some configuration of stalls (for example stall sizes, position of neck rail and brisket border

and dividers type) also have major effects on cow comfort and stall usage and a poorly designed and managed free stall barn can increase animal's discomfort and stress, indicated with increased time of standing, decreased resting time and increased lameness (Tucker et al., 2004; Tucker et al., 2005; Tucker et al., 2006). Besides the design of stalls, environmental conditions and herd management also can determine much of the variation in lying behavior of cows (Fergonesi et al., 2007). Krawczl, *et.al.* reported that during peak lying time, stall usage index decreased with increasing stocking density.
Several studies have shown that decreasing lying time of cows, leads to physiological changes accompanied with stress, finally have implications with different aspects of animal health. Cows experimentally prevented from lying down for 14 h day (Rushen, de Passille AMB, 1992) have been shown to have reduced plasma concentrations of growth hormone (Munksgaard, Lavendahl, 1993). Short term cost of reduced resting time may be 2-3 lb milk per hour of rest lost. Longer term costs include increased lameness and decreased reproductive performance (Stone, 2006).
The issue of cow comfort has received considerable interest within dairy industry (Leblanc et al., 2006). Unfortunately, our dairy industry is now suffering from traditional management or blindly acquisition of modern facilities. Producers spend millions of Rials building and renovating their barns with the aim of improving efficiency and health status of their dairy cows, but there has been little work done, especially in our country, to scientifically assess cow comfort on commercial farms and to allow producers to evaluate their own facilities. Itseems encouraging new researches to be focused on the effect of housing system up on animal welfare and health status is a necessity. The aim of this study was evaluation of resting behavior of dairy cattle as an indicator of cow comfort and efficiency of free stall housing system during two different climatic conditions.

Materials and Methods

Farm animalsand management

This study was conducted at a commercial Holstein dairy cattle farm with free stall housing system in Golestan province with 200 cattle. Lactating cows (60) and pregnant heifers (17-20) were kept in 3 pens equipped with total 78 stalls in two east-west rows (toward a side wall and toward manger alley). Stall rows had separated from alleys with a 15-20 cm rear curband were filled with sand. Every stall space wasconfined with super comfort dividers. Some configurations of stalls is summarized in table 1. Resting area of other cattle were straw yards and new born calves were kept in individual pens until weaning. Cows were fed a TMR ration and milked 3 times (at 4:00, 12:00 and 20:00) a day and average milk yield of herd was 23 Kg cow (Rushen J, de Passille AMB, 1992).

Table 1: Some dimensions of stalls and alleys in pens used by lactating cows

Stalls and alleys dimensions	Size (cm)
Stall length (toward side wall)	200
Stall length (toward alley)	200
Stall width	122
Neck rail height	110
Neck rail distance from rear curb	150
Alley width	350
Rear curb height	15
Dividers length	175

Video recording and data collection

Two pens of 25-28high (27 kg) and 30-35 low (20 kg) producing lactating cows were video recorded using two video cameras. Video recordings were include twenty 24-hour continuous periods (almost one day per week) in two different season (May-July and October-December 2013). Data for different behaviors (including standing in stalls, resting in stalls, standing in alleys, perching in stalls and resting in alleys) were collected using 30 minutes interval scanningthe 480 h video records. Once a cow observed resting or standing in one scan, it is considered doing the same until next scan (Seyfi, 2013). Data were analyzed in a 2×2 factorial experimentusing general linier model in SPSS (IBM SPSS Statistics 22).

Results

Comparisons of average time spent for different behaviors in different seasons and milk production groups are shown in table 2 and 3. Counteraction effects of season×milk production on behavioral variableswere not significant. Overall mean time spend resting in stalls in this study was 6.68±0.27 h/day. The results showed no differences between high producing cows and low producing cows in resting or standing behaviors, however, season of recording has a strong effect on resting behavior and stall usage. Cows spend more time resting in stalls in colder season thanin hot season, whilethey spend more timeresting in alleys (p<0.05, table 2). In addition, total resting time of cows also was significantly higher during autumn and winter than spring and summer (p<0.05, table 2).

Mean standing time in stall or alley and stall perching had no significant difference between two filming seasons or two production groups of cows (table 3). However, time spent standing in alleys in this experiment was extremely higher than reported amounts of this behavior by Cook *et.al.* (5.93 h/d *vs.* 2.4 h/d), instead, standing in stalls was relatively lower (1.00 h/d *vs.* 2.9 h/d) (Cook et al., 2004).

Table 2: Daily mean hours spent for resting in stall, resting in alley and total resting behaviors

Behavior	Factor		Mean (H/day/cow)	Std, Error	Significancy
Stall resting	Season	warm	5.57	0.31	0.000
		cold	7.78		
	production	high	6.54	0.31	0.525
		low	6.82		
Alley resting	Season	warm	2.49	0.12	0.000
		cold	1.41		
	production	high	1.95	0.12	1.000
		low	1.95		
Total resting	Season	warm	8.03	0.25	0.003
		cold	9.16		
	production	high	8.62	0.25	0.482
		low	8.88		

Mean standing time in stall or alley and stall perching had no significant difference between two filming seasons or two production groups of cows (table 3). However, time spent standing in alleys in this experiment was extremely higher than reported amounts of this behavior by Cook *et.al.* (5.93 h/d *vs.* 2.4 h/d), instead, standing in stalls was relatively lower (1.00 h/d *vs.* 2.9 h/d) (Cook et al., 2004).

Discussion

Observed overall mean time spend resting in stalls in this study was noticeably lower than 12-14 h rest requirement per day suggested by other authors (Cook et al., 2004; Stone, 2006; Chaplin, 2000).

This critical reduction in resting time of cows in this study is probably resulted by wrong or inappropriate design of stalls. Comparing the measured stall dimensions in this study (table 1) with the amounts proposed by Faull and Hughes and Anderson (120 cm width and 240 cm length from rear curb to brisket border), it is clearly predictable that stalls in this barn are not providing adequate space for normal resting position for mature Holstein cows, therefore are not preferred by cows for resting (Faull, Hughes, 1996; Anderson, 2003).

Table 3: Daily mean hours spent for standing in stall, standing in alley, perching in the stall and total standing behaviors

Behavior	factor		Mean (h/day/cow)	Std. Error	Significancy
Stall standing	Season	warm	1.03	0.09	0.627
		cold	0.96		
	production	high	1.00	0.09	0.911
		low	0.99		
Alley standing	Season	warm	6.05	0.16	0.276
		cold	5.80		
	production	high	6.02	0.16	0.431
		low	5.84		
Stall perching	Season	warm	0.84	0.07	0.919
		cold	0.85		
	production	high	0.80	0.07	0.363
		low	0.89		
Total standing	Season	warm	7.92	0.16	0.134
		cold	7.57		
	production	high	7.78	0.16	0.774
		low	7.71		

Inadequate lying surface is one of main factors influencing behavior of cows in free stall barns. In a survey in UK it has been found that 87 percent of stalls were too short, 50 percent of them were too wide or too narrow and only 12 percent of stalls permitted real freedom of movement. They also observed that fully 10 percent of cows showed moderately or severely restricted when lying down, 33 percent when rising and 55 percent when standing (Faull, Hughes, 1996). Absence or shortage of forward lying space in stalls also is a common problem in many free stall barn. Anderson observed that a mature Canadian Holstein cow needs a 60 cm space for forward lunge during lying down and standing up from rest position (Anderson, 2003). In this barn, one of free stall rows (toward side wall), actually do not have forward lying space. In such short stalls with front wall, cows will encounter serious problem while lying down and standing up, therefore will refuse to use these stalls next time. This provides more evidence to support our hypothesis about wrong. Ergonomic stalls must be designed to meet the requirement of each cow to obtain adequate rest, by performing natural lie down and stand up behavior. Designs which fail to provide for the movement of lying and rising, adequate resting space, or a cautioned surface will lead to reduced lying behavior to less than 10 h/d (Cook et al., 2004).

In agreement with our findings Seyfi studying dairy cow behavioral indexes during different seasons, reported that the cow comfort index and stall usage index were highest in winter, whereas the lowest values for these indexes observed during summer (Seyfi, 2015). Lee and Hillman also stated that once core body temperature reaches approximately 102°F mature Holstein cattle seek shade and stand rather than lie down (Lee, Hillman, 2007). Cook *et.al.* comparing among four filming sessions with mean daily average THI of 56-74 in mattress free stall barns, also observed a 3 hour per day increase in standing time between the coolest session and hottest session.

Increased resting time during colder seasons was not surprising; however, increased resting time in alleys during warmer seasons is alarming. This fact that during warm seasons many cows prefer to rest on wet and hard surface of alleys instead of soft and dry stalls, indicates a problem in general ventilation system of barn which is not provide enough cooling on stall rows. Another reason for reducing stall usage during warm probably interfere the air conduction in barn. Lendelova*et.al.* evaluated cow comfort index and stall usage index in different cooling systems (sprinkles and sprinkles plus vents) and found that animals from group without vents, which were less cooled were significantly more lying down in alleys (2.52 h/d vs. 0.56 h/d). Total time spend by lying in stalls and in alley (Lendelova et al., 2012). Low standing time in stalls beside relatively long time spent perching behavior in this barn (table 3), indicates a serious problem in stall design that makes it difficult for cows to stand normally in stalls. Comparing neck rail height and distance from rear curb in this barn (table 2) with recommended amounts (165-170 cm for first lactation and 170-175 cm for mature cows forward from rear curb and 110-115 cm height from surface of bedding), it can be deduced that neck rail of stalls in this barn is too restricting and disturbs normal standing behavior of cows. Tucker, et.al. showed that both the height of neck rail and its distance from the curb affect standing behavior of cows (Tucker, 2005). More restricting neck-rail (lower and closer to rear curb) prevents cows from standing fully in the stall and this in turn increases the time cows spend on concrete flooring elsewhere in the barn (Keyserlingk, Weary, 2009). Leonard *et. al.* also observed that free stalls with concrete surface and a restrictive divider design resulted in reduced lying time, increased periods spent perching in heifers two months after calving compared to heifers kept in a stall with greater space and more cautioned surface with less restrictive divider design (Leonard et al., 1994).

Several studies, particularly in UK, have suggested that very low lying times or excessive time spent standing, especially perching with front two feet on the stall platform and rear two feet in the alley, are significant risk factor for claw horn lesions and lameness (Leonard et al., 1994; Anisworth et al., 1989). Both of these make sense as increased weight bearing will put further pressure on the connection between the podal bone and claw horn capsule, potentially causing more damage to the sole.

Neck rail positioning is a critical aspect of stall management in free stall barns. Stalls should provide a clean, dry and also comfortable area for cows to lie down or stand. However, when cows stand fully in stalls, the risk of feces falling onto the stall surface increases. The common approach by dairy farmers to avoid of contamination of bedding has been to make the stalls more restricting by pulling back the neck rail. This will force cows back into the concrete alleys. Haskell *et.al.* reported that lameness and claw lesions are more common in free stall systems, especially where the cows have no access to pasture (Haskel et al., 2006). These researcher concluded that this is probably caused by standing too much on concrete alleys.

Based on these results, it can be concluded that many of the standards used to construction of free stall barns are probably inadequate for care of animals and needs total revision based on cow natural behaviors. Seifi studied area preference of dairy cows in free stall housing, and observed that cows clearly prefer open area to the free stalls for resting or standing, especially in summer (Seyfi, 2013). Based on these results, she suggested that new barn designs incorporate preferences and comfort of the cattle rather than high-cost equipment. The issueof cow ergonomics which concerns the improvement of cow health and performance through the careful design of animal house and environment, should be the main framework of future dairy cattle barn designs.

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