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The Effect of Straw Bedding Usage in Loose Housing Systems on Behavior and Milk Production of Holstein Dairy Cows

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Abstract: Thirty one Holstein Friesian cows were allocated to two groups. For a period of 7 weeks, twice a week, the behavior of each cow was registered for 9 h (07:00, 09.00, 10.00, 11.00, 13:00, 14.00, 15.00, 17.00 and 19:00 h) eating, drinking, ruminating, standing, resting, locomotor and other behaviors were recorded. The frequencies of eating, drinking, ruminating, standing, resting, locomotor and other behaviors for bedding and nonbedding usage groups were 32.9 and 34.6% ($p>0.05$); 1.7, 2.6% ($p<0.01$); 20.3 and 20.5% ($p>0.05$); 20.5 and 28.4% ($p<0.01$); 14.8 and 7.9% ($p<0.01$); 8.5 and 4.4% ($p<0.01$) and 1.7 and 1.5% ($p>0.05$), respectively. The percentage of the eating behavior of cows of the bedding group at 9:00, 11:00, 13:00 and 17:00 observations were higher than the nonbedding group, while the other results at different observation hours show reverse results. As a result, the amount of time cows spend resting is higher in the bedding group, which is considered to significantly influence their comfort level. Resting behavior is an indicator of animal welfare and as such, this result suggests that bedding usage in loose housing systems provides a more comfortable and socially interactive environment that satisfies conditions of a more positive animal experience.

Key words: Dairy cow, loose housing, behavior, milk yield, high producing, ruminating

INTRODUCTION

Cattle housing system can vary between tie stall to loose housing to provide more comfort to animals. One of the dairy farmer's problems is to obtain low-cost housing that serves the enterprise effectively by minimizing production costs, accommodating an optimum-size herd and providing facilities for the production of high-grade products. Proponents of both loose housing systems and conventional barns have claimed that their respective systems satisfy these requirements. Housing systems and bedding levels in particular can have a significant effect on cow comfort (Wechsler *et al*., 2000). A number of studies have examined the effects of housing environments on standing and resting behavior of cattle (Lidfors, 1989). Dairy cattle spend approximately, 8-16 h $days^{-1}$ resting (Dechamps *et al*., 1989) and between 35 and 175 min day^{-1} standing in free stalls (Stefanowska *et al*., 2001). Earlier research has shown that cattle spend more time engaged in head-swinging behavior when entering a lying area without bedding than a bedded area (Muller *et al*., 1989) and are twice as likely to interrupt the head-swinging behavior when, housed in a tie-stall system compared with a deep-bedded system or pasture (Ladewig and Smidt, 1989; Krohn and Munksgaard, 1993). Dairy cattle prefer heavily bedded concrete stalls to lightly bedded mats (Jensen *et al*., 1988; Manninen *et al*., 2002) and deep-bedded stalls are preferred to stalls with concrete or geotextile mattresses covered with 2-3 kg of sawdust (Muller and Botha, 1997; Tucker *et al*., 2003); preferences depend on many factors that involve cow comfort. With the introduction of loose housing system as an alternative housing system, a need has arisen for a study of behavior in this type of housing. Especially, bedding usage is a critical item in this type of housing system. The research on dairy cattle behavior in loose housing systems would provide valuable information to improve the effectiveness of loose housing.

This study was planned to observe the method of improving loose housing systems for comfort of high producing cows.

MATERIALS AND METHODS

The experiment was conducted at the Research and Training Farm of Cukurova University in Adana (37.01°N, 35.18°E) Province of Turkey. The recorded average temperature and humidity, respectively, for this location were 15.66°C, 74.79% at 07:00; 24.27°C, 44.21% at 13:00

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Table 1: Description of the recorded behavior of experimental cows

Observed behaviors	Description of behaviors
Eating	Eating feed mixture
Drinking	Drinking without any behavior
Ruminating	Only ruminating behavior during either standing or lying position
Standing	Standing without any body movement or behavior
Resting	Lying without ruminating activity
Locomotor activity	Body movements, grooming, sounding, sniffing, jumping and touching
Others	Defecation and urination, etc.

and 22.29°C, 51.86% at 18:00 in the 7 weeks observation period April-May 2007. Thirty one high producing (30 kg days^{-1}) Holstein Friesian cows in their second and third lactation were allocated to two experimental groups on the basis of straw bedding usage: group 1 (bedding) (n:17) and group 2 (nonbedding) (n:14). All cows were 100-150 days in their lactation periods. In this experiment, a bedded area, in which the straw bedding was changed daily was provided. Cows were milked two times a day at 04:00 and 16:00 h, using herringbone milking machine system. Group feeding was applied to cows *ad libitum* in concrete tray mangers (28.5 m group^{-1}, i.e., 0.71 m cow^{-1}). Concentrate feed (2600 kcal ME and 180 g crude protein kg^{-1}), maize silage and alfalfa hay were offered to cows as a mixture in a unifeed system 3 times a day (at 08:00, 11:00, 15:00 h) with free access to fresh water all day. Feed mixture included 30% concentrate feed, 60% silage and 10% alfalfa hay. Straw usage in the straw-bedded resting area was 8-13 kg/cow/day. A straw-bedded resting area size was 4 m^2 head^{-1} for milking cows. The floors in straw-bedded resting area were the same level at the paddock. Bedding was removed and reapplied and pens cleaned once each day during the morning and afternoon feedings (08:00) to maintain the appropriate amount of bedding on the surface, as there was no bedding retainer. Observations were made the uniformly in the two experiments. For each cow, behavioral observations were recorded at 10 min intervals twice a week for a period of 1 h at 07:00, 09:00, 10:00, 11.00, 13:00, 14:00, 15:00, 17:00 and 19:00 h the frequency of eating, drinking, ruminating, standing, resting, locomotion and others were recorded (Table 1) and registered by scan sampling (Altmann, 1974).

The bedding usage behavioral responses of dairy cows compared with nonparametric behavioral data were analyzed using Chi-square (SPSS for Windows, release 10.01), based on the count and frequency for nine observations. Each observation at 10 min intervals were performed (1st, 10th, 20th, 30th, 40th, 50th and 60th min) for 1 h. The proportional counts of behaviors were calculated according to each element's frequency to distinguish the difference between the groups. Milk production data were analyzed using ANOVA for each treatment week and also an analysis using ANOVA repeated measures was done to obtain treatment differences for the entire period.

RESULTS AND DISCUSSION

The daily activities of the groups, based on the percentage count for 1 h of observation, are presented in Table 2.

As shown in Table 2, eating, drinking, ruminating, standing, resting, locomotor and other behaviors of bedding and nonbedding cows were determined as 32.9% versus 34.6; 1.7% versus 2.6; 20.3% versus 20.5; 20.5% versus 28.4; 14.8% versus 7.9; 8.5% versus 4.4% and 1.7% versus 1.5%, respectively. Also, 13.44% cows prefer bedding area for resting, while just 1.46% cows prefer concenterte area for resting. In the nonbedding group, 28.4% cows prefer standing while, 7.90% prefer lying on the concrete floor.

The findings show significant similarity with research results (O'Connell and Meaney, 1997; Rushen *et al*., 2001; Wechsler *et al*., 2000; Manninen *et al*., 2002), which found that housing cows in large pens with a mattress flooring increased resting time by 4 h day^{-1} compared to housing them in tie stalls with concrete flooring. Also, Muller *et al*. (1989) found that cows in tie stalls without any bedding showed more investigation of the resting area, using sweeping head movements performed close to the floor, than cows in groups with bedding. Daily variation between the percentage of the groups was also determined, which was attributed to many factors such as, feeding, milking, diurnal behavioral changes, etc. (Albright, 1993; Osterman and Redbo, 2001; Muller *et al*., 1989; Pennington and Albright, 1985; Tyler *et al*., 1997). Osterman and Redbo (2001) reported that resting before milking may be uncomfortable or even more painful for the cow to be lying with a filled udder, since there is an external pressure and heat from the floor on the udder when lying. Especially at 15:00 pm, observations were made on half of the cows, while eating and on many cows, while resting.

The percentage of the eating behavior of cows for the bedding group increased from 4.17% (at 7:00 h) to 48.04% (at 9:00 h). The percentage of the ruminating behavior of

Table 2: The daily activities of the groups, based on the percentage count for 1 h of observation

Times	Groups	Eating	Drinking	Ruminating	Standing	Resting	Locomotor	Others
07:00	Bedding	4.17	0.37	27.33	17.52	44.24	4.29	2.08
	Nonbedding	12.30	2.58	33.33	30.36	18.25	1.98	1.19
	Chi-square	30.57	12.73	5.38	29.49	93.34	5.03	1.45
	p-values	<0.000	<0.000	<0.020	<0.000	<0.000	<0.025	NS
09:00	Bedding	48.04	2.57	11.64	21.32	5.64	8.70	2.08
	Nonbedding	33.33	3.37	24.40	28.37	4.76	3.57	2.18
	Chi-square	27.59	0.712	36.80	8.49	.475	13.04	0.015
	p-values	<0.000	NS	<0.000	<0.004	NS	<0.000	NS
10:00	Bedding	17.28	1.35	25.74	25.00	20.47	6.99	3.19
	Nonbedding	24.60	1.98	26.59	32.74	5.75	5.75	2.58
	Chi-square	10.42	0.805	0.117	9.26	53.333	0.776	0.400
	p-values	<0.001	NS	NS	<0.002	<0.000	NS	NS
11:00	Bedding	39.09	1.35	21.81	15.56	15.81	5.15	1.23
	Nonbedding	48.21	2.78	13.49	22.62	7.94	3.97	0.99
	Chi-square	10.60	3.43	14.23	10.39	17.30	0.967	0.15
	p-values	<0.001	NS	<0.000	<0.001	<0.000	NS	NS
13:00	Bedding	19.36	0.98	36.03	21.57	15.07	6.25	0.74
	Nonbedding	13.10	1.79	33.53	39.29	8.73	2.98	0.60
	Chi-square	8.69	1.59	0.853	48.16	11.35	7.03	0.09
	p-values	<0.003	NS	NS	<0.000	<0.001	<0.008	NS
14:00	Bedding	23.53	0.98	36.15	20.59	11.40	5.88	1.47
	Nonbedding	31.55	1.98	24.60	31.35	5.75	3.37	1.39
	Chi-square	10.26	2.33	19.18	19.40	11.83	4.19	0.02
	p-values	<0.001	NS	<0.001	<0.000	<0.001	<0.041	NS
15:00	Bedding	44.73	2.57	11.89	25.98	3.92	9.68	1.23
	Nonbedding	50.60	3.57	7.94	25.99	5.36	5.75	0.79
	Chi-square	4.30	1.08	5.23	0.000	1.50	6.40	0.554
	p-values	<0.038	NS	<0.023	NS	NS	<0.011	NS
17:00	Bedding	57.11	1.23	7.97	13.48	8.09	10.54	1.59
	Nonbedding	50.20	2.58	16.07	20.63	5.56	4.17	0.79
	Chi-square	5.99	3.33	2081	11.74	3.02	16.99	1.56
	p-values	<0.014	NS	<0.001	<0.001	NS	<0.000	NS
19:00	Bedding	43.14	4.04	9.93	15.93	11.15	13.60	2.21
	Nonbedding	47.62	3.77	10.52	17.46	10.52	7.74	2.38
	Chi-square	2.53	0.62	0.119	0.53	0.130	10.64	0.04
	p-values	NS	NS	NS	NS	NS	<0.001	NS
Pooled	Bedding	32.9	1.7	20.3	20.5	14.8	8.5	1.7
	Nonbedding	34.6	2.6	20.5	28.4	7.9	4.4	1.5
	Chi-square	3.521	13.55	0.773	101.811	127.090	57.176	1.827
	p-values	NS	<0.000	NS	<0.000	<0.000	<0.000	NS

NS: Not Significant

cows for the bedding groups were determined to be lower at 7:00 and 9:00 observation periods and higher till 15:00, decreasing to a low level in the bedding group. As shown in Table 2, bedding group cows showed more resting behavior during all observation periods except at 15.00 h ($p<0.00$). Although, bedding was provided to the cows, cows were milked at 16:00 and the cows did not prefer resting. Cattle clearly prefer a soft resting place rather than a hard one (Natzke *et al*., 1982; Herlin, 1997). For example, cattle kept on concrete floors tended to lie down or stand up less frequently and displayed more abnormal movements during these transitions than animals kept on straw (Andreae and Smidt, 1982). Normally cows should rest for 11-12 h each day, which approximates, the normal cud chewing time required to maintain a healthy rumen. It is felt that getting adequate rest impacts milk production in two ways: first, blood flow to the mammary gland improves 22% in cows resting versus standing. And second, stall comfort has a dramatic effect on reducing laminitis in cows even on the same diets (Colam-Ainsworth *et al*., 1989).

The weekly milk production mean of the groups during the experimental period are given in Table 3.

There are no decreases in the bedding group, while nonbedding groups decreased to 31.15 kg from 36.77 kg during the experimental period. The differences between the groups in the last week was determined to be statistically important ($p<0.024$), while the period effect was also important ($p<0.001$) at the milk production level of the groups.

Decreased resting times in bulls have been associated with increased levels of plasma cortisol, an indicator of stress (Munksgaard and Simonsen, 1995; Ladewig and Smidt, 1989). In addition, lower resting times can result in a reduction in the circulating growth hormone (Munksgaard and Løvendahl, 1993). This reduction in growth hormone may particularly be harmful in young, growing animals and may also be linked to a decrease in milk production (Hart *et al*., 1978).

Finally, blood flow to the udder is, on average, 28% higher when cows are resting compared to when

Table 3: Milk production changes during experimental weeks

	Weeks						
Groups	1	2	3	4	5	6	7
Bedding	35.28±1.33	36.35±1.24	35.25±1.10	35.08±1.30	34.68±1.45	34.64±1.38	35.86±1.25
Nonbedding	36.77±1.20	36.86±1.26	35.77±1.40	34.75±1.54	34.17±1.31	31.79±1.49	31.15±1.55
p-values	0.424	0.772	0.769	0.874	0.805	0.173	0.024*

standing (Metcalf *et al*., 1992). This increase in blood flow to the mammary gland provides precursors for the synthesis of milk components in the gland.

CONCLUSION

As a result, bedding usage in loose housing systems can be a good option to improve resting time of the cows, which is to keep high milk production level in intensive dairy farms.

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