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Effect of flooring types on cleanliness or hygiene score of various body regions (lower limbs, udder, upper limbs and flank) of crossbred cows under loose housing system

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Abstract
The present investigation was undertaken to study the effect of flooring types on hygiene score of various body regions (lower limbs, udder, upper limbs and flank) of crossbred cows under loose housing system. All the 21 experimental crossbred cows were randomly allotted into 3 treatment groups (n=7 each) *viz.* T0 (Concrete flooring), T1 (Rubber floor), T2 (Asphalt/bitumen flooring). The cow cleanliness or hygiene score for different body regions such as lower legs, udder, upper legs and flank with the degree of manure contamination was observed fortnightly by using cook's 4-point scale system. For lower limb score, there was significant (p<0.05) difference in overall mean between asphalt/bitumen floor with both concrete floor and rubber mat but no significant difference was seen between concrete and rubber mat floor. There was also significant (p<0.05) difference between asphalt/bitumen floor and both concrete floor and rubber mat but no significant difference was seen between concrete floor & rubber mat floor groups in overall mean of udder hygiene score. And lastly for upper limb & flank region hygiene score, there was significant difference (p<0.05) found in between asphalt/bitumen floor and both concrete floor and rubber mat. Therefore, cows kept on asphalt was cleaner when compared with concrete and rubber mat flooring in terms of hygiene score.

Keywords: Concrete floor, rubber mat, asphalt/bitumen floor, hygiene score

Introduction
Crossbred cows contribute a significant amount in milk production of the country. They are high milk yielder and also intolerance to heat, stress and more susceptible to management factors. Therefore, they required a good comfortable housing, management and welfare for optimum production performances. Flooring is one of the most important components in animal housing. It provides maximum comfort of cow needs of sufficient 50% of resting or lying time from its 24 hour (Krohn and Munksgaard, 1993) [8] which contributes in an optimal level of production. Floor hygiene is important concerns for cow's health, since it is the place where cow spends most of its time. Therefore, maximum care should be taken to maintain good floor hygiene. The hygiene or cleanliness of dairy cow also affects quality of the milk. Clean cows are less likely to contaminate the milk. The cleanliness of the animals depends on accessibility for clean lying area (Scott and Kelly, 1989) [11]. However, the frequency of cleaning impacts the availability of a dry and clean lying area (Fregonesi and Leaver, 2002) [7].

The defile in lower leg zone indicates the amount of manure cows be made walking in alleyways. The flank region & upper leg reflect contamination from lying in manure and in wet unclean and dirty area. The manure passes on from the lower legs and tail to the udder (Cook, 2002) [5]. The lower leg scores the dirtiest among upper leg, udder, belly and hind quarter (Upadhyay *et al.*, 2015) [14]. There is an association between clean housing, clean animals and lower herd bulk tank somatic cell counts (Bodoh *et al.*, 1976; Barkema *et al.*, 1998; Chaplin *et al.*, 2000) [2, 1, 4]. The somatic cell count rises with low hygienic condition of hind legs and udder (Schreiner and Ruegg, 2003; Reneau *et al.*, 2005) [10, 9]. The lying area have impact on udder health of the cows, so cleaning of udder, lower legs and other regions

are necessary before milking to prevent contamination of milk (Tucker *et al*., 2003) [13]. The overall hygiene of the herd is affected by housing design. Most importantly, the bedding material or floor surface should assist in minimizing soiling, water or urine retention, and improve cow comfort. This study was carried out to evaluate the effects of concrete, rubber and asphalt floors on the cleanliness or hygiene score of various body regions (lower limbs, udder, upper limbs and flank) of crossbred cows under loose housing system.

Materials and Methods

Location of Experiment

The study was conducted at Livestock Research Centre (LRC) of National Dairy Research Institute (NDRI), Karnal, India which is located at 29° 423' 20'' N and 76° 583' 52.5 sec E at an altitude of 834 feet above mean sea level. In summer, the maximum and minimum ambient temperature goes up to 45 ºC and down to 2 ºC respectively with diurnal variation of 15-20 ºC. The average annual rainfall is about 700mm, most of which is received from early July to mid-September.

Experiment Animals

For this experiment, 21 Karan Fries cows (Tharparkar X Holstein Friesian) in their early lactation were randomly selected and put in three treatment groups for the experiment. Groups were formed on the basis of their body weight, parity and milk production performance and seven cows in each group were kept. Initial recording of their body weight, gait score, hoof condition, limb lesions and cleanliness score was made. Blood samples and milk samples for all the animals were also collected during initial stage of experiment. The study was conducted for a period of eight months covering summer and winter seasons. All the cows were checked for any ailment before beginning of the experiment. During the experimental period routine health management practices of the farm was followed and sick cows were immediately taken to dispensary of LRC.

Housing Management

All the 21 experimental animals were kept in loose housing system with adequate slope for better drainage, feeding manger and water troughs as per BIS standard. It facilitates free movement and sufficient exercise to the animals. Cows kept in control group were provided with the existing housing facility of the LRC- farm i.e. both covered and open area with concrete floor and fans during hot humid season. The treatment group (T1) was provided with rubber mat on existing concrete floor both on covered and open area. In both covered and open area of the treatment group (T2), the cows was kept on asphalt floor or bitumen of 40mm thickness. The cows under the treatment groups i.e. T1 and T2, were also provided fans during hot season as in control group.

Feeding and Milking Management

All the cows were fed *ad-libitum* fodders (Maize, Jowar, Cowpea, Berseem and Oats) supplied daily by Forage Production Section, of the institute as per as availability with season. The concentrate mixture was offered in morning hour around 8.00 AM and the chaffed green fodder was offered at around 10.00 AM. All the cows were machine milked, twice daily i.e., in morning (5.00 to 6.00 AM) and evening (5.00 to 6.00 PM). The pulsators were adjusted to give a pulsation rate of around 50 pulsations per minute with the uniform vacuum level of 400 mm Hg. After washing the cows each cow stimulated for letdown for one minute before connecting the milking machine. Daily milk yield and total milk yield of all experimental cows was recorded till the end of experiment. Milk yield of individual cow was displayed on the automatic milking machine system in the herringbone parlor while milking of cows. It was recorded in the morning and evening separately and added to obtain total milk yield of the day for each animal

Cleanliness/Hygiene Scoring of Cows

All the animals were examined for hygiene score fortnightly using 4-point scale system (Cook, 2002) [5] with the degree of manure contamination in 3 major areas (lower legs, udder, upper legs and flank). Before hygiene score examination, cleaning and washing of all the animals mostly the three major regions score was done at early morning and scoring was performed at evening before milking every fortnightly

Table 1: Cleanliness/Hygiene score of cows

Score	Description of contamination of dung		
	Lower leg	**Udder**	**Upper leg and flank**
1	Little or no manure/dung	No manure present	No manure
2	Minor splashing	Minor splashing of manure near teats	Minor splashing of manure
3	Distinct plaques of manure but visible with leg hair	Distinct plaques of manure on the lower half of the udder	Distinct plaques of manure with hair showing through
4	Solid plaque of manure extending high up the leg	Confluent plaques of manure encrusted on and around teats	Confluent plaques of manure

Cook, (2002) [5]

Statistical Analysis

The data obtained in the present study were analyzed by one-way ANOVA (analysis of variance) as per the methods described by Snedecor and Cochran (1994) [12] and the significance of the difference between the mean values of various parameters was determined by Duncan's Multiple Range test using SPSS (version 20.0) computer software. All data were presented as Mean ± SE.

Results and Discussion

Cleanliness or Hygiene Score of Lower Leg Region of Cows

The effect of different floor types on lower limbs hygiene score of crossbred cows is presented in table 2 and figure 1. There was significant difference ($p<0.05$) between concrete floor and asphalt/bitumen floor and also in between rubber mat floor and asphalt/bitumen floor, but there was no significant difference ($p>0.05$) between concrete floor and

rubber mat floor during 5th and 6th,7th 12th 13th,14th, 16th fortnight. There was also significant difference (p<0.05) in between concrete floor and asphalt/bitumen floor, but there was no significant difference (p>0.05) between concrete floor and rubber mat floor and in between rubber mat floor and asphalt/bitumen floor during 8th,10th,11th, 15th fortnight. Rubber mat score for lower leg hygiene was highest between treatment as there was more accumulation of dung under and in-between the mat and also it took time and laborious work during cleaning. However, there were no significant difference (p>0.05) observed in between all the three groups from 1st to 4th, 9th, 17th and to 18th fortnights. The overall mean of lower limb hygiene score for crossbred cows on concrete, rubber mat and asphalt floor were 3.16±0.08, 3.26±0.08 and 2.61±0.12, respectively. There was significant difference (p<0.05) in between asphalt/bitumen floor with both concrete floor and rubber mat but no significant difference (p>0.05) was seen in between concrete floor and rubber mat floor.

Cleanliness or Hygiene Score of Udder Region of Cows

Effect of different floor types on udder hygiene of crossbred cows is presented in table 3 and figure 2. Study revealed that there was significant difference (p<0.05) in between rubber mat floor and asphalt/bitumen floor, but there was no significant difference (p>0.05) between concrete floor and rubber mat and also in-between concrete floor and asphalt/bitumen during 2nd, 6th, 7th,14th fortnight. There were also significant difference (p<0.05) in between concrete floor and asphalt/bitumen floor and also in between rubber mat floor and asphalt/bitumen floor, but no significant difference (p>0.05) was seen between concrete floor and rubber mat floor during 4th and 5th fortnight. There was significant difference (p<0.05) in between concrete floor and asphalt/bitumen floor, but no significant difference (p>0.05) between concrete floor and rubber mat floor and in between rubber mat floor and asphalt/bitumen floor during 8th, 18th fortnight. There were again significant difference (p<0.05) in between concrete floor and rubber mat floor and in between rubber mat floor and asphalt/bitumen floor, but no significant difference (p>0.05) observed between concrete floor and asphalt/bitumen floor during 10th fortnight. The hygiene score of rubber mat cows scored higher than bitumen as cow dung tends to accumulate under the rubber mat even after cleaning, making it unhygienic to udder. However, there was no significant difference (p>0.05) observed in between all the three groups at 1st, 9th, 11th, 12th, 13th, 15th, 16th, and 17th fortnights. The overall mean of udder hygiene score for crossbred cows on concrete, rubber mat and asphalt floor were 2.78±0.05, 2.95±0.09 and 2.32±0.11, respectively. There was significant difference (p<0.05) in between asphalt/bitumen floor with both concrete floor and rubber mat but no significant difference (p>0.05) was seen in between concrete floor and rubber mat floor.

Cleanliness or Hygiene Score of Upper Legs and Flank Region of Cows

The Effect of different floor types on upper limbs and flank hygiene of crossbred cows is presented in table 4 and figure 3. There were also significant difference (p<0.05) in between concrete floor and asphalt/bitumen floor, but there was no significant difference (p>0.05) between concrete floor and rubber mat floor and in between rubber mat floor and asphalt/bitumen floor during 1st,3th,5th,6th,7th fortnights. There was also significant difference (p<0.05) in between rubber mat floor and asphalt/bitumen floor, but there was no significant difference (p>0.05) between concrete floor and rubber mat floor and also between concrete floor and asphalt/bitumen floor during 10th, 11th, 12th and 17th fortnight. There were also significant difference (p<0.05) in between concrete floor and asphalt/bitumen floor and also in between rubber mat floor and asphalt/bitumen floor, but there was no significant difference (p>0.05) between concrete floor and rubber mat floor during 13th and 15th fortnight. The upper legs and flank region of cows kept on asphalt floor were cleaner than the other two treatment floors. It might be due to easy cleaning process of asphalt as there was no retention of slurry manure. However, there were no significant difference (p>0.05) in between all the three groups at 2nd, 8th, 9th, 14th and 16th fortnights. The overall mean of upper limb and flank score for crossbred cows on concrete, rubber mat and asphalt floor were 2.69±0.18, 2.79±0.06 and 2.03±0.08, respectively. There was significant difference (p<0.05) in between asphalt/bitumen floor with both concrete floor and rubber mat but no significant difference (p>0.05) was seen in between concrete floor and rubber mat floor.

In the experiment, hygiene score of lower leg was found dirtiest among various body parts (lower limbs, udder, upper limbs and flank) regions, irrespective of the floor. It may be due to the reason of lower leg remained in contact frequently with the floor than other regions of the body. The contamination of lower leg zone is the indication of amount of manure cows have to walk (Cook, 2002) [5]. In this study, cows on concrete and rubber mat floor showed high similar score in lower legs, udder, upper legs and flank regions. The study is supported by Boyle *et al*. (2005) [3] who reported that rubber flooring was as dirty as the concrete floor. From the lower legs and tail the manure gets transferred ultimately to the udder. The contamination of upper leg and flank zone results from lying in manure in wet unhygienic dirt lots. The cost of poor hygiene for dairy cows reflects in the high risk of mastitis and lameness (Cook, 2002) [5]. Constantly in contact with urine and feces, the claws become susceptible to infection and later cause lameness (Vermunt and Greenough 1994) [15]. In present study, the result of hygiene score in various body regions of cows kept in asphalt/bitumen floor were superior among the other floors. This might be due to the characteristic of asphalt material as it is smooth, easy to clean, absorb and no retention of water and urine (EAPA, 2007) [6]. In this respect, asphalt/bitumen floor was superior in this study for hygiene score.

Table 2: Effect of different floor types on lower limbs hygiene of crossbred cows

Fortnight	Concrete	Rubber mat	Asphalt/bitumen
1	2.71±0.18	2.86±0.14	2.29±0.18
2	2.43±0.30	2.71±0.18	2.14±0.14
3	3.71±0.18	3.86±0.14	3.29±0.18
4	3.57±0.20	3.71±0.18	3.14±0.26
5	3.71^{b}±0.18	3.86^{b}±0.14	3.14^{a}±0.14
6	3.86^{b}±0.14	3.86^{b}±0.14	3.14^{a}±0.14
7	3.43^{b}±0.20	3.57^{b}±0.20	2.86^{a}±0.14
8	3.57^{b}±0.20	3.43^{ab}±0.20	2.71^{a}±0.18
9	3.43±0.20	3.43±0.20	2.86±0.26
10	3.29^{b}±0.18	3.43^{ab}±0.20	2.71^{a}±0.18
11	3.29^{b}±0.18	3.43^{ab}±0.20	2.57^{a}±0.20
12	3.14^{b}±0.14	3.29^{b}±0.18	2.43^{a}±0.20
13	3.14^{b}±0.14	3.29^{b}±0.18	2.43^{a}±0.20
14	2.86^{b}±0.14	3.14^{b}±0.14	2.29^{a}±0.18
15	2.86^{b}±0.14	2.71^{ab}±0.18	2.29^{a}±0.18
16	2.71^{b}±0.18	2.86^{b}±0.14	2.14^{a}±0.14
17	2.57±0.20	2.86±0.14	2.29±0.18
18	2.71±0.18	2.57±0.20	2.14±0.14
Overall mean	3.16^{b}±0.08	3.26^{b}±0.08	2.61^{a}±0.12

a,b, Means bearing different superscripts in a row differ significantly (p<0.05)

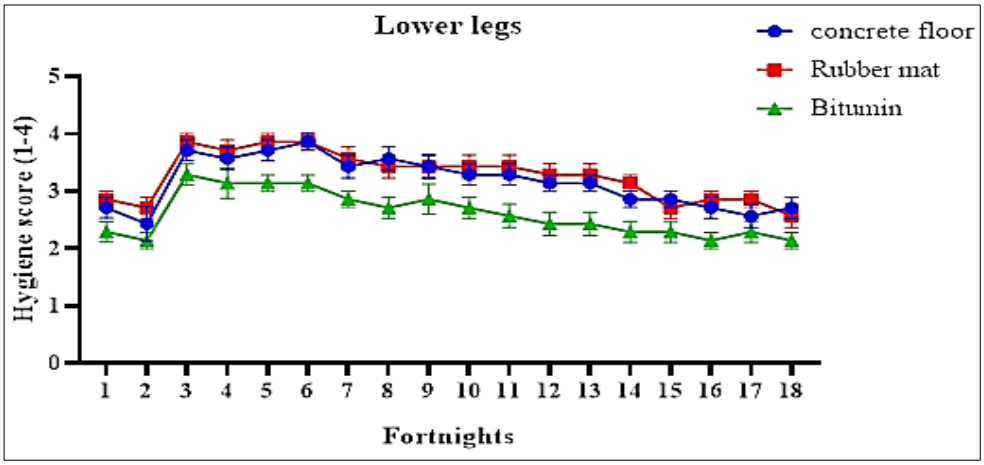

Fig 1: Fortnightly lower leg hygiene score of cows on different floors

Table 3: Effect of different floor types on udder hygiene of crossbred cows

Fortnight	Concrete	Rubber mat	Asphalt/bitumen
1	2.29±0.18	2.43±0.20	2.29±0.18
2	2.43^{ab}±0.20	2.57^{b}±0.20	1.57^{a}±0.20
3	3.29±0.18	3.57±0.20	3.14±0.14
4	3.43^{b}±0.20	3.43^{b}±0.20	2.71^{a}±0.18
5	3.29^{b}±0.18	3.57^{b}±0.20	2.86^{a}±0.14
6	3.29^{ab}±0.18	3.71^{b}±0.18	2.86^{a}±0.26
7	3.14^{ab}±0.14	3.43^{b}±0.20	2.71^{a}±0.18
8	3.29^{b}±0.18	3.14^{ab}±0.14	2.57^{a}±0.20
9	3.00±0.22	3.29±0.18	2.57±0.20
10	2.86^{a}±0.14	3.14^{b}±0.14	2.43^{a}±0.20
11	2.86±0.26	3.14±0.14	2.43±0.20
12	2.71±0.18	2.71±0.18	2.29±0.29
13	2.57±0.20	2.71±0.18	2.29±0.18
14	2.43^{ab}±0.20	2.86^{b}±0.14	2.14^{a}±0.14
15	2.43±0.20	2.43±0.20	1.86±0.14
16	2.29±0.18	2.57±0.30	1.86±0.14
17	2.29±0.18	2.29±0.18	1.71±0.18
18	2.29^{b}±0.18	2.14^{ab}±0.14	1.57^{a}±0.20
Overall mean	2.78^{b}±0.05	2.95^{b}±0.09	2.32^{a}±0.11

a,b, Means bearing different superscripts in a row differ significantly (p<0.05)

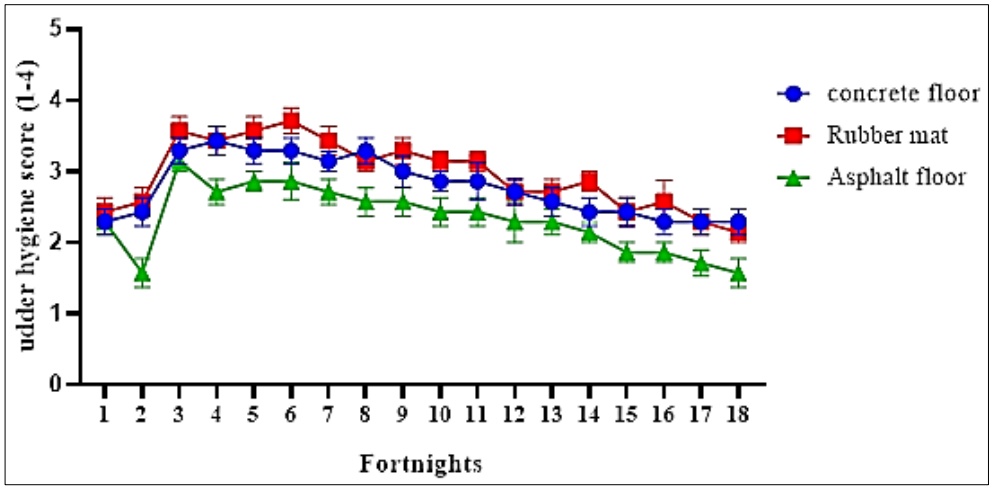

Fig 2: Fortnightly udder hygiene score of cows on different floors

Table 4: Effect of different floor types on upper limbs and flank hygiene of crossbred cows

Fortnight	Concrete	Rubber mat	Asphalt/bitumen
1	2.57^{b}±0.20	2.71^{ab}±0.18	1.71^{a}±0.18
2	2.14±0.26	2.14±0.14	1.86±0.14
3	3.57^{b}±0.20	3.71^{ab}±0.18	2.71^{a}±0.18
4	3.29±0.18	3.29±0.18	2.86±0.14
5	3.57^{b}±0.20	3.43^{ab}±0.20	2.57^{a}±0.20
6	3.71^{b}±0.18	3.43^{ab}±0.20	2.71^{a}±0.18
7	3.29^{b}±0.18	3.14^{ab}±0.14	2.57^{a}±0.20
8	2.86±0.14	2.71±0.29	2.43±0.20
9	2.86±0.14	3.14±0.14	2.43±0.30
10	2.71^{ab}±0.18	3.00^{b}±0.22	2.14^{a}±0.26
11	2.57^{ab}±0.20	2.86^{b}±0.14	1.86^{a}±0.14
12	2.43^{ab}±0.20	2.57^{b}±0.20	1.71^{a}±0.18
13	2.43^{b}±0.20	2.43^{b}±0.20	1.57^{a}±0.20
14	2.29±0.18	2.29±0.18	1.71±0.18
15	2.29^{b}±0.18	2.14^{b}±0.14	1.29^{a}±0.18
16	1.86±0.26	2.00±0.22	1.43±0.20
17	2.14^{ab}±0.26	2.86^{b}±0.14	1.57^{a}±0.20
18	1.86±0.26	2.43±0.30	1.43±0.20
Overall mean	2.69^{b}±0.18	2.79^{b}±0.06	2.03^{a}±0.08

^{a,b,} Means bearing different superscripts in a row differ significantly (p<0.05)

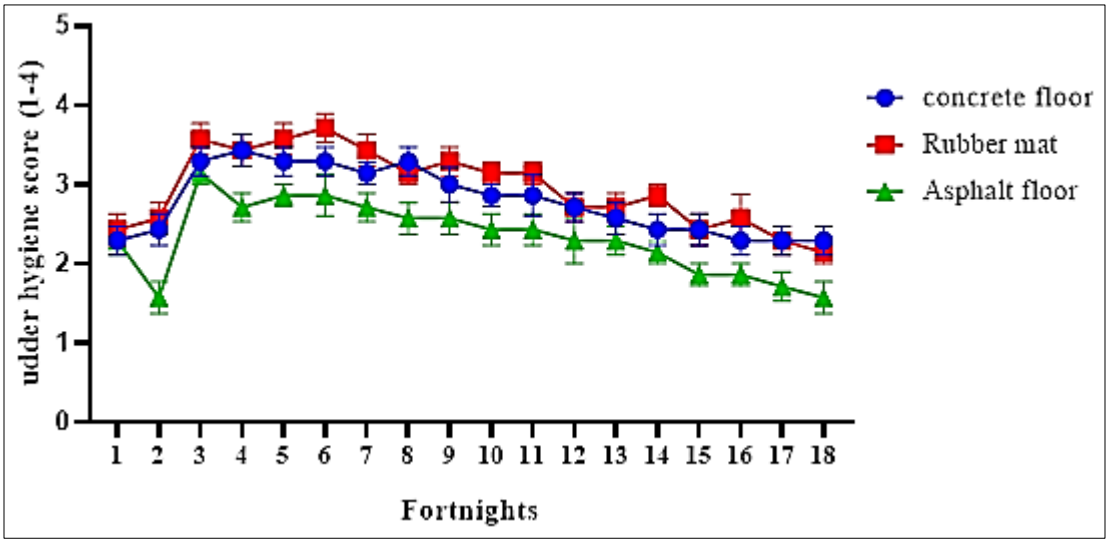

Fig 3: Fortnightly upper leg and flank hygiene score of cows on different floors

Conclusion

The finding of the present experiment shows that cows kept on asphalt floor showed more cleaner i.e., less splashing of manure on their region of lower legs, udder, upper legs & flank region when compare among the groups. Asphalt flooring was found superior in hygiene score over rubber mat bedding and concrete as an alternative flooring material. Therefore, it may be recommended that asphalt floor can be

used as an alternative flooring material for housing dairy cows and maintaining optimal production and their welfare. Yet more studies can be conducted to further support the use of asphalt flooring and its effect on cleanliness of cows.

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