



Effect of flooring on growth performance, behaviour, health and economics in Surti buffalo calves during winter

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ABSTRACT

Surti buffalo calves (25) of an average 63.52 ± 6.01 days age and 49.68 ± 2.16 Kg weight were randomly divided into 5 homogeneous treatment group of floor types, viz. Concrete floor (CC), *Kachcha* soil floor without bedding (SOIL), Concrete floor with paddy straw bedding (CC+PS), *Kachcha* soil floor with paddy straw bedding (SOIL+PS) and Rubber mat bedding (RM) as per Latin Square Design (LSD) for 60 days. DM intake and body weight were recorded at fortnightly interval. The behavioural parameters of the calves were studied by four instantaneous observations for three days in a week. Faecal consistency scoring and eye scoring was recorded as per standard method. Average daily gain (ADG) was highest in SOIL+PS (424.00 g) and lowest in CC (294.80 g). The pooled concentrate, roughage, milk and total DMI was 0.93 ± 0.04 , 0.92 ± 0.05 , 0.22 ± 0.01 and 2.07 ± 0.07 kg/day, respectively. Highest concentrate intake was in CC group whereas lowest was in SOIL group. Roughage intake was higher in SOIL+PS and CC+PS in which paddy straw was used. Behavioural parameters like cross grooming, licking of floor, playfulness by running/fighting and smelling were statistically ($P < 0.05$) significant amongst treatment group. Significantly higher numbers of calves were found in standing position in CC group as compared to other groups indicating altered comfort zone. The mean faecal consistency score was lower ($P < 0.05$) in SOIL+PS, RM and CC+PS group than SOIL and CC group. However, mean eye score remained statistically non-significant amongst treatment. Thus, paddy straw bedding during winter proved to be most effective either on concrete or soil surface as it overall increases growth performance and welfare of calves.

Key words: Average daily gain, Behaviour, Buffalo calf, Concrete, Feed efficiency, Floor, Paddy straw, Rubber mat

The success of dairy enterprise mainly depends upon calves reared successfully upto a breedable age. Dairy farmers can get sufficient and quick replacement of their animals if their calf rearing has minimum mortality rate and maximum growth rate. The loss of calf will also cease the lactation of most of buffaloes in India, hence, causing heavy economic loss. Calves with poor growth rate require longer time to reach maturity than healthy stock which increase age at first calving (AFC) and reduce profitability. Winter is crucial period for newborn calves for occurrence of diseases and mortality. Furthermore, new born calf does not have sufficient body fat content for heat production that can protect them from severe cold stress as a consequence burning body fat for heat production can lead to decreased growth rate, compromised immune status and even death.

Therefore, flooring should have insulation property at least in winter months. Bare concrete flooring has no insulation property, hence, it is not suitable in calf shed during winter. Comfortable housing with proper flooring is essential for adequate rest, sleep and to exhibit normal behaviours of calves. Adequate rest and sleep is essential for the welfare of growing animals (Siegel 2005). There is positive correlation between resting time and body weight gain in growing cattle (Mogensen *et al.* 1997). The alternate or modification to concrete floor particularly in winter is having great role. Straw is the choice of bedding as it is easily available and has good insulation property. However, due to shortage of dry fodder, farmers are widely using bare concrete flooring. Concrete flooring is hygienic and maintenance free but cause abnormal standing, lying and transitional movements, as well as reduced traction, which can lead to injuries (Cozzi *et al.* 2013). When given the choice, cattle prefer other flooring substrates, such as straw, wood chips or rubber mats as compared to concrete (Schutz and Cox 2014). The insulation property and softness of bedding material protects the young ones during extreme cold weather. Therefore, the appropriate floor and bedding material for calves have to be provided in calf shed. However, due to shortage of dry fodder, in recent years,

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rubber mats and wooden slats have also begun to use as alternative flooring materials. Impact of the various flooring materials on the dairy performance, welfare and health of the cows were investigated by several researchers (Tucker *et al.* 2003, Vanegas *et al.* 2006, Norring *et al.* 2010) drawing conclusions that dairy cows had a preference for rubber mats in their stalls and the animals had lower incidence of claw lesions and clinical lameness that is of crucial importance for dairy performance, longevity of the cows and for production economy. However, there is lack of comparative study investigating the effect of different flooring materials on the growth performance and welfare of the early weaned buffalo calves. Therefore, the present study was carried out to investigate the effects of the various flooring materials on the growth rate and behavioural characteristics of Surti buffalo calves.

MATERIALS AND METHODS

Location of experiment: The present experiment was conducted at Livestock Research Station, Navsari agricultural university, Navsari, Gujarat. The minimum and maximum temperature during experimental duration was between 13.3–18.1°C and 30.8–35.0°C, respectively.

Animals, experimental design and diet: Surti buffalo calves (11 male and 14 female) were divided into five homogeneous groups based on two way randomization according to age and body weight as per Latin Square Design (LSD) for 60 days. The average age and body weight of calves were 63.52±6.01 days and 49.68±2.16 kg, respectively which was non-significant among the groups. The floor types under testing were: Concrete floor (CC), *Kachcha* soil floor without bedding (SOIL), Concrete floor with paddy straw bedding (CC+PS), *Kachcha* soil floor with paddy straw bedding (SOIL+PS) and Rubber mat bedding (RM). Calves under all five treatments were kept in their respective pens (3 m × 3 m) throughout experimental period except milking time (3.30 to 6.30 AM and 3.30 to 6.30 PM) for suckling to their dams. Calves were fed compound concentrate once and good quality chaffed mixture of green and dry fodder twice a day. All the calves were weighed on electronic balance in morning before suckling and after suckling at fortnightly interval to measure milk intake. Feed intake was measured fortnightly. Animals had *ad lib.* access to drinking water. All routine operations like deworming, vaccination, weighing etc. carried out regularly. The paddy straw as litter materials were changed once in a week. The size of rubber mat used was 120 cm × 180 cm × 0.15 cm. Representative samples of feed and leftover were subjected for proximate analysis as per AOAC (2000).

Behaviour: The behaviours of the calves were studied by instantaneous sampling of one researcher by walking around the calf shed. Animals were identified by numbers given on neck belts. The behaviours described by Hepola *et al.* (2006) presented in Table 1 were studied. The behaviours were classified as oral, other and lying. Four observations were taken in a day during 07.00–9.00, 10.00–12.00, 13.00–14.00, and 16.00–17.00 h for three days in a

Table 1. Definitions of various behavioural activities studied

Name of activity	Definition
<i>Oral behaviours</i>	
Self grooming	Calf licking any part of itself
Cross grooming	Calf's tongue touching any part of another calf
Suckling of scrotum	Calf's tongue touching any part of scrotum of male pen mate
Tongue rolling	Calf rolling its tongue outside the mouth
Licking floor	Calf's tongue touching any part floor
<i>Other behaviours</i>	
Playfulness by fighting	Calf fight each other as a part of playfulness
Playfulness by running	Calf run behind pen mates as a part of playfulness
Smelling	Calf smells ground or parts of pen mates
<i>Lying behaviours</i>	
Standing	Calves stands on their foots
Sitting	Calves rested on sternum
Lying	Calves rested on their sides
Huddling	Two or more calves sit together in which most of their body parts touches each other.

week. Total 101 observations for 5 calves in each treatment were recorded. During each observation number of calves performed or not performed predefined activity were counted and recorded. Calf scour is one of the main causes of calf mortality in calves. It can be diagnosed by observing the consistency of faeces. Respiratory disease is the second most common factor related to calf mortality (Love *et al.* 2016). The severity of respiratory diseases can be judged based on degree of secretion eyes, nose and ears. Faecal consistency scoring (1, normal; 2, pasty; 3, loose stay on top bedding and 4, watery, seeps through bedding) and Eye scoring (1, none; 2, small amount of ocular discharge; 3, moderate amount of bilateral discharge and 4, heavy ocular discharge) were recorded fortnightly as per Calvo-Lorenzo *et al.* (2016).

Statistical analysis: The data were subjected for analysis as per Snedecor and Cochran (1989). The mean body weight, ADG, eye/faecal score and cost parameters were analyzed as per the standard techniques of Latin square design in which body weight and age of calves was arranged in rows and columns, respectively by using multivariate test under general linear model in IBM SPSS 25. The Duncan's post hoc test was used to compare various means. The data related to resting frequencies and various behaviours frequencies were analyzed by using chi square test in crosstabs menu in descriptive statistics in IBM SPSS 25.

RESULTS AND DISCUSSION

Feeding of calves: All the calves were allowed to suck their dam in morning and evening before milking. They were offered with concentrate, finely chaffed hybrid jowar and dry jowar straw twice a day. Chemical composition and nutritive value of feed offered is given in Table 2.

Growth performance of calves: Effect of floor types on

Table 2. Chemical composition of feed offered (On % DM basis)

	Concentrate	Green fodder (Hybrid jowar)	Dry fodder (Jowar straw)
Organic matter	97.10	92.30	89.40
Crude Protein	22.60	05.40	03.10
Crude fibre	09.90	24.60	35.70
Ether extract	05.20	01.80	01.10
NFE	59.40	60.50	49.40
Total Ash	02.90	07.70	10.60

ADG and DMI in Surti buffalo calves is presented in Table 3. Table reveals that ADG (g/d) was significantly ($P<0.05$) higher in SOIL+PS (424.00 g), CC+PS (400.20 g) and RM (373.00 g) as compared to CC (294.80 g). Bedding with either paddy straw or rubber mat might have increased the comfort zone of calves, thus, better ADG was revealed in all treatment groups in compared to CC. Madke *et al.* (2010) found higher ADG in Karanfries calves kept on floor bedded with paddy straw as compared to rubber mat or CC floor. Keane *et al.* (2017) found higher ADG in crossbred heifers kept on straw bedded floor than concrete slated floor. Similar results were found by various researchers (Yanar *et al.* 2010; Kartal and Yanar 2011) with better ADG in on crossbred calves kept on wooden slated floor than rubber mat floor. Surprisingly they found better ADG in calves kept on concrete floor than those on rubber mat as they observed more dirtiness in rubber mat floor than concrete floor. The dirt in litter or floor has more significance in case of exotic or crossbred cattle. However, wet litter may not be having negative effects on buffalo calves in present study, hence, ADG was found better in rubber mat group than CC group. The concentrate, roughage, milk and total dry matter intake is depicted in Table 3. Highest concentrate intake was revealed in CC group whereas lowest was in SOIL group. Roughage intake was significantly ($P<0.05$) higher in SOIL+PS treatment and was lowest in CC. Roughage intake was higher in both treatments (SOIL+PS and CC+PS) in which paddy straw used. The calves housed on straw bedding started nibbling at very early age, hence,

they starts to eat roughage at early age. This may be reason for higher roughage intake in these groups of calves housed on paddy straw bedding. The milk intake was higher in SOIL and lowest in CC group. However, Total DMI was non-significant amongst treatments. Panivivat *et al.* (2003) revealed that calves housed on rice hulls have higher starter intake than wood shavings and sand. They also found better DMI in calves kept on either long wheat straw or rice hulls than sand floor. Earley *et al.* (2015) revealed that there was no difference in total DMI in steers housed on different floor types.

Oral and other behaviours: Effect of floor types on frequency of various behaviours in Surti buffalo calves is presented in Table 4. Cross grooming, licking of floor, playfulness by running/fighting and smelling were statistically significant ($P<0.05$) amongst treatment groups. The cross grooming activity was found highest (6.1%) in CC group and lowest (1.2%) in RM group. Licking of floor is associated with disease transmission; hence, it is not desirable. It was found less in floor topped with paddy straw. Kumar (2008) revealed that the calves housed in pen bedded with straw have exhibited less abnormal behaviours. Playfulness behaviours were much exhibited in calves kept on soil floor with or without straw bedding. As soil floor is much softer calves likes to play on them. The frequencies of different oral and other activities observed in present study were higher than reported by Hepola *et al.* (2006). Tongue rolling was observed non-significant between groups. Suckling of scrotum and smelling were found rarely in all the treatment under study. Generally tongue rolling and sucking of scrotum were often seen in neonatal calves fed only with milk. It may be due to stronger sucking reflex in neonatal calves. Sometimes smelling of milk in their mouth when not washed properly promotes suckling of scrotum, ears of other pen mates. Playfulness by fighting or running was observed higher in both soil groups. Hepola *et al.* (2006) shown that the behaviours of calves was affected by change in bedding.

The huddling was more frequent in concrete groups than soil groups. Concrete surface is being cold and it has less insulation property, therefore, calves huddles to protect them

Table 3. Effect of floor types on ADG (g/d) and DMI (kg/d) in Surti buffalo calves

Parameter	CC	SOIL	CC+PS	SOIL+PS	RM	P value		
						Row (BW)	Column (Age)	Treatment
<i>BW and ADG</i>								
Initial BW	54.40 ±7.22	46.80±1.86	47.00 ±5.52	48.80 ±2.62	51.40 ±6.10	0.598	0.648	0.841
Final BW	71.80 ±7.35	68.00±2.61	70.60 ±5.63	73.80 ±3.27	73.40 ±6.14	0.666	0.557	0.949
ADG	294.80 ^a ±13.82	359.40 ^{ab} ±21.10	400.20 ^b ±15.77	424.00 ^b ±19.39	373.00 ^b ±22.81	0.661	0.107	0.003
<i>Dry matter intake</i>								
Concentrate Intake	1.05±0.07	0.79±0.04	0.89±0.01	0.93±0.04	1.02±0.11	0.289	0.760	0.184
Roughage intake	0.75±0.11	0.88±0.05	1.02 ±0.13	1.15±0.06	0.83 ±0.07	0.775	0.971	0.091
Milk intake	0.18 ^a ±0.01	0.25 ^b ±0.01	0.21 ^{ab} ±0.02	0.23 ^{ab} ±0.02	0.23 ^{ab} ±0.02	0.452	0.891	0.023
Total DMI	1.97±0.17	1.92±0.07	2.11 ±0.21	2.30 ±0.09	2.07 ±0.18	0.528	0.889	0.534

Mean values with different superscript within a row differ significantly.

Table 4. Effect of floor types on frequency of behaviours in Surti buffalo calves (n=505/treatment)

Name of activity	Treatment					Total	Chi square value
	CC	SOIL	CC+PS	SOIL+PS	RM		
Self grooming	33 (6.5)	38 (7.5)	38 (7.5)	33 (6.5)	33 (6.5)	175 (6.9)	0.92
Cross grooming	31 (6.1)	10 (2.0)	18 (3.6)	22 (4.4)	6 (1.2)	87 (3.4)	23.29*
Suckling of scrotum	6 (1.2)	5 (1.0)	4 (8.0)	13 (2.6)	6 (1.2)	34 (1.3)	7.57
Tongue rolling	27 (5.5)	20 (4.0)	36 (7.0)	29 (5.7)	18 (3.6)	130 (5.2)	7.49
Licking floor	52 (10.3)	24 (4.8)	10 (2.0)	10 (2.0)	65 (12.9)	151 (6.0)	107.23*
Playfulness by fighting	9 (1.8)	21 (4.2)	20 (4.0)	31 (6.1)	15 (3.0)	96 (3.8)	14.34*
Playfulness by running	9 (1.8)	26 (5.1)	15 (3.0)	22 (4.4)	11 (2.2)	83 (3.3)	13.03*
Smelling	9 (1.8)	18 (3.6)	2 (4.0)	5 (1.0)	4 (0.8)	38 (1.5)	21.54*
Huddling	22 (25.9)	12 (14.1)	18 (21.2)	14 (16.5)	19 (22.4)	85 (14.1)	4.53

*Significant ($P<0.05$); NB, Figures in parenthesis is percentage value.

from cold. The results of our study illustrate the importance of providing a dry bedded lying surface to young calves. Depth of bedding was not investigated, but calves may benefit from deep bedding, as this allows them to nestle into the bedding, perhaps reducing heat loss via radiation and convective cooling. Deep, dry bedding may be a more effective method of managing for drafts and cold stress (Lago *et al.* 2006).

Lying behaviour: Effect of floor types on resting frequency in Surti buffalo calves is depicted in Table 5. It shows that significantly ($P<0.01$) higher number of calves were found in standing position in CC group. Madke *et al.* (2010) and Earley *et al.* (2017) also reported that the calves kept on concrete floor had less lying frequency. Lying behaviour is an important activity for dairy calves, occupying about 70 to 80% of the day (Panivivat *et al.* 2004; Hänninen *et al.* 2005). The calves feel comfortable on floor having good softness, cleanliness and dryness property. Further, insulation property of bedding in winter is highly important. Therefore, the calves have preferred paddy straw for sitting or lying as it is dryer, softer and having good insulation property. In contrast Yanar *et al.* (2010) found that the calves preferred to lie down on concrete floor than either rubber mat or straw bedding. They reported that rubber mat or straw bedding created dirtiness, furthermore, both studies were on crossbred calves, and hence, they prefer to lie down on dryer surface i.e. concrete floor.

Mean faecal and eye score: Mean eye and faecal score for CC, SOIL, CC+PS, SOIL+PS and RM were 1.30 ± 0.08 ,

1.18 ± 0.06 , 1.12 ± 0.05 , 1.12 ± 0.05 , 1.22 ± 0.08 and 1.72 ± 0.12 , 1.66 ± 0.12 , 1.30 ± 0.08 , 1.42 ± 0.11 , 1.60 ± 0.11 , 1.54 ± 0.05 , respectively. The mean eye score remained non-significant amongst the groups. Mean faecal score was significantly lower when paddy straw was used either on concrete or soil surface. While in rubber mat faecal score was significantly lower than concrete and soil. Panivivat *et al.* (2003) observed that calves bedded on rice hulls, granite fines and sand produced faecal fluidity scores higher than those bedded on long wheat straw and wood shavings.

The cost benefit analysis is presented in Table 6. The cost of milk and total cost was significant among various treatments. The price of milk, concentrate, green fodder, paddy straw and manure was ₹ 45, 16, 2, 3.5 and 2, respectively. It shows that 0.27 kg/d/calf (40 kg/month) paddy straw was required to replace old litter in both treatments. Amount of paddy straw used as bedding material was considered as amount of manure generated and it was deducted from cost of bedding, hence, net paddy straw cost considered is ₹ 1.5. Two rubber mats of ₹ 2500 each was used in treatment, hence, ₹ 5,000 is considered and 1% monthly depreciation deducted from cost.

Total cost (₹/d) was highest in SOIL+PS and lowest in CC group. Further, it is clear that the cost of rubber mat or paddy straw was meagre in total expenditure. Cost/kg body weight gain was more efficient in CC+PS treatment indicating better feed efficiency as compared to either CC or SOIL. Expenditure toward straw bedding proved to be beneficial, as the calves kept on paddy straw had better and cheaper growth rate as compare to CC or RM. Kartal and Yanar (2011) revealed better feed efficiency in calves ageing upto 4 months housed on wooden slats in compare to rubber mat or concrete floor. However, Earley *et al.* (2017) and Kartal and Yanar (2011) did not reveal significant changes in feed efficiency in calves older than 4 months kept on different bedding materials. Thus, bedding material is an important factor determining feed efficiency for the early aged calves.

Average daily gain was excellent in the calves kept on SOIL+PS and CC+PS group whereas in RM and SOIL groups it didn't prove much efficient. Total DM intake was higher in the calves kept on paddy straw in respective

Table 5. Effect of floor types on resting frequency in Surti buffalo calves (n=505)

Treatment	Nature of resting			Chi square value
	Standing	Sitting	Lying	
CC	233 (46.1)	242 (47.9)	30 (5.9)	177.97*
SOIL	93 (18.4)	380 (75.2)	32 (6.3)	
CC+PS	107 (21.2)	323 (64.0)	75 (14.9)	
SOIL+PS	84 (16.6)	374 (74.1)	47 (9.3)	
RM	138 (27.3)	309 (61.2)	58 (11.5)	

*Significant ($P<0.01$); NB, Figures in parenthesis is percentage value.

Table 6. Effect of floor types on cost benefit analysis in Surti buffalo calves (₹/d/calf)

Treatment	CC	SOIL	CC+PS	SOIL+PS	RM	P value		
						Row (BW)	Column (Age)	Treat ment
Cost of milk	39.20 ^a	56.40 ^c	44.80 ^{ab}	50.40 ^{bc}	50.40 ^{bc}	0.411	0.935	0.017
Cost of concentrate	19.76	14.92	16.77	17.45	19.19	0.289	0.760	0.184
Cost of roughage	7.48	8.76	10.20	11.48	8.24	0.775	0.971	0.091
Bedding cost	0	0	0.40	0.40	0.33	—	—	—
Total cost	66.44 ^a	80.08 ^b	72.17 ^{ab}	79.73 ^b	78.16 ^b	0.221	0.721	0.028
ADG	0.29	0.36	0.40	0.42	0.37	0.661	0.107	0.003
Cost/ADG (₹/kg)	229.10 ^b	222.44 ^b	180.43 ^a	189.83 ^a	211.24 ^{ab}	0.154	0.245	0.023

*Mean values with different superscript with in a row differ significantly.

groups, while, lower in calves kept on soil and concrete floor. The sitting/lying and playfulness behaviours suggest that the calves in all the pens except on CC floor were in good welfare state. Cost/kg weight gain was lower in SOIL+PS group. Thus, paddy straw as bedding material during winter either on concrete or soil surface provides better welfare conditions to calf and better economic returns to farmers.

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