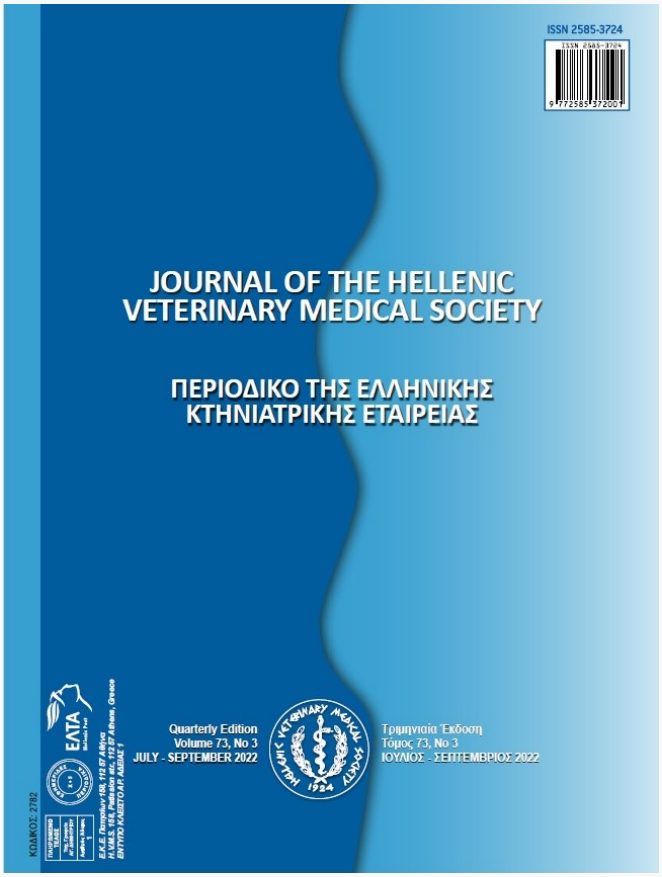
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Research article
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Effects of Flooring Types on Growth Performance, Behaviour and Health of Dairy Calves

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ABSTRACT: In this study, perforated rubber mats (PRM), concrete floor bedded with long wheat straw (CLS) and concrete floor bedded with wheat straw (CS) were compared as flooring types for dairy calves. Growth, feed efficiency ratio, gains in body measurements, some behavioural activities as well as faecal scores, bedding scores and calf's cleanliness scores of the dairy calves were evaluated for 6 months. Overall growth rate differed significantly due to types of floor, and total weight gains of the dairy calves in PRM group was 7.0% and 16.0% higher than those of calves in CLS and CS groups respectively. However, differences with regard to the amount of dry matter of milk, concentrate as well as total dry matter of the feeds consumed per kg of weight gain during pre-weaning and post-weaning periods among the PRM, CS and CLS groups were not statistically significant. When, gains in linear body measurements were evaluated, total gains in height at withers, body length, chest depth and heart girth of the calves in PRM group were superior to those in CLS and CS groups. The calves in PRM group had high growth rate along with high percentage of time spent for lying behaviour which is one the most significant activities among the behaviours of the calves. The calves kept on PRM group exhibited 52.6% and 45.5% higher percentage of time spent for lying behaviour than those in CS and CLS groups respectively. Data regarding the bedding scores and calf's cleanliness scores also revealed that the PRM flooring was the cleanest and driest one compared to the other flooring types, and the calves in the PRM group were cleaner than those in CLS and CS groups. Calves in PRM group exhibited significantly ($P<0.01$) lover faecal consistency scores than those in CLS and CS groups. In conclusion, based upon growth rate, feed efficiency ratio, behavioural parameters as well as the bedding scores, calf's cleanliness scores and faecal consistency scores, PRM is preferable to CLS and CS floorings for individual dairy calves' pens.

Keywords: Floor types, calves, behavioural traits, growth performance, welfare

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INTRODUCTION

Proper housing is required to obtain improved production, health, reproduction performances as well as the welfare of dairy cattle. Many characteristics of a dairy cow barn affect the overall environment experienced by the cows. Flooring is one of the most important components of dairy cattle barns and unavoidable part of appropriate housing. It provides overall comfort, promotes performance of the production, and helps in avoiding injuries and lameness to the dairy cattle. Inappropriate flooring may cause trauma and wear on the claw of dairy cattle notably by limiting the duration of contact and the distance walked on the surface.

The most common types of floors and beddings used in dairy cattle barns are concrete, slatted concrete and rubber floorings (Kammel and Graves, 2007). Generally, a thick layer of sand, straw or other organic substances such as saw dust, rice hulls, wood shavings, wood chips, long wheat straw are often placed on the top of the floor as bedding materials (Tucker et al., 2003; Mee, 2008).

The rearing and management as well as housing methods used during first 6 months of a dairy calf's life is also so crucial to decrease stress and to minimize the risk of disease(Sutherland et al., 2014). Although there are several calf diseases appeared in the preweaning and post weaning periods of the calves, diarrhea is one of the most frequently came across diseases which is related to calf mortality in calves. Its diagnosis can be made by observing the consistency of faeces. For this purpose, the faecal consistency score reported by Larson et al. (1977) was used commonly in many studies including the current study (Ayyilmaz and Uzmay, 2010, Yanar et al., 2010, Ghassemi Nejad et al., 2013; Kaygisiz ve Sonmez, 2018).

A suitable floor is essential for dairy calves to get adequate sleep, rest and exhibit normal behaviours. Appropriate flooring materials also provides comfortable area to improve health and growth performance as well as welfare of the growing animals(Siegel, 2005; Sorathiya et al., 2019). General conclusions drawn from the studies are that the dairy cows had clear preferences for solid rubber mats, and the rubber flooring had benefits in terms of lower occurrence of clinical lameness as well as claw lesions, and hence better cow welfare(Tucker et al., 2003; Vanegas et al., 2006; Norring et al., 2010; Sadharakiya and Sorathiya, 2019). Additionally, cows spend longer time in lying down on the rubber mats as compared to concrete floor (Telzhenko et al., 2007; Rushen et al., 2007, Gautam et al., 2020).

Even though results of the studies suggested use of solid rubber mats as flooring material for cattle housing facilities, some researchers did not recommend use of the solid rubber mats for dairy calves' pens as flooring material due to poorer calf's cleanliness score and worst bedding cleaning scores as well as lower percentage of time spend for lying and higher percentage of time spend for standing (Yanar et al., 2010; Madke et al., 2010; Kartal and Yanar, 2011). The researchers stated that calves housed on the pens containing solid rubber mats were dirtier and wetter than other flooring groups.It was seen that dairy cow prefers dry bedding more as compared to wet bedding(Singh et al., 2020).Additionally, Sorathiya et al.(2019) also reported that dirt in litter or floor has more importance for dairy calves compared to buffalo calves. The undesired results of the solid rubber flooring material used in calf housing facilities could be attributed its impermeable and non-absorbent structure.

In the current study, perforated rubber mats (PRM) instead of solid ones were used in order to eliminate disadvantages of the solid rubber mats. PRM was placed on the elevated stainless steel floor grille of the pens. Therefore, the study was conducted to compare different floor types of the calf pens such as PRM, concrete floor bedded with wheat straw (CS) and concrete floor bedded with long wheat straw (CLS). The aim of the present study was to search effects of the three flooring types (PRM, CS and CLS) on the growth rate and feed efficiency traits, behavioural traits, faecal scores, bedding scores and calf's cleanliness scores of the dairy calves.

MATERIAL AND METHODS

A total of 54 dairy calves (28 Brown Swiss and 26 Holstein Friesian) were used in the study which was approved by the Ethical Review Committee for the Use of Animals, under the administrative control of the Office of Food and Livestock Application and Research Centre of Atatürk University, Erzurum, Turkey.After birth, calves were allowed to suckle their dams in order to receive colostrum for 3 days. Dairy calves were housed in a closed calf barn containing individual calf pens. Bases of the pens were constructed by concrete. In the current study, concrete floors of the pens were either bedded with wheat straw (CS) or with long wheat straw (CLS), or an elevated stainless

steel floor grille covered with perforated rubber mats (PRM) were placed on the concrete floor. The calves at 4 days of age were allocated randomly to the one of three treatment groups. The individual pens contained hay and starter feeders, plastic calf milk feeding bottles as well as water buckets. The trial lasted for 6 months.

The calves received whole milk from milk feeding bottles twice a day (8.30 AM, 17.30 PM). The amount of milk given to calves was 10% of their birth weight. The quantity of whole milk was kept constant during the pre-weaning period, andthe young animals were weaned at 8 weeks of age. Calf starter, dry hay in good quality and water were always available in the individual pens. Two different kinds of calf starter (Starter 1 and Starter 2) were utilised in the present study. Starter 1 was given the calvesuntil 4 months of age, while Starter II was offered after 4 months of age. The daily amount of starter offered to calves was maximum 2 kg/head, and dry hay was offered *ad lib*. throughout the trial. After amount of starters and dry hay left in the feeders were weighed back every day, amounts of feeds consumed were calculated and recorded. The calves were able to access*ad lib.* to drinking water. The chemical compositions of starter 1 and 2 were 90.2% and 91.0% dry matter, 19.1% and 18.0% crude protein, 2.7% and 3.1 crude ether extract, 5.2% and 6.0% crude ash, 9.3% and 10.5% crude cellulose respectively. Dry hay contained 93.1% dry matter, 5.2% crude protein, 2.4% crude ether extract, 8.1% crude ash, 28.1% crude cellulose. Whole milk had also 12.1% dry matter, 3.4% crude protein, 3.9% crude ether extract, 0.9% crude ash.

Body weights of the calves at various stages of the growth, such asat birth, weaning and 6 months of ages were determined by using electronic balance at morning before serving milk. Height at withers, body length, heart girth, chest depth, cannon bone girth of the dairy calves as body measurements were also taken at birth as well as 6 months of age.

Faecal consistency was evaluated by using a scale of 1 to 4 (1 = normal consistency, 2 = soft or pasty, 3 = lose faeces andrunny, 4 = watery) (Larson et al., 1977).Bedding score was developed by Panivivat et al. (2004)and it was rated on a scale of 1 to 5 as follows: 1: dry and clean, 2: 20% to 40% surface dirty or wet, 3: 40% to 60% of surface dirty or wet, 4: 60% or 80% surface dirty or wet. Calf cleanliness score reported by Panivivat et al. (2004) was utilised in the current study. Calf cleanliness score was estimated based on a scale of 1 to 4 as follows: 1: calf is clean only manure at lower ends of legs, 2: tail head region and back end of calf are soiled with manure, 3: tail head region, back end of calf and thighs or legs are soiled with manure, and 4: back end of calf, thighs, legs, and tail head region are soiled with manure(Panivivat et al., 2004).Faecal consistency score, bedding score and calf cleanliness score were determined and recorded 1-week intervals throughout the study.

Data concerning behavioural parameters were obtained by utilising Instantaneous sampling method(Martin and Bateson, 1993). In this method, calf's behaviour was determined once a week by walking from end to end of the calf barn, observations were made at a distance from the hutches of the calves at least 2.1 m, every 15 min from 9.00 AM until 12.00 AM. The behaviour was determined for each of the following activities by a slight modification of the methods of Panivivat et al. (2004) in which 1: lying (calf's body contacted bedding and ground), 2: standing (calf was inactive in upright position), 3: eating (calf's head was in feed bucket). Percentage time spent in each activity was calculated weekly.

In the present study, since all data except for scores of calf cleanliness, bedding and faecal consistency had normal distribution, 3x2 completely randomized factorial experimental design was employed for statistical analysis. Since interactions among the main factors were not statistically significant in the preliminary statistical analysis, they were excluded from the statistical model. Therefore, only main effects of the treatment groups were statistically analysed. The ANOVA analysis and Duncan's multiple comparison test were carried out by using SPSS statistics program(SPSS, 2004).The data that did not have normal distribution were statistically analysed by using Kruskal Wallis non-parametric test, and Mann Whitney U test was also utilized for dual comparisons of the subgroups of the main factors. The non-parametric tests were also performed by using SPSS statistics computer program(SPSS, 2004).

RESULTS

Weights of the dairy calves at various phases of the growth of calves are presented in Table 1. Mean birth weights of the calves allocated into the various flooring groups were not statistically different, and the sex of the calves did not significantly differ the

birth weight.Differences with regard to the weights at weaning (P<0.01) and 6 months of age (P<0.05) among the PRM, CS and CLS groups were statistically significant. Sex of the calves had significant influence on the weaning weight (P<0.05) as well as weight at 6 months of age (P<0.01).

Total weight gains in the pre-weaning and post-weaning periods are depicted in Table 1. The weight gains of the calves obtained in the pre-weaning period were significantly (P<0.05) affected by the type of floor, however, sex of the calves did not result in significant variation about weight gains between birth and weaning age. In the post-weaning period, the rate of total weight gain was significantly (P<0.01) affected by the flooring types, and sex of the calves had also a significant (P<0.05) effect on the weight gains. Overall weight gain of the calves in the period during 6 months was affected significantly (P<0.05) by flooring groups as well as sex of calves.

Least square means for feed efficiency ratio of the dairy calves are given in Table 2. Amount of dry matter of milk, concentrate as well as total dry matter of the feeds consumed per kg of weight gain during pre-weaning period was not significantly influenced by type of floor and sex of calves. Only differences among the flooring groups were significant (P<0.05) for amount of dry hay consumed per kg of weight gain. Sex of the calves did not significantly affect feed efficiency ratios determined at various stages of the growth of the calves. The feed efficiency ratios obtained between weaning and 6 months of age was not influenced by kinds of floor as well as sex of calves. Additionally, overall feed efficiency ratio was also not significantly influenced by flooring types as well as sex of calves.

Gains in body measurements, such as body length, chest depth, heart girth, height at withers, cannon bone girth during the trial are tabulated in Table 3. Type of floor was a significant (P<0.01) source of variation in the gains of height at withers, body length, chest depth, heart girth in a period between birth and 6 months of age. Sex of the calves also significantly (P<0.05) affected gains in chest depth, heart girth as well as cannon bone girth.

Behavioural data as well as faecal consistency score, bedding score and calf cleanliness score are presented In Table 4. The effects of the flooring types on the percentage of time spent on different activities of the dairy calves were statistically significant (P<0.01). However, these behavioural traits were not significantly influenced by the sex of the calves. Bedding score of the pens differed significantly (P<0.01) by floor types a long with sex of calves. Differences among the floor types in terms of calf cleanliness score were significant (P<0.05). The calf cleanliness score was also affected significantly (P<0.01) by the sex of calves. Faecal consistency score of dairy calves was also significantly influenced by the flooring types while effect of the sex of calves on the faecal consistency score was not significant.

Table 1. Least Square Means and Standard Errors for Growth Performance and Weight Gain of Dairy Calves

					Total weight Gains		
	n	Birth Weight (kg)	Weaning Weight	6 Months Weight	In the Pre-Weaning Period	In the Post-Weaning Period	Between Birth and 6 Months of Age
Flooring Types							
CLS[1]	19	34.0±1.0	51.2±1.7^{a}	132.6±4.1^{ab}	17.2±1.4^{a}	81.3±3.5^{a}	98.5±3.9^{ab}
CS[2]	19	34.6±1.0	55.7±1.7^{b}	125.5±4.0^{a}	21.1±1.4^{b}	69.8±3.4^{b}	90.9±3.9^{a}
PRM[3]	16	37.6±1,1	59.2±1,9^{b}	143,1±4,4^{b}	21.6±1.5^{b}	83.9±3.7^{a}	105.4±4.2^{b}
Significance		ns	**	*	*	**	*
Sex							
Male	32	36.6±0.8	58.2±1.3	140.5±3.2	21.6±1.1	82.3±3.7	103.8±3.0
Female	22	34.3±0.9	53.2±1.6	127.0±3.7	19.1±1.3	73.7±3.2	92.8±3.6
Significance		ns	*	**	ns	*	*

[1]CLS:Concrete flooring bedded with long wheat straw,[2]CS:Concrete flooring bedded with wheat straw,
[3]PRM: Perforated rubber mats
[a, b] Means with different superscriptswithin flooring groups are statistically different.
ns: Non significant, *: P<0.05, **: P<0.01

DISCUSSION

In order to reveal the effects of different kinds of floorings on the growth properties of the dairy calves, the calves were weighed at the different stages of their growing period. Then, weight gains belonging different parts of the growth were determined. Mean birth weight of male calves was 6.7% higher than that of female ones. However, the difference was not statistically significant since the calves used were randomly distributed to the treatment groups. The insignificant difference between sex groups for birth weight was in agreement with results of Ugur et al. (2004).

Type of floor was a significant (P<0.01) source of variation in the weaning weight, and the average weaning weight of the dairy calves in PRM group was 6.3% and 15.7% heavier than that of calves in CS and CLS groups respectively. Sex of the calves significantly affected (P<0.01) weaning weight of the dairy calves. Six month weight of the dairy calves in PRM group was 7.9 % and 14.0 % higher (P<0.05) than those of calves in CLS and CS flooring groups respectively. The 6 month weight was significantly affected by the kinds of floor as reported by Kartal and Yanar(2011). The researchers revealed that the mean 6-month weight of the calves kept on wooden slatted pens was greater than those housed on other flooring types. Six-month weight was also significantly affected by the sex of the calves, and average 6 month weight of the male calves was 10.6 % heavier than that of female ones.

Growth performance of the dairy calves housed on pens with PRM was superior to those in CLS and CS groups. The calves in PRM group in the pre-weaning and post-weaning periods had 2.3%, 25.6% and 3.2%,

Table 2. Least Square Means and Standard Errors for Feed Efficiency Ratios in Various Stages of the Growth of Calves

		Feed Efficiency Ratio in the Pre-Weaning for				Feed Efficiency Ratio in the Post-Weaning for			Overall Feed Efficiency Ratio
	n	Milk	Concentrate	Dry Hay	Total Feeds	Concentrate	Dry Hay	Total Feeds	
Flooring Types									
CLS[1]	19	1.81±0.12	3.54±0.20	4.30±0.21	4.54±0.25	0.96±0.1	0.40±0.03[a]	3.59±0.21	4.30±0.21
CS[2]	19	1.48±0.12	4.04±0.20	4.69±0.21	5.22±0.24	0.77±0.1	0.38±0.03[ab]	3.27±0.22	4.69±0.21
PRM[3]	16	1.63±0.13	3.66±0.22	4.37±0.22	4.69±0.28	0.75±0.1	0.28±0.04[b]	3.40±0.25	4.37±0.22
Significance		ns	ns	ns	ns	ns	*	ns	ns
Sex									
Male	32	1.59±0.09	3.92±0.16	4.22±0.16	4.56±0.20	0.88±0.08	0.34±0.03	3.18±0.16	4.22±0.16
Female	22	1.69±0.11	3.58±0.19	4.68±0.19	5.07±0.24	0.78±0.09	0.37±0.03	3.53±0.18	4.68±0.19
Significance		ns	ns	ns	ns	ns	ns	ns	ns

[1]CLS: Concrete flooring bedded with long wheat straw,[2]CS: Concrete flooring bedded with wheat straw,
[3]PRM: Perforated rubber mats
[a, b] Means with different superscriptswithin flooring groups are statistically different.
ns: Non significant, *: P<0.05, Feed efficiency ratio: dry matter consumed (kg)/weight gain (kg)

Table 3. Least Square Means and Standard Errors for Gains in the Body Measurements of Calves Between Birth and 6 Months of Age

	n	Height at Withers (cm)	Body Length (cm)	Chest Depth (cm)	Hearth Girth (cm)	Cannon Bone Girth (cm)
Flooring Types						
CLS[1]	19	26.90±1.0[a]	32.52±1.4[a]	15.72±0.6[ab]	40.90±1.42[a]	3.49±0.18
CS[2]	19	24.16±1.0[b]	28.02±1.4[b]	15.28±0.6[a]	40.29±1.41[a]	3.38±0.18
PRM[3]	16	29.80±1.1[a]	40.88±1.5[c]	18.07±0.7[b]	48.42±1.53[b]	3.41±0.20
Significance		**	**	**	**	ns
Sex						
Male	32	27.69±0,8	33.48±1.1	17.17±0.49	44.98±1.11	3.56±0.14
Female	22	26.26±0.9	34.13±1.3	15.54±0.58	41.43±1.32	3.28±0.16
Significance		ns	ns	*	*	*

[1]CLS: Concrete flooring bedded with long wheat straw,[2]CS: Concrete flooring bedded with wheat straw,
[3]PRM: Perforated rubber mats
[a, b] Means with different superscriptswithin flooring groups are statistically different.
ns: Non significant, *: P<0.05, **: P<0.01

Table 4. Least Square Means and Standard Errors for Percentage of Time Spent on Different Activities, Bedding Scores, Calf's Cleanliness Scores, Faecal Consistency Scores Between Birth and 6 Months of Age

	n	Lying (%)	Standing (%)	Eating (%)	Drinking Water (%)	Bedding Scores	Calf's Cleanliness Score	Faecal Consistency Score
Flooring Types								
CLS[1]	19	28.1±1.5[a]	32.5±1.2[a]	37.3±1.5[b]	1.04±0.16[a]	3.09±0.06[a]	2.88±0.06[a]	1.33±0.01[a]
CS[2]	19	26.8±1.6[a]	26.1±1.3[ab]	45.1±1.6[a]	1.07±0.17[a]	2.91±0.06[a]	2.79±0.05[a]	1.12±0.01[b]
PRM[3]	16	40.9±1.5[b]	22.8±1.4[b]	33.7 1.1[b]	2.50±0.16[b]	2.44±0.02[b]	2.00±0.03[b]	1.06±0.02[c]
Significance		**	**	**	**	**	*	**
Sex								
Male	32	31.9±1.4	30.6±1.1	34.9±1.1	1.6±0.15	3.02±0.06	2.65±0.04	1.16±0.02
Female	22	32.0±1.2	31.0±0.9	35.0±1.3	1.5±0.12	2.60±0.04	2.45±0.03	1.19±0.03
Significance		ns	ns	ns	ns	**	**	ns

[1]CLS: Concrete flooring bedded with long wheat straw,[2]CS: Concrete flooring bedded with wheat straw,
[3]PRM: Perforated rubber mats
[a, b] Means with different superscriptswithin flooring groups are statistically different.
ns: Non significant, *: P<0.05, **: P<0.01

20,2% higher weight gain than those in CLS and CS groups respectively. While maximum total weight gain in a period between birth and 6 months of age was detected from calves in PRM group, the overall growth rate of the young animals in CS group was the lowest among the flooring groups. Total weight gains of the dairy calves in PRM group obtained throughout the trial was 7.0% and 16.0% higher than those of calves in CLS and CS groups respectively. Higher total weight gain of the calves in PRM group might be the result of increased the comfort zone of calves. Significant effects of the various flooring types on the weight gains of the calves were reported by several researchers (Panivivat et al., 2004; Hanninen et al., 2005; Kartal and Yanar, 2011; Sorathiya et al., 2019). Madke et al. (2010) reported higher average weight gain of the calves kept on flooring bedded with paddy straw compared to concrete floor and solid rubber mats. In a period between birth and 6 months of age, Yanar et al. (2010) revealed higher total weight gains of the dairy calves kept on wooden slatted pens than solid rubber mats and concrete floorings. Keane et al. (2017) also compared effect of straw bedded flooring with concrete slatted floor regarding the weight gain of the crossbred heifers, and the highest growth rate was obtained from young animals in straw bedded flooring group. Total weight gain of male calves in post-weaning period was 11.7% higher (P<0.05) than female ones. Similarly, the total weight gain of the male calves in a period between birth and 6 months of age was also 11.9% higher (P<0.05) than that of female counterparts, and the results were in agreement by the findings of Kocyigit et al. (2016).

Differences with regard to the amount of dry matter of milk, concentrate as well as total dry matter of the feeds consumed per kg of weight gain during pre-weaning and post-weaning periods among the PRM, CS and CLS groups were not statistically significant (Table 2). The result was supported by the findings of Panivivat et al.(2004)who indicated that feed efficiency ratio of calves from day 1 to day 42 were not affected by 5 different types of bedding materials. Similar results were also reported by Kartal and Yanar (2011) and Keane et al. (2015).

Growth of the young animals could be also defined as increases in the body measurements as well live weight. Height at withers and body length are largely a reflection of skeletal development. As a result of that fact, they are used commonly to evaluate and to compare growth of the calves. In the present study, dairy calves in PRM group had the highest increases of the body measurements comparing those in CLS and CS groups between birth and 6 months of age. The lowest enhance of linear body measurements was obtained from calves in CS group (Table 3). Total gains in height at withers, body length, chest depth, heart girth of the calves in PRM group were respectively 23.3%, 45.9%, 18.3% and 20.2% higher than those in CS group. In the current study, sex differences have been observed in the developmental pattern of the body measurements (heart girth, chest depth and cannon bone girth) in favour of male calves. These results were in harmony with findings of Essien and Adesope(2003)who reported significantly (P<0.01) higher body measurements such as height at withers, body length, heart girth of male calves comparing fe-

male ones.

Lying (resting) is one the most significant activity among the behaviours of the calves and it occupies about 70% to 80% of a day (Panviviat et al., 2004). When a flooring material has good cleanliness, dryness, softness and insulation properties, the calves exhibit lying behaviour, and amount of time spent for lying increases (Sorathiya et al., 2019). In the present study, the calves in PRM group showed 52.6% and 45.5% higher lying behaviour than those in CS and CLS respectively. On the other hand, standing behaviour of the calves kept on PRM group was 12.6% and 29.8% lower than those in CS and CLS groups. Positive correlation (r=0.32) between amount of resting and body weight gain was reported by Hänninen et al.(2005). They postulated that undisturbed rest could allow calves to use more energy for their growth. Additionally, increased resting time may lead to a better quality sleep which results in an altered secretion of the growth hormone and improved growth. In the present study, the calves in PRM group demonstrated higher growth rate along with longer time for lying behaviour. The findings of the current study support findings of Hänninen et al.(2005). In the contrary of the results of the present study, Kartal and Yanar (2011) found that calves kept on the solid rubber mats had the lowest percentage of time for lying and the highest percentage of time for standing behaviours comparing those housed on concrete flooring and wooden slatted pens. The difference between results of the studies could be attributed to the usage of PRM in place of solid rubber mats in the current study. Eating and water drinking behaviours were also significantly ($P<0.01$) affected by kinds of floor, and the results were in accordance with findings of Yanar et al. (2010). Sex of calves did not significantly affect the behavioural activities of the young animals, and the result was supported by the findings of Kartal and Yanar(2011).

The bedding score of the PRM group was significantly ($P<0.01$) lower than that of the rest of the floor type groups (Table 4). In other words, the floor of the pens with PRM was the cleanest and driest compared to the other flooring types. The best calf's cleanliness score determined weekly throughout the present trial was obtained from calves in PRM group, and they were cleaner than those in CLS and CS groups. Significant effects of the various types of bedding materials on the bedding score as well as calf's cleanliness score was also reported by Panivivat et al. (2004)who revealed that calves reared on granite fines had lower cleanliness scores than calves reared on sand, rice hulls, wheat straw, or wood shavings. As well, in the present study, average cleanliness score of the female calves was better ($P<0.05$) than that of the male ones. Calves in PRM group exhibited significantly ($P<0.01$) lover faecal consistency scores than those in CLS and CS groups. The result was in agreement with results of Sorathiya et al.(2019) who revealed that faecal score of the calves kept on rubber mat significantly lower than concrete and soil.

CONCLUSION

Overall results demonstrated that usage of PRM brought about improvements in growth performance parameters, such as total weight gain, gains in body measurements as well as cleanliness score for the flooring of the pens besides calf's cleanliness score and faecal consistency score of the young animals. Therefore, it was concluded that PRM flooring material in place of solid rubber mats could be recommended for calves' pens without causing adverse effect on growth traits, hygiene and health status of the dairy calves.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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