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Housing conditions during the last month of gestation affect hoof health after calving in dairy heifers

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ABSTRACT - This study evaluated the effects of housing in the last month of gestation on hoof health in postpartum dairy heifers. The hooves of the heifers were evaluated during functional claw trimming and lameness scoring at 30 days before the expected calving date, and only heifers without any hoof lesions and lameness were included in the study. The heifers were kept in cubicle housing systems with mats (MAT, n = 12), mattresses (MATR, n = 12) and solid concrete floors, and on a straw yard (SY, n = 12) without exposure to concrete during the last month of gestation. The effects of housing systems on hoof lesions and lameness were evaluated during functional claw trimming and locomotion scoring at 60 and 90 days in milk (DIM). The evaluation of hoof lesions with respect to the study group, time, and their interaction was performed with the general linear mixed model for repeated measures. All heifers displayed sole hemorrhages (SH), white-line hemorrhages (WLH), and heel horn erosion in the postpartum period, but none of the heifers displayed lameness. The mean SH severity score was significantly higher in groups MAT and MATR than in group SY (2.25, 1.92, 0.75, respectively) at 60 DIM, and significantly higher in group MAT than in groups MATR and SY (1.92, 0.92, 0.92, respectively) at 90 DIM. The mean WLH severity score was higher in group MAT than groups MATR and SY (1.92, 1.17, 0.92, respectively) at 60 DIM, and similar (0.83, 0.75, 0.50, respectively) at 90 DIM. Heel horn erosion did not differ in severity among the groups. Improving housing comfort during the last month of pregnancy significantly decreases the severity of postpartum SH and WLH.

Keywords: calving, cow comfort, hoof hemorrhages, dairy heifer

1. Introduction

Lameness is one of the most important problems of modern dairy farming with implications for production, reproduction, health, and welfare (Sprecher et al., 1997; Hernandez et al., 2001; Warnick et al., 2001; Juarez et al., 2003; O'Callaghan et al., 2003; Hernandez et al., 2005; Calderon and Cook, 2011). While 90% of all lameness cases originate from hoof lesions, not all hoof lesions cause lameness (Manske et al., 2002b). However, subclinical foot lesions significantly affect animal welfare (Bruijnis et al., 2012) and cause economic loss (Bruijnis et al., 2010).

The transition period is critical to the occurrence of hoof lesions (Cook and Nordlund, 2009). Around calving, heifers are exposed to stress caused by transitioning to a high-energy diet, change of housing and social groups, as well as social interactions among animals (Cook and Nordlund, 2009; Bergsten et al., 2015). The severity of subacute ruminal acidosis (SARA) in first-lactation cows, which are subjected to the same feeding regime, may vary due to several reasons, including differences in management factors and ruminal fermentation, and susceptibility or resistance to SARA (Kofler et al., 2023; Hartinger et al., 2024). Calving and lactation may result in claw horn disruption (CHD) lesions, the severity of which may increase with housing and nutritional conditions (Webster, 2001). Nonetheless, the ruminal acidosis (acute or subacute) and laminitis hypothesis describing the pathogenesis of CHD lesions is controversial in the current literature (Randall et al., 2018; Passos et al., 2023). Acute ruminal acidosis induced by oral oligofructose administration was followed by the establishment of the clinical and histological findings of acute laminitis (Danscher et al., 2009). Hovewer, Kofler et al. (2023) reported that the severity (light, moderate, and severe) of SARA cases induced by high levels of concentrate feed in first-lactation Holstein cows had no effect on the locomotion score and prevalence of claw lesions. The effects of nutrition on hoof health are related to the role of micronutrients in the maintenance of the structural integrity of the hoof rather than the laminitis hypothesis (Langova et al., 2020; Queiroz et al., 2021). Recent studies on the pathogenesis of CHD lesions in dairy cattle have investigated environmental and animal-based risk factors and alternative hypotheses that may explain associations previously identified in the literature (Randall et al., 2018; Laven and Laven, 2024). Major herd and animal related risk factors that cause predisposition to postpartum CHD lesions include hormone- and enzyme-induced deterioration of the supportive system of the hoof (Tarlton et al., 2002a,b; Knott et al., 2007), reduced thickness of the soft tissue of the claw sole (Bach et al., 2021), changes in the biochemical and physical structure of the digital cushion (Bicalho et al., 2009; Newsome et al., 2017; Wilson et al., 2021), altered metabolic status and lying behaviour (Sepúlveda-Varas et al., 2018), increased standing time and standing bout duration in early lactation (Eriksson et al., 2021), low body condition (Green et al., 2014; Lim et al., 2015; Randall et al., 2015), and decreased horn growth and increased hoof wear (Blowey, 2015) around calving.

While hoof lesions can develop in dairy heifers in the pre-calving period (Kofler et al., 2011; Randall et al., 2016), hoof lesions and lameness are most prevalent in early lactation (Cook and Nordlund, 2009; Mahendran et al., 2017). A prevalence of 48.7% has been reported for sole hemorrhages two months after calving (Drendel et al., 2005). High prevalences have been reported for white line lesions (72%) and sole hemorrhages (55%) in Danish Holstein heifers during 1–100 days of lactation (Capion et al., 2009). Similarly, 95% of dairy heifers were reported to display lesions on at least one claw between days 50 and 80 postpartum (Maxwell et al., 2015). Mahendran et al. (2017) reported a lameness prevalence of 12.2% at 29-42 days post-calving and 1.1% between 295 and 383 days post-calving. Thus, the prevention of foot lesions in heifers is a major critical control point of lameness control in dairy cattle (Bell et al., 2009).

Housing in free stalls forces cattle to walk on hard, wet, slippery, and manure-contaminated concrete floors for routine daily activities including feeding, milking, finding a resting area, and social behavior (Bergsten et al., 2015). This increases the exposure of cattle to adverse environmental factors such as traumas due to suboptimal flooring and increased standing time on concrete floors, and thereby, increases the risk of lameness (Cook and Nordlund, 2009; Akköse and İzci, 2017). Previous studies have shown that the prevalence of lameness is associated with the bedding material used for dairy cows (Webster, 2001; Cook, 2003; Cook et al., 2004; Barberg et al., 2007). Good stall comfort could prevent lameness by improving the resting time, decreasing the standing time and avoiding the exposure of cattle to adverse environmental effects. It also complements the treatment of foot diseases by reducing the pain of lame animals and improving their living conditions (Cook and Nordlund, 2009).

Webster (2002) reported that the housing of heifers in straw yards (SY) during the last month of gestation and the first two months of lactation significantly reduced the occurrence of sole hemorrhages (SH) and white-line hemorrhages (WLH) compared with housing on concrete floors in free stalls during the same period. Laven and Livesey (2004) determined that the prevalence of SH and WLH during the last four weeks of gestation and the first 12 weeks postpartum was lower in cows housed in straw yards compared with those housed in mat- and mattress-based free stalls.

Livesey et al. (1998) reported that Holstein heifers diagnosed with SH and WLH before calving, after being housed in either free stalls or SY during the previous trimester and 12 weeks postpartum, displayed an increased severity of SH and WLH in response to being housed in free stalls and a decreased severity of WLH in response to being housed in straw yards.

The results of previous research on hoof horn haemorrhage in heifers have contributed to a better understanding of CHD by showing the major involvement of housing conditions and the relatively less importance of postpartum nutrition. Furthermore, these results have revealed that parturition serves as an important risk factor for CHD, and through interaction, heightens the effects of other risk factors involved (Laven and Laven, 2024).

In this study, we hypothesized that improving housing comfort (straw yard > mattress > mat) throughout the last month of gestation would decrease the severity of hoof lesions in the postpartum period. Thus, the present study was aimed at the assessment of postpartum hoof lesions in dairy heifers kept under different housing conditions during the last month of gestation (but under similar housing conditions in the postpartum period).

2. Material and Methods

Research on animals was conducted according to the Ethics Committee of the Selçuk University, Faculty of Veterinary Medicine (2016/2).

2.1. Animals and housing conditions

This study was carried out between December 2016 and May 2017 on a commercial dairy farm located in the Şanlıurfa province of Turkey (36°48’51.8” N, 39°51’51.8” E). The study material comprised 36 clinically healthy Holstein heifers with body condition scores (BCS) of 3.0 to 3.5, measured on a 1 to 5 scale (Edmonson et al., 1989). The heifers were housed in either mat-based free stalls (MAT), mattress-based free stalls (MATR), or SY during the last month of gestation. They were assigned randomly to the experimental housing groups and were housed under similar conditions, in a semi-open yard barn with a manure-covered concrete floor before being moved to the experimental housing systems.

Animals in late pregnancy, on the farm in which this study was conducted, were housed in MAT with 45 stalls on one side of the barn. The farm management team decided to make a renovation and replace the mat beds of the free stalls with mattresses because the cow comfort index (Nelson, 1996) was below the target value. We conducted this study by establishing housing groups during the renovation period. For our study, the barn was divided into three equal pens, each consisting of 15 free stalls. While there was a mat-based free stall in one of these pens, a mattress-based free stall was constructed in the other pen. Mat beds of 2.8±0.2 cm thickness were made of rubber, and mattress beds of 3.7±0.2 cm thickness were made of chapped rubber and foam (İşbir Ziraat, Ankara, Turkey). There was not any soft covering like sawdust on the beds. In the third pen, the beds on the floor and cubicles were removed, and wheat straw, nearly 30 cm deep, was laid on the floor. The alleys of the free-stall pens were cleaned daily, and the straw yard pen was cleaned twice a week. A scraper attached to the rear of a tractor was used for cleaning. Calvings were regularly monitored by experienced employees. The heifers were taken to the maternity pen after calving. After staying in the maternity pen for three days, they were included in the early lactation group. The maternity pen was covered with nearly 30 cm-deep wheat straw.

In the postpartum period, all animals included in the study were housed under the same conditions, in mattress-based free-stall sand on solid concrete floors. The heifers were mixed with other cows from the herd. All animals had free access to a soil-covered backyard. All three of the study groups were fed in accordance with the recommendations of the National Research Council (NRC, 2001). The animals were fed a total mixed ration. Cows were milked twice a day. The dairy cows raised on the farm, where the study was conducted, were treated twice daily, on each day of the week, with footbaths, after being milked. Replacement heifers were given a footbath once a week. The footbaths contained a mixed solution of 5% copper sulphate and 3% formaldehyde. When preparing the footbaths, approximately

1 L of solution was used per animal. For example, after 400 animals passed through a pool containing ~400 L of the footbath solution, the solution was reconstituted.

2.2. Hoof examination and locomotion scoring

Hoof lesions were assessed in the rear feet of the animals. After undergoing functional hoof trimming, the rear hooves of each animal were examined at 30±3 days before the expected calving time, and at 60±3 days in milk (DIM) and 90±3 DIM. For hoof examination, the animals were restrained in a mechanical foot crush (Mechanic Animal Care Trolley, Sezer, Bursa, Turkey).

The hooves were trimmed following the five-step Dutch method using a hoof knife (Demotec, Disc DR-Pro, Nidderau, Germany) and an angle grinder (Bosch, GWS 7-115, Leinfelden-Echterdingen, Germany). Hoof examination was based on the evaluation of common CHD lesions and heel horn erosions (HHE). The findings observed in each animal were scored using a four-point scale (normal: 0, mild lesion: 1, moderate lesion: 2, severe lesion: 3). Briefly, heifers with an SH score of 0 had a normal sole; heifers with an SH score of 1 had a superficial hemorrhage of the typical site in the sole; heifers with an SH score of 2 had a deep hemorrhage of the typical site in the sole; heifers with an SH score of 3 had diffuse extensive hemorrhage across the sole. Heifers with a WLH score of 0 had a normal white line; heifers with a WLH score of 1 had localized redness in the white line of the outer claw; heifers with a WLH score of 2 had diffuse redness in the white line of one or both claws; heifers with a WLH score of 3 had diffuse hemorrhage and separation in the white line region. Heifers with a HHE score of 0 had a normal heel; heifers with a HHE score of 1 had small pockmarks of erosion or small fissure; heifers with a HHE score of 2 had a single large V-shaped fissure across the heel; and heifers with a HHE score of 3 had a multiple-layered heel erosion (Burgi and Cook, 2006). The scoring of the severity of SH, WLH, and HHE detected in the hooves of the animals was based on the highest score assigned to the lesions on the rear feet of the animals.

Following hoof trimming, the hoof lesions of each animal were imaged with a digital camera (Samsung WB100, Seoul, South Korea). The standing posture and locomotion of the animals included in all three groups were evaluated at 30±3 days before the expected calving time, and at 60±3 DIM and 90±3 DIM, according to the gait scoring criteria (score of 1–5) described by Sprecher et al. (1997). Animals with a score of 1 or 2 were classified as healthy (not lame) and animals with a score of 3, 4, or 5 were classified as clinically lame (Espejo et al., 2006). Locomotion scoring was performed after hoof trimming on a solid concrete floor. Animals confirmed to be healthy during functional trimming and the locomotion scoring performed at the beginning of the study were included in the study (inclusion criteria were a lesion score of 0 and a locomotion score of ≤2). The first author of the article scored the hoof lesions and locomotion of the dairy heifers.

2.3. Statistical analysis

All statistical analyses were performed using the SPSS version 24-software package (IBM Corp., Armonk, NY, USA). The severity of the CHD lesions is presented as the group mean ± standard error. The prevalences of the claw lesions were analysed by Fischer's exact test. The possible effects of the age at first calving (AFC) and 100-day milk yield on each of the hoof disorders at different times (60 and 90 DIM) were investigated with an ordinal logistic regression model.

The evaluation of hoof lesions with respect to the study group (mat-based free stall, mattress-based free stall, straw yard), time and the interaction of the group and time was performed with the general linear mixed model (GLMM) for repeated measures. The model was included with the cows in the study groups as random effects and with the housing groups, measurement time and their interactions as fixed effects. Variance components were used as the covariance structure in the established model since it resulted in the lowest Akaike information criterion (AIC). When differences for the group, measurement time, and their interactions were determined to be statistically significant, the significance test of the differences was made with a Bonferroni-corrected simple effects analysis (post-hoc). The effects of housing conditions (mat-based free stall, mattress-based free stall, straw yard) on hoof lesions were analyzed statistically using the model described as follows:

$$Y_{ijkl} = \mu + H_i + T_j + (H \times T)_{ij} + C_k + e_{ijkl},$$

in which Y_{ijkl} = the record of each observation, μ = intercept, H_i = effect of housing conditions (mat-based free stall, mattress-based free stall, straw yard), T_j = effect of different times (at 60 and 90 DIM), $(H \times T)_{ij}$ = effect of housing and time interaction, C_k = the random effect of the cows, and e_{ijkl} = error effect.

3. Results

The AFC ranged from 24.0 to 41.2 months, and the 100-day milk production of the first-calving heifers ranged from 1051.0 to 2800.0 L (Table 1). The AFC and 100-day milk yield did not differ among the groups.

Table 1 - Descriptive statistics of the 100-day milk yield and age at first calving of the study groups

Parameter	Group	n	Mean±SEM	Median	Minimum	Maximum
	MAT	12	1959.4±157.6	1895.0	1092.0	2800.0
MY	MATR	12	2228.4±63.8	2200.0	1975.0	2590.0
	SY	12	2011.6±142.9	1964.5	1051.0	2770.0
	MAT	12	27.1±0.7	26.5	25.0	32.8
AFC	MATR	12	30.3±1.7	28.0	24.6	41.2
	SY	12	28.2±1.2	27.1	24.0	38.0

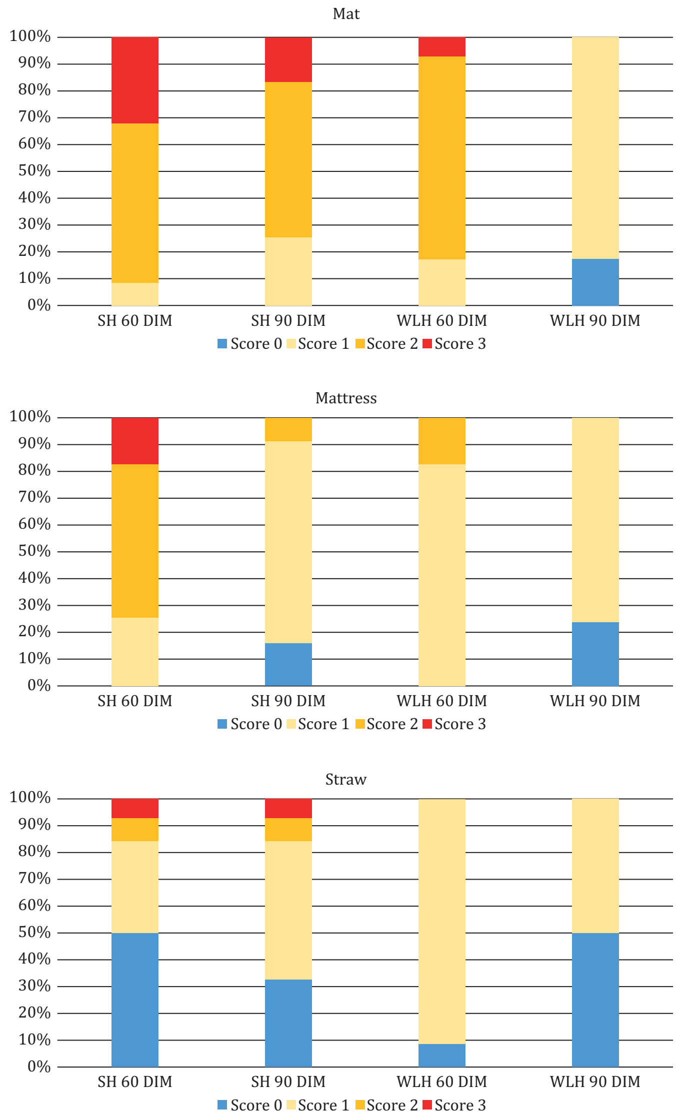
MAT - mats; MATR - mattresses; SY - straw yard; MY - 100-day milk yield; AFC - age at first calving; SEM - standard error of the mean.

We detected SH, WLH, and HHE at 60 and 90 DIM in all heifers. The prevalence of SH at 60 DIM was significantly higher in groups MAT and MATR compared with group SY (P = 0.003). On the other hand, we did not observe any differences for the prevalence of SH at 90 DIM and the prevalence of WLH at 60 and 90 DIM among the three study groups postpartum. The distribution of SH and WLH scores determined in groups MAT, MATR, and SY at 60 and 90 DIM are presented in Figure 1.

While the mean severity score of SH at 60 DIM was significantly higher in group MAT (P<0.001) and MATR (P = 0.002) compared with group SY, no difference was observed between groups MAT and MATR. The mean severity score of SH at 90 DIM was similar in groups MATR and SY, but significantly higher in group MAT (P = 0.005). In group MAT, the mean severity score of SH remained similar during the period from 60 to 90 DIM (2.25 and 1.92, respectively; P>0.05). On the other hand, in group MATR, the mean severity score of SH significantly decreased during the period from 60 to 90 DIM (from 1.92 to 0.92; P<0.001). In group SY, the mean severity score of SH was observed to remain similar between 60 to 90 DIM (0.75 and 0.92, respectively; P>0.05). Furthermore, during the period between 60 to 90 DIM, the mean severity scores of WLH were determined to have significantly decreased in all groups.

While the mean severity score of WLH at 60 DIM was significantly higher in group MAT, compared with groups MATR and SY (P<0.001) (Table 2); no difference was detected among the groups at 90 DIM. Ordinal logistic regression showed that the AFC and 100-day milk yield did not affect the severity of SH and WLH.

In the present study, 92% (33/36) of the animals were diagnosed with mild (1) HHE at 60 and 90 DIM. It was observed that HHE developed in parallel with the junction of the hoof with the skin and had progressed downward to the heel with the growth of the hooves (Figure 2). No differences were observed among the study groups for the prevalence and severity of HHE in the postpartum period. Clinical lameness (LS ≥3) was not detected in any of the groups throughout the study period.



SH - sole hemorrhages; WLH - white-line hemorrhages; DIM - days in milk.

Figure 1 - Distribution of hoof lesion scores in groups mats, mattresses, and straw.

Table 2 - Mean severity scores of sole hemorrhages (SH) and white-line hemorrhages (WLH) in the postpartum period in heifers exposed to different prepartum housing conditions

Hoof lesion	Group	n	Time			P-value		
			At 60 DIM	At 90 DIM	Total	Time	Group	Group × Time
SH	MAT	12	2.25±0.18A	1.92±0.19A	2.08±0.13	0.017	<0.001	0.015
	MATR	12	1.92±0.19Aa	0.92±0.15Bb	1.42±0.19			
	SY	12	0.75±0.28B	0.92±0.26B	0.83±0.19			
	Total	36	1.64±0.17	1.25±0.14				
WLH	MAT	12	1.92±0.15Aa	0.83±0.11b	1.38±0.15	<0.001	<0.001	0.009
	MATR	12	1.17±0.13Ba	0.75±0.14b	0.96±0.10			
	SY	12	0.92±0.08Ba	0.50±0.15b	0.71±0.10			
	Total	36	1.33±0.10	0.69±0.08				

MAT - mats; MATR - mattresses; SY - straw yard; DIM - days in milk.
A,B - Differences between the mean values with different uppercase letters in the same column are significant (P<0.05).
a,b - Differences between the mean values with different lowercase letters in the same row are significant (P<0.05).

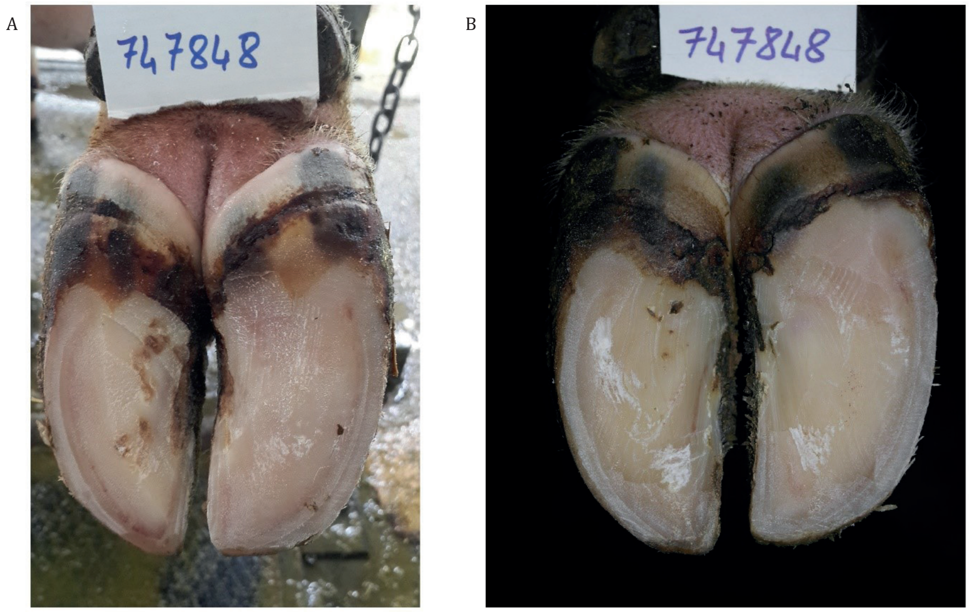


Figure 2 - Appearance of the hoof at 60 (A) and 90 days in milk (B) in a heifer that developed heel horn erosion around calving.

4. Discussion

Hemorrhage in the sole of the hoof is an indication of serum and erythrocyte leakage from the capillary bed of the corium to the claw horn (Bergsten et al., 2015). As is the case with other CHD lesions, hoof hemorrhages generally occur during the transition period and become visible within a period of 8-12 weeks (Leach et al., 1997; Chapinal et al., 2009). In agreement with previous research (Leach et al., 1997; Webster, 2002; Chapinal et al., 2009), the heifers in all three study groups presented with hoof hemorrhages of varying severity at 60 and 90 DIM.

It is indicated that functional hoof trimming contributes to the prevention of hoof diseases and the improvement of the hoof structure (Manske et al., 2002a; Sadiq et al., 2020). Throughout the study period, the hoof lesions of each animal were assessed after performing functional hoof trimming. In the present study, no CHD lesion, except for SH and WLH, having been detected in the animals, was attributed to the beneficial effects of functional hoof trimming.

Previous studies have indicated that WLH are observed as of the second week postpartum and occur earlier than SH (Kempson and Logue, 1993; Leach et al., 1997). As the earliest hoof examinations were performed at 60 DIM in our study, no data was obtained on this particular aspect.

Previous epidemiological research has demonstrated that the prevalence of hoof lesions tends to increase during the first few months after calving. In a study in Holstein heifers, Capion et al. (2009) determined that the prevalence of moderate and severe SH and white line lesions increased from the last four weeks of gestation to 200-250 days postpartum (SH: 27% vs. 56%; WLH: 44% vs. 70%). Randall et al. (2016) indicated that the prevalence of sole lesions (sole hemorrhage and sole ulcers) in dairy heifers increased up to a level of 97% from the prepartum period to the fourth month postpartum. In the present study, the prevalence of SH was determined to have increased up to 100% by 60 DIM in groups MAT and MATR, and up to 83.3% by 90 DIM in group SY. Furthermore, the prevalence of WLH was ascertained to have increased up to 100% in group MAT, 91.7% in group MATR, and 75% in group SY by 60 DIM. These results comply with those of previous reports. The findings of the present study suggest that the transition from heifer to lactating cow (including calving, changes in housing, BCS, feeding, time budgets, etc.) and the occurrence of hoof lesions are associated with each other.

Hoof lesions that occur around calving are indicated to become more severe with adverse environmental factors such as hard flooring (Proudfoot et al., 2010). In the present study, as all three study groups were exposed to uniform nutrition, housing, and management conditions after calving, the differences detected among the groups for the severity of the hoof hemorrhages were attributed to possible previous traumas during the prepartum period.

Cattle prefer to lie on softer surfaces and tend to stand for longer periods in less comfortable areas (Wagner-Storch et al., 2003; Cook and Nordlund, 2009). Mat-based free stalls offer a lower level of comfort in comparison to mattress-based free stalls and are considered to resemble concrete floors (Wagner-Storch et al., 2003). Cattle housed in SY display longer lying times on straw (Singh et al., 1993; Phillips and Schofield, 1994), and their hooves are exposed to less mechanical stress from the flooring when standing on straw (Singh et al., 1993). Therefore, cattle housed in SY present less severe hoof lesions (Webster, 2002; Laven and Livesey, 2004; Bergsten et al., 2015).

In the present study, the mean SH severity score was significantly lower in group SY at 60 DIM and significantly higher in group MAT at 90 DIM. Furthermore, from 60 to 90 DIM, the mean SH severity score was observed to remain similar in group SY, to decrease to a level similar to that of group SY in Group MATR, and to remain significantly higher compared with the other two groups in group MAT. On the other hand, the mean WLH severity score was found to be significantly higher in group MAT at 60 DIM. These findings demonstrate that, in group MAT, which was housed under less comfortable conditions in the last month of gestation, the hooves of the heifers were exposed to adverse flooring effects, whilst in group SY, the heifers were affected only mildly by the flooring. In the present study, group SY having displayed significantly lower levels for both the prevalence and mean severity score of SH at 60 DIM compared with the other two groups, and a significantly lower mean SH severity score at 90 DIM compared with group MAT, shows that the housing of dairy heifers in SY during the prepartum period significantly reduces the severity of hoof lesions in the postpartum period.

Heel horn erosion is generally described as an infectious foot disease, to which environmental conditions associated with poor hygiene cause predisposition (Enevoldsen et al., 1991; Knappe-Poindecker et al., 2013; Bergsten et al., 2015). Offer et al. (2000) reported that the severity of HHE increased during early lactation and decreased during late lactation. Chapinal et al. (2010) indicated that the severity of HHE was significantly higher in mid-lactation compared with early lactation and the prepartum period. We consider that, due to decreased hoof growth and the growth of poor-quality hoof tissue during the calving period (Blowey, 2015), the invasion of infectious agents, including *Dicherobacter nodosus*, in the heels becomes relatively easier, and thereby, the prevalence of HHE increases in mid-lactation, depending on environmental hygiene. We observed that, between 60 to 90 DIM, 92% of the animals had developed HHE, which were localized in parallel with the coronary band and progressed downward over time with the growth of the hooves. In view of the softest region of the hoof tissue being the heel, it is most probable that, during the postpartum period, insufficient and weak hoof tissue growth occurs mainly in the heels. The location of HHE detected in the present study clearly demonstrated that the insufficient growth and poor quality of newly grown tissue are both influential on the development of such lesions. On the other hand, the severity of HHE remaining the same throughout the three-month period after calving suggested that the use of footbaths on the farm where the present study was conducted may have prevented the increase of the severity of these erosions. Footbaths may serve to harden the hooves and control the microbial population present on the hoof (Cook, 2017).

Animals in all three groups, at 60 and 90 DIM, were graded as either score 1 or score 2. The lameness scores assigned, not being high, was attributed to the regular practice of functional hoof trimming and effective footbath treatment having prevented the development of lameness.

5. Conclusions

The housing of dairy heifers in straw yards during the last month of gestation aiming to provide improved flooring and bedding conditions significantly decreases the severity of SH and WLH.

Since 92% of the dairy heifers showed HHE in parallel with the coronary band after parturition, we believe that there may be a relationship between calving and the development of HHE.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: Akköse, M. and İzci, C. **Formal analysis:** Akköse, M. **Investigation:** Akköse, M. and İzci, C. **Methodology:** Akköse, M. and İzci, C. **Supervision:** İzci, C. **Writing – original draft:** Akköse, M. and İzci, C. **Writing – review & editing:** Akköse, M. and İzci, C.

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