

Influence of claw disorders on production and reproduction performance in observed dairy cows herds

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The aim of this study was to evaluate the influence of claw disorders on claw formation, production and reproduction performance of Holstein and Slovak Spotted dairy cows. Claw formation after functional trimming was evaluated by measurement of claw angle, claw length, heel index, claw height, diagonal and claw width. Incidence of interdigital dermatitis and heel erosion, digital dermatitis were observed. Separately was observed the incidence of sole ulcers with the progress of diseases. Measurements were carried out in spring and in autumn. Holstein dairy cows ($n = 101$) with production 11,874.77 kg of milk, 3.94% of fat and 3.34% of protein and Slovak Spotted cows ($n = 101$) with production 5,834.25 kg of milk, 4.44% of fat and 3.59% of protein were included into study. Holstein and Slovak Spotted dairy cows affected with claw diseases produced on the first lactations 553.67, resp. 838.71 kg of milk more than average production of observed groups. On the second and higher lactations dairy cows of Holstein and Slovak Spotted breed affected with claw diseases produced 734.3, resp. 1,118.3 kg of milk less than healthy dairy cows. The occurrence of digital dermatitis was 5.77% and 4.85% in Holstein, resp. in Slovak Spotted breed. Age at the first calving with claw defects was shorter of 24.45 days and the calving interval was longer of 18.52 days in comparison to cows without claw disorders in Holstein breed. Difference in age at first calving was minimal with value 1.85 days on behalf of healthy cows and on the other hand cows with claw defects had shorter calving interval by 4.97 days than healthy cows in Slovak Spotted breed. Statistically significant differences in claws formation were observed in both breeds according to the claw trimming season.

Keywords: Holstein breed, Slovak Spotted breed, claws, interdigital dermatitis and heel erosion

1 Introduction

Claw disorders occurrence is manifested by lameness, decreased BCS and reduction of production (Solano et al., 2015; Von Keyserling et al., 2012; Norring et al., 2014; Bicalho et al., 2009; Randall et al., 2015). Days open prolongation, higher number of services per conception, later start of luteal activity and oestrus after calving as well as influence of lameness on oestrous intensity and external signs of oestrus reported Schrick et al. (2001), Borsberry and Dobson (1989), Collick et al. (1989), Petersson et al. (2006), resp. Walker et al. (2008).

Janssen et al. (2015) observed that incidence of claw diseases has impact on the animals' needs and that the pain limits animal locomotion, what result in decrease of trough visits as well as reduced feeding time, increase of the feeding rate and prolonged lying time. Michie and Andonovic (2015), Thorup et al. (2015) confirmed the influence of lameness on feed intake during the day.

Claw disorders cause almost 90% of all lameness. The most frequent are digital dermatitis, interdigital dermatitis, sole ulcers, heel horn erosion and chronic laminitis (Weaver, 2000).

Interdigital dermatitis and heel erosion (IDHE) is an acute or chronic inflammation of the skin between the claws, extending to the dermis. The lesions are confined to the skin which is usually thickened and are often painful to the touch. In many cases the condition extends to the heel horn resulting in heel erosion. In the initial stages the heel horn develops a pitted appearance but later fissures with undermining of heel horn appears (Shearer et al., 2005).

Digital dermatitis (DD) is focal disease of derma located at the distal part of limbs in cattle. Disease has mostly circular shape, similarly to warts, with hairs and reddish. Disease spot is very painful. Disease can be situated at several locations around the circumference of the claw (Šťastný et al., 2008).

A sole ulcer (SU) is a specific circumscribed lesion of the sole at the sole/heel junction nearer to the axial than the abaxial wall and affecting dairy cows and occasionally beef bulls. It is rarely seen in growing cattle and beef cows. The highest prevalence occurs during late winter after cattle have been housed for 3–6 months. Sole ulcer affects the lateral digits, often involving both hind feet (Scott et al., 2011).

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Leach et al. (2012) resp. Šárová (2011) reported that the lameness detection by farmers is low, ranged from 25 to 40%. Early detection and treatment of lameness is essential to short up healing and decrease the occurrence of relapse. Regular claws' trimming is highly effective as claws disorders and lameness prevention (Leach et al., 2012).

Less lame cows were found at farms with free cubicle housing compared to deep litter housing resp. straw yard (Jurkovich, 2015). Morphological differences in claw formation depending on housing floor type of dairy cows were observed by Somers et al. (2005) and Kremer et al. (2007).

The aim of the study was to evaluate the influence of claw disorders on claw formation, production and reproduction performance.

2 Material and methods

The input data were results of claw measurements and the evaluation of claw disorders occurrence in the selected farms of dairy cows, 101 Holstein cows and 101 Slovak Spotted cows were evaluated. Groups of high productive cows were observed on the both farms. Holstein cows were free cubicle housed and Slovak Spotted-cows were housed on deep litter. Evaluation of claws conformation (Figure 1) and the stage of IDHE were made according to the methodology by Vermuth and Greenough (1995). Digital dermatitis was classified by the methodology of Döpfer (1994). Measurements were realized repeatedly, after functional trimming in spring and autumn. Sole ulcer occurrence was classified separately.

Vermunt and Greenough (1995) described interdigital dermatitis and heel erosion:

- 0 – heel horn intact,
- 1 – slight defect of the horn integrity. pits or small fissures,
- 2 – v-shaped fissures or circular craters, extending small area of the heel,

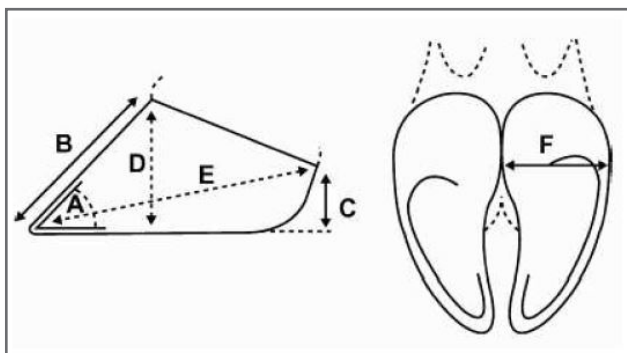


Figure 1 Claw measurements (Vermunt a Greenough, 1995)
A – claw angle (degrees), B – claw length (mm), C – heel index (mm), D – claw height (mm), E – diagonal (mm), F – claw width (mm)

- 3 – v-shaped fissures or circular craters, extending entire heel,
- 4 – profound fissures or craters, extending to the corium of the heel.

Döpfer (1994) classified digital dermatitis:

- M1 – early stage with a circumscribed granulomatous area (lesion 0.5 to 2 cm in diameter).
- M2 – classical ulceration (lesion >2 cm in diameter).
- M3 – healing lesion covered by a scab after therapy.
- M4 – skin alterations due to former M1 or M2 lesion.
- M5 – no lesion or skin abnormalities.

Results of cows milk recording in control year 2013–2014 realized on farms by the Breeding Services of The Slovak Republic, s. e. were used for evaluation of formation influence and the stage of claw defects on production and reproduction traits. Reproduction traits as age at first calving and calving interval were observed. To evaluate the differences between groups was used T-test and the results were statistically analysed by software SAS V 9.2.

3 Results and discussion

3.1 Statistical analysis of production, reproduction traits and of claw measurement in Holstein

Evaluated Holstein farm (Farm 1) belonged to the 20 the top farms in Slovakia. Average milk production of 421 dairy cows from this farm was 9650 kg of milk per lactation. Production of observed 101 dairy cows was by 2,225 kg over the herd average (Table 1). High selection pressure is resulting from age structure of the herd, when 62.37% of all herd are cows at the first lactations ($n = 63$). From long-term point of view this exchange rate of herd is hardly sustainable. Results of performance recording show that the age at first calving is in accordance to average value of Holstein breed in Slovakia. Calving interval of observed cows was about 26 days longer than herd average and in comparison to breed average more than 49 days longer. Average length of production cows' life in herd was 1.99 lactations.

According to analysis of first lactations results, cows affected with claw disorders produced 553.67 kg of milk more than the average of group. Observed differences in production level of cows with defects and cows without claw defects as well as in another production traits resp. in age at first calving were not significant. Age at first calving of animals with claw defects was shorter by 24.45 days which shows possible relationship between high intensity of breeding and reproduction and generally higher disorders occurrence by these animals due to higher metabolic load. On the other side it could refer to reserves in the nutrition management. Explanation of higher milk production of cows during the first lactations affected with claw disorders will necessitate more

Table 1 Production and reproduction traits of Holstein cows in observed herd

Variable	Lactations 1		Lactations 2 and higher		All lactations	
	\bar{x}	s.d.	\bar{x}	s.d.	\bar{x}	s.d.
Milk (kg)	11146.13	2889.92	13082.79	2122.59	11874.77	2781.02
Fat (kg)	438.87	128.35	515	102.08	467.51	124.27
Fat (%)	3.94	0.39	3.94	0.45	3.94	0.41
Protein (kg)	374.89	99.26	430.68	74.04	395.88	94.20
Protein (%)	3.36	0.19	3.29	0.17	3.34	0.18
Age at 1. calv/ Calving interval	800.97	57.30	485.21	131.29	–	–

investigation but could be explained by the observation of Oikonomou et al. (2013). They also observed that cows with at least 1 lesion during their first 3 lactations had also a significantly higher 305 days milk yield compared to cows that had never developed a lameness lesion. Given the detrimental effect of lameness on milk yield was connected with higher milk production of cows before they became lame.

On the second and higher lactations was confirmed generally accepted fact that animals with claw disorders produced less by 734.3 kg of milk and deteriorated reproduction, presented by calving interval prolongation of 18.52 days as possible result of higher days open (Schrack et al., 2001) in comparison to cows without claw disorders.

In total 35 dairy cows were affected by claw disorders in evaluated group of high production cows (occurrence of more than one disorder on cow was observed) what represented 34.7%.

In observed farm incidences of disorders were 21.15% for IDHE, 5.77% for DD and 9.62% for sole ulcers (Figure 2). Animals were during the evaluation fixed in cage, therefore it was not possible to set the locomotion score.

Differences of evaluated measures between healthy and cows affected by the claw disorders were observed by analysis of claw formation. Observed differences were

statistically non-significant (Figure 3). The most important differences of claw conformation were found in case of IDHE and incidence of ulcers, where higher occurrence were observed by cows with longer diagonal and wider claws (overgrowth claws).

Kasarda et al. (2015) found occurrence of IDHE in 16%, DD in 16% and also sole ulcers in 16% at sample of the Holstein breed in Slovakia. Incidence of lameness (Solano et al., 2015) according to the particular herd was observed in range 0–69%. On the other side Von Keyserling et al. (2012) mentioned the average incidence of claw disorders of Holstein cattle from 30 to 55%, where 3 to 8% of cows were severely lame. Jurkovich et al. (2015) reported that impairment claw formation and higher locomotion score resulted in statistically significant decrease of BCS. Noring et al. (2014) reported that lame animals spent significantly shorter time with feeding mainly in initial period of lactation, moreover Bicalho et al. (2009) found substantial decrease of digital cushion in heel area as effect of negative energetic balance at the start of lactation, what Randall et al. (2015) reported as increase of probability, that this animal will be lame.

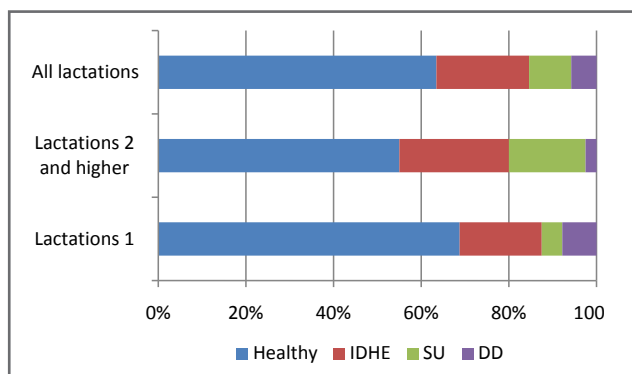


Figure 2 Claw disorders occurrence in Holstein cows

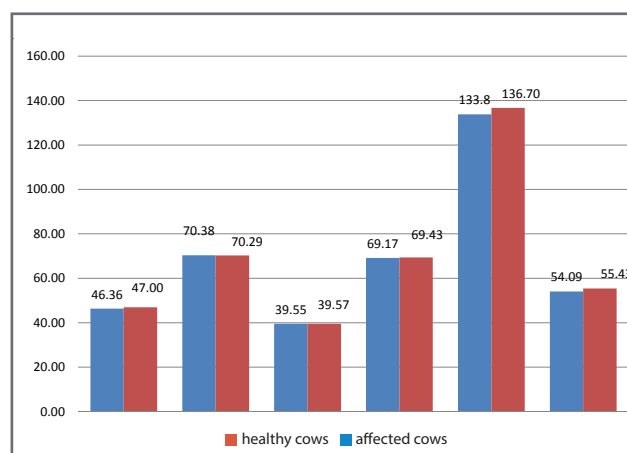


Figure 3 Comparison of claw measurements between healthy and affected cows (A in degrees, B–F in mm)

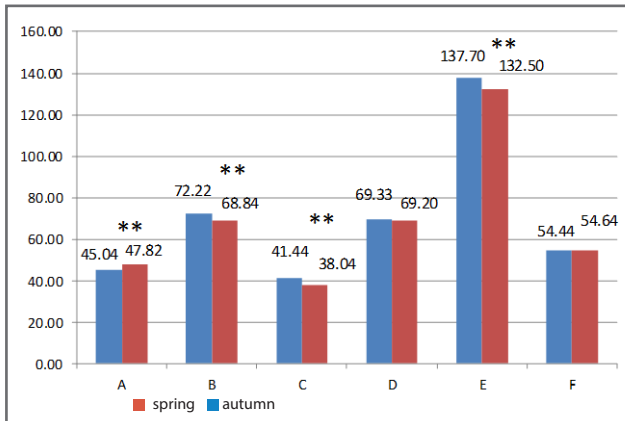


Figure 4 Claw measurements comparison of Holstein dairy cows by seasons, when the functional claw trimming was performed (A in degrees, B–F in mm)
 ** $P < 0.01$, * $P < 0.05$

Differences in claw angle, claw length, heel index and diagonal of Holstein dairy cows according to season, when the functional claw trimming was performed, were observed (Figure 4). Cows trimmed in spring had by 2.78 ° smaller claw angle, 3.38 mm longer claw length, 3.41 mm higher heel index and 5.17 mm longer diagonal compared to cows observed in autumn. Observed differences were highly statistically significant.

3.2 Statistical analysis of production, reproduction traits and claw measurements of Slovak Spotted cows

Average milk production of Slovak Spotted herd with 384 dairy cows was 5588 kg per lactation. Results of performance recording showed that the value of age at the first calving of experimental 101 cows were in accordance to average value of observed herd and by 54 days lower compared to average value of Slovak Spotted breed in Slovakia. Average calving interval was better by 28 days than the average of herd and by 12 days better compared to average of Slovak Spotted breed in Slovakia. Average length of production cow's life in herd was 2.18 lactations.

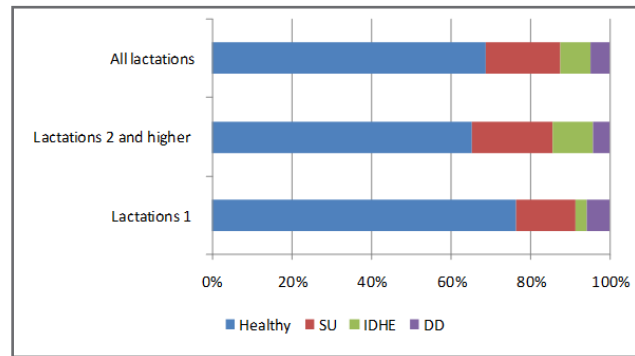


Figure 5 Claw disorders occurrence in Slovak Spotted cows

Cows after the first parturitions affected with claw disorders produced by 838.71 kg more milk than the average of the group. Production differences between affected cows and cows without claw defects were significant. Significant differences in contain of fat (%) were found. Cows without claw defects produced by 0.29% of fat more than affected cows. Difference in age at first calving was minimal with value 1.85 days on behalf of healthy cows.

On the second and higher lactations was confirmed generally valid fact that healthy animal produced by 1118.3 kg of milk, 59.18 kg of fat and 44.45 kg of protein more than cows with claw defects. Observed differences were highly statistically significant. Cows with claw defects had shorter calving interval by 4.97 days than healthy cows.

Thorup et al. (2015) observed the cows proceeding and feeding during a day and found that cows affected with lameness spent in average about 52 minutes less with feeding and 34 times less visited the trough during a day than healthy cows. In group of affected cows was found higher speed of feeding compare to healthy. Significant differences in feeding speed during the period, when cows were affected with lameness found Michie and Andonovic (2015).

In total 30 dairy cows were affected by claw disorders in evaluated group of high production cows (occurrence

Table 2 Production and reproduction traits in observed herd of Slovak Spotted

Variable	Lactations 1		Lactations 2 and higher		All lactations	
	\bar{x}	s.d.	\bar{x}	s.d.	\bar{x}	s.d.
Milk (kg)	5,466.39	1,378.26	6,012.76	1,710.07	5,834.25	1,622.81
Fat (kg)	241.12	58.11	266.21	76.08	258.01	71.40
Fat (%)	4.44	0.33	4.43	0.36	4.44	0.35
Protein (kg)	196.48	49.10	214.72	60.80	208.76	57.64
Pretein (%)	3.61	0.24	3.58	0.20	3.59	0.21
Age at 1. calv/ Calving interval	885.55	130.48	397.12	63.73	–	–

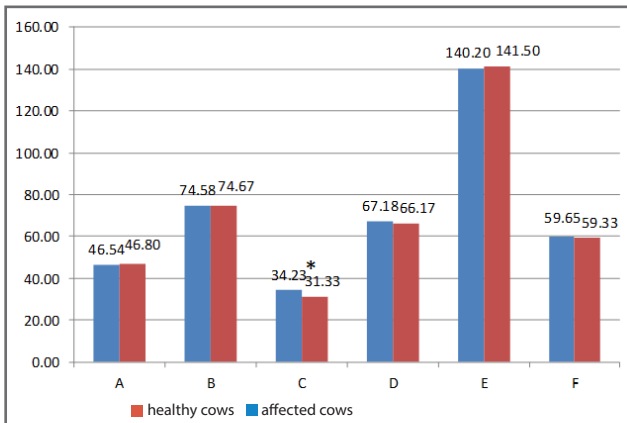


Figure 6 Comparison of claw measurements between healthy and affected cows (A in degrees, B–F in mm)
 ** $P < 0.01$, * $P < 0.05$

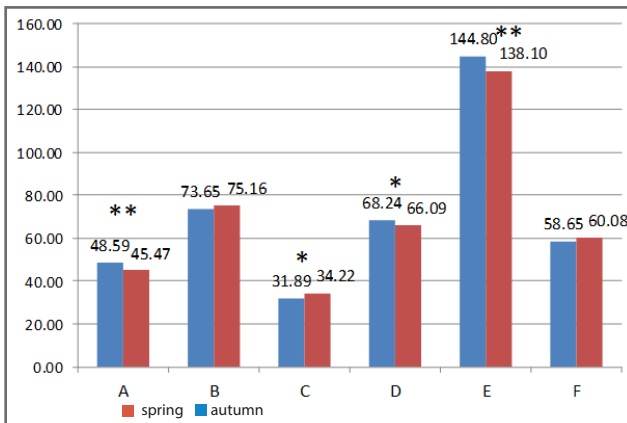


Figure 7 Claw measurements of Slovak Spotted dairy cows by the seasons, when the functional claw trimming was made (A in degrees, B–F in mm)
 ** $P < 0.01$, * $P < 0.05$

of more than one cow disorder was observed) what represented 29.7%.

In observed farm incidences of disorders were 7.77% for IDHE, 4.85% for DD and 18.45% for sole ulcers (Figure 5). Kasarda et al. (2015) reported occurrence of claw disorders IDHE and DD in 8% and sole ulcer in 21% at sample of Slovak Spotted breed. Dippel et al. (2009) reported occurrence of claw disorder in 31% (in range 6–70%) and Rouha-Müllder et al. (2009) in range 0–77% in Simmental cows.

Differences in claws formation of Slovak Spotted cows between healthy and cows with claw disorders were observed. Heel index and claw height of healthy cows were higher compared to affected cows. Observed difference in heel index was statistically significant (Figure 6).

Statistically significant differences were observed in heel index and claw height of Slovak Spotted dairy cows by the seasons, when the functional claw trimming was

performed. Cows trimmed at spring had by 2.33 mm lower heel index and by 2.15 mm higher claw height than cows trimmed at autumn. High statistically significant differences were observed in claw angle and diagonal. Cows trimmed in spring had by 3.13° higher claw angle and by 6.71 mm longer diagonal than cows trimmed at autumn (Figure 7).

Smith (2015) reported prolongation of interval from calving to last service from 80 days to 100 days as influence of lameness. Longer interval from calving to last service of cows affected with sole ulcers connected with longer interval from calving to first service represent, that the diseases have relation to onset of postpartum oestrous cycles (Sogstad et al., 2006). Krupová et al. (2016) found that the economic value of claw disease incidence was -26.73 € per case per cow and year.

Morphological differences in claw shape between cows housed on some concrete types of floor and on deep litter, exceed claw angle were not found. Horn growth was not influenced by type of floor (Somers et al., 2005).

Differences in claw formation of dairy cows housed on concrete-slatted flooring and and rubber-matted slatted flooring observed Kremer et al. (2007). Shorter claw length and higher claw angle were found by cows on concrete flooring.

4 Conclusions

Claw disorders caused the deviations of production performance. First lactation cows affected by claw disorders produced more than healthy cows. In contrast, cows with claw disorders produced less milk during the second and higher lactations compared to healthy cows. Claw disorders had negative influence on production and fertility and were results of metabolic factors complex. Statistically significant differences in claw formation of both herds were observed by repeated functional claw trimming. Even with a higher incidence of deviations in claw formation, with two consecutive trimming it is possible to achieve the correction of claw formation and gait in herd. Functional claw trimming is prerequisite for ensuring good health of claws and it is essential in management of all herds.

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