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Relationship between Claw Traits and Hoof Disorders in Crossbred Dairy Cattle Maintained Under Field Conditions

Rohit Kumar[1], Mukund A. Kataktalware[2*], Letha Devi G[3] and M. Sivaram[2]

[1]M.V.Sc, ICAR-National Dairy Research Institute, Karnal, Haryana, INDIA
[2]Southern Regional Station, ICAR-National Dairy Research Institute, Bengaluru, Karnataka, INDIA
[3]ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka, INDIA

*Corresponding Author: mtalware@gmail.com

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Abstract

The major objective of the present study was to find the relationship between the claw traits measurements and hoof disorders in crossbred dairy cattle maintained under field conditions. Claw traits of 180 crossbred dairy cattle were measured from all four hooves of crossbred dairy cattle and out of them 62 cows were affected with the hoof disorders. Statistical analysis was carried using unpaired (two-tailed) t-test at 95% confidence interval to examine the level of significance for the claw and hoof disorder traits, whereas Spearman correlation test was applied to detect the effects of claw traits on hoof disorders. The results revealed that the claw traits viz. claw length (CL), claw height (CH), lateral claw width (LCW) and interdigital space width (IDW) were significantly higher in cows affected with the hoof disorders in comparison to normal hooves. It can be concluded from the present study that the increased length, height, width, heel height and space between the claws of a cow affected with hoof disorder has a significant correlation of claw traits with hoof disorders.

Keywords: Claw Traits, Crossbred Dairy Cattle, Hoof Disorders

Introduction

Lameness has become a serious concern of welfare throughout the world as it causes pain and discomfort in the suffering animals (Whay and Shearer, 2017). This leads to heavy economic losses to the dairy farmers (Green *et al*., 2014; Thomas *et al*., 2016) due to increase in added costs of treatment, culling, replacement (Whitaker *et al*., 2000) and reduction in the productive as well as reproductive performance of dairy cattle (Tyagi *et al*., 2017). It is reported in the earlier studies that hoof disorders are the major reason behind the occurrence of lameness in dairy cattle (Somers and O'Grady, 2015; Solano *et al*., 2016; Sadiq *et al*., 2017 and Moreira *et al*., 2018) and there are various factors which predispose them to the incidence of hoof disorders (Kumar *et al*., 2019). Distl *et al*. (1984) have concluded in their study that the abnormal shape of the claws in dairy cattle can predispose them to hoof disorders. It has been recognized earlier that the ability to assess the accurate measurements of hoof traits of dairy cattle can be of significant use in the studies of environment and genetic effects on hooves of dairy cattle (Hahn *et al*., 1984). However, there may be variations in measurement taken by different individuals and using a reliable technique or instrument with better precision can be more helpful in taking precise measurements. Various techniques have been used earlier for measurements of claw traits of the dairy cattle i.e. use of divider for measurement and read it using meter ruler (Distl *et al*., 1984; Hahn *et al*., 1984; Boelling and Pollot, 1998), flexible measuring tapes (Laven *et al*., 2015 and Lohith *et al*., 2016), vernier calliper (Telezhenko *et al*., 2009) and digital image analysis using Image J software (Laven *et al*., 2015). However, in comparison of digital image analysis and manual measurements, there was not any acceptable concordance found between digital and manual measurements of the claw traits except for toe angle (Laven *et al*., 2015). As per the available literature, the studies involving the comparison among the claw traits of normal cows and cows affected with hoof disorders and influence of claw traits on the hoof disorders are scanty in the field conditions. Therefore, the objective of the present study was to find the relationship between the claw traits measurements and hoof disorders in crossbred dairy cattle maintained under field conditions.

Materials and Methods

The present study was carried out in crossbred dairy cattle maintained in Doddabalapura Taluk of Bengaluru Rural District, Karnataka, India during November 2017 - May 2018. A total of 180 crossbred dairy cattle were involved in the study comprising of 108 Hf crossbred and 72 jersey crossbred dairy cattle. Different claw traits like claw length (CL), claw height CH), heel height (HH), interdigital space width (IDW), lateral claw width (LCW) and medial claw width (MCW) (Figure 1) were measured from all four hooves (right front hoof (RF), left front hoof (LF), right hind hoof (RH) and left hind hoof (LH)) of all animals. The instrument used for claw trait measurements was digital vernier calliper and measurements unit was millimetre (mm). Data obtained was entered in MS excel 2007 and then loaded into software IBM, SPSS Statistics version 20.0 for analysis in window 10. Unpaired (two-tailed) t-test was used at a 95% confidence interval to know the significance among the claw traits of normal hooves and hooves affected with hoof disorders. For knowing the effect of claw traits on the hoof disorders the Spearman correlation test was used.

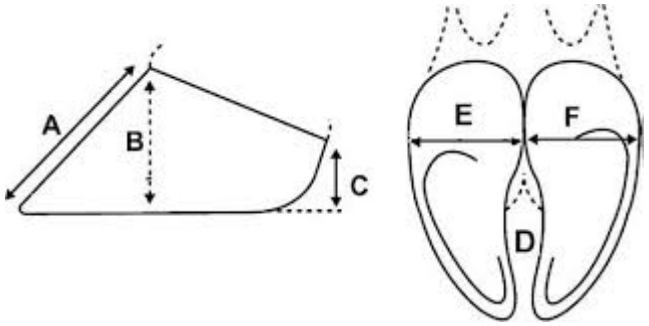

Figure 1: Diagrammatic illustration of claw traits measured during the study (courtesy: Somers *et al*., 2005): A= claw length (CL), B= claw height (CH), C= heel height (HH), D= interdigital space width (IDW), E= lateral claw width (LCW) and F= medial claw width (MCW).

Results and Discussion

Out of 180 crossbred dairy cows utilized for the claw trait measurements, 62 cows were affected with hoof disorders and 118 cows had normal hooves. It was observed that crossbred dairy cattle affected with hoof disorders had higher

measurements for claw traits like CL, CH, HH, IDW, LCW and MCW when compared to the claw traits of normal animals which were not affected with hoof disorders (Table 1). Overall, these results were significant (P<0.05) for claw length (in RF, RH and LH), claw height (in RF, RH and LH), lateral claw width (in LF and LH), and interdigital space width (in all four hooves) but non-significant for medial claw width and heel height (P>0.05) (Table 1). The results of the present study are found to be not in agreement with a study done in Poland by Olechnowicz and Jaskowski (2010), where they didn't find any significant differences in hoof-measurement traits of non-lame cows and hoof disorders affected lame cows. This could be attributed to different types of lesions found in our study in comparison to their study. However, the common lesion for both the study found was the interdigital growth (IDG), where the presence of IDG (0.70%) was found to be lower as compared to the present study (48.8%). Further, difference was recorded in the present study for other lesions were associated with claw wall (43.95%), white line (2.27%) and the heel region of the hoof (3.03%). Therefore, this variation can be attributed to the presence of different kind of lesions in different areas.

Table 1: Mean ±SE of claw traits measurements in normal cows and cows affected with hoof disorders

Parameters		Hf crossbred		Jersey crossbred		Overall	
		Normal (n=62)	**Affected** (n=46)	**Normal** (n=56)	**Affected** (n=16)	**Normal** (n=118)	**Affected** (n=62)
Claw length (mm)	RF	70.04±6.12	71.62±7.41	67.96±6.9	71.02±4.11	69.05±6.21^{a}	71.47±6.69^{b}
	LF	69.16±6.09	71.04±8.72	68.24±6.02	69.68±5.53	68.73±605	70.69±8.00
	RH	70.24±6.32	72.71±7.22	68.03±7.32	71.40±5.31	69.19±6.88^{a}	72.37±6.76^{b}
	LH	69.92±7.03	72.09±7.08	67.71±7.24^{a}	71.79±8.48^{b}	68.87±7.19^{a}	72.06±7.40^{b}
Claw height (mm)	RF	58.04±6.82	59.93±7.44	55.18±5.17^{a}	61.70±6.29^{b}	56.68±6.46^{a}	60.39±7.15^{b}
	LF	57.45±7.35	59.39±6.69	54.83±5.29^{a}	59.96±5.60^{b}	56.21±6.56	59.54±6.38
	RH	57.07±7.10	59.35±7.53	53.34±5.50^{a}	60.31±6.84^{b}	55.30±6.63^{a}	59.60±7.32^{b}
	LH	56.58±6.47^{a}	59.65±6.54^{b}	53.65±5.59^{a}	59.05±6.37^{b}	55.19±6.22^{a}	59.49±6.45^{b}
Lateral claw width (mm)	RF	48.69±4.58	49.49±4.07	47.60±6.00	50.23±5.52	48.17±5.31	49.68±4.45
	LF	48.57±4.27	49.50±365	46.76±3.70^{a}	51.38±6.09^{b}	47.71±4.10^{a}	49.99±4.43^{b}
	RH	48.67±4.37	48.72±3.36	46.42±3.95^{a}	49.70±7.26^{b}	47.60±4.31	48.97±4.63
	LH	48.12±4.14	48.37±4.09	46.57±3.74	47.70±2.83	47.38±4.01^{a}	48.20±3.80^{b}
Medial claw width (mm)	RF	46.11±4.20	46.11±4.41	44.42±3.26^{a}	46.94±3.80^{b}	45.31±3.86	46.32±4.25
	LF	45.91±3.81	45.55±4.02	44.38±3.07^{a}	46.55±4.69^{b}	45.19±3.55	45.81±4.19
	RH	44.94±6.48	45.51±4.05	43.91±3.28^{a}	45.57±5.83^{b}	44.45±5.22	45.53±4.52
	LH	45.62±4.53	45.44±3.64	43.86±3.48	43.33±3.83	44.78±4.15	44.89±3.78
Heel height (mm)	RF	35.89±6.72	36.59±5.48	35.80±7.05	35.41±5.03	35.85±6.85	36.29±5.35
	LF	35.07±6.01	35.71±5.35	34.22±5.16	36.87±5.04	34.67±5.62	36.01±5.26
	RH	33.69±6.06	34.49±4.11	32.57±5.12	33.11±4.40	33.16±5.64	34.14±4.20
	LH	33.30±5.90	35.04±6.28	32.21±5.52	32.28±4.02	32.78±5.72	34.33±5.88
Interdigital space width (mm)	RF	13.24±3.41^{a}	17.65±8.39^{b}	12.90±3.02	14.94±3.63	13.09±3.24^{a}	17.32±7.97^{b}
	LF	12.93±3.29^{a}	17.84±9.18^{b}	12.77±3.33	15.91±2.75	12.86±3.30^{a}	17.61±8.65^{b}
	RH	12.65±3.20^{a}	15.91±5.70^{b}	12.69±3.42	16.15±4.01	12.67±3.29^{a}	15.94±5.46^{b}
	LH	12.63±2.80^{a}	16.72±7.21^{b}	12.40±2.91	13.83±5.80	12.53±2.84^{a}	16.37±7.02^{b}

Mean±SE with different superscripts (a, b) differ significantly (P < 0.05) from each other

There is a variation noticed in the results of different claw traits measurements in the present study (Table 2) in comparison to different studies conducted worldwide under different flooring systems (Telezhenko *et al*., 2009; Dohoo and Martin, 1984; Distl et al., 1984). Telezhenko *et al*. (2009) concluded in their study that different flooring systems had no significant effect on claw traits and their asymmetry. However, the abnormal shape of the hooves predisposes a cow to hoof disorder (Distl *et al.,* 1984). A study conducted by Dohoo and Martin (1984) in North Caroline University reports that claw length and heel height of Holstein Friesian cattle were 42.08 mm and 14.56 mm respectively. Distl *et al*. (1984) reported that claw length and heel height of Holstein Friesian cows were 76.9 mm and 37.5 mm. Telezhenko *et al*. (2009) reported the means of the different claw traits measurements like claw length (88.68±2.33 mm), lateral claw width (56.33±2.01 mm), medial claw width (49.20±1.92mm) and heel height (57.0±1.84 mm) in Swedish Holstein. All these studies involved Holstein Friesian cattle whereas our study involved hf crossbred and jersey crossbred animals of the study area and this difference in inheritance level can be the reason behind the variation.

Table 2: Correlation matrix showing the correlation coefficients between the different claw traits of hoof disorders affected crossbred dairy cattle

Attributes (N=62)	Clrf	Cllf	Clrh	Cllh	Chrf	Chlf	Chrh	Chlh	Icwrf	Icwlf	Icwrh	Icwlh	Mcwrf	Mcwlf	Mcwrh	Mcwlh	Hhrf	Hhlf	Hhrh	Hhlh	Idwrf	Idwlf	Idwrh	Idwlh
Clrf	1																							
Cllf	.740**	1																						
Clrh	.661**	.541**	1																					
Cllh	.606**	.412**	.748**	1																				
Chrf	.581**	.449**	.630**	.520**	1																			
Chlf	.555**	.594**	.651**	.508**	.789**	1																		
Chrh	.459**	.523**	.504**	.320*	.631**	.707**	1																	
Chlh	.534**	.481**	.594**	.557**	.710**	.826**	.743**	1																
Icwrf	.396**	.304*	.374**	.307*	.488**	.416**	.398**	.307*	1															
Icwlf	.371**	.289*	.413**	.223	.409**	.276*	.473**	.287*	.692**	1														
Icwrh	.249**	.204	.213	.057	.330**	.254*	.255*	.272*	.706**	.647**	1													
Icwlh	.460**	.286*	.352**	.361**	.449**	.349**	.239	.494**	.609**	.397**	.569**	1												
Mcwrf	.525**	.393**	.497**	.376**	.578**	.533**	.479**	.424**	.897**	.642**	.654**	.727**	1											
Mcwlf	.412**	.273*	.3*7**	.252*	.453**	.296*	.421**	.375**	.641**	.758**	.616**	.611**	.770**	1										
Mcwrh	.380**	.304*	.368**	.175	.342**	.378**	.307*	.390**	.614**	.544**	.810**	.688**	.770**	.730**	1									
Mcwlh	.359**	.244	.336**	.221	.325**	.313*	.281*	.407**	.592**	.360**	.562**	.770**	.722**	.654**	.764**	1								
Hhrf	.640**	.542**	.614**	.454**	.579**	.610**	.413**	.452**	.590**	.430**	.272*	.481**	.664**	.434**	.375**	.373**	1							
Hhlf	.579**	.490**	.664**	.429**	.615**	.569**	.369**	.369**	.339**	.413**	.200	.258*	.487**	.418**	.363**	.199	.720**	1						
Hhrh	.528**	.510**	.520**	.334**	.529**	.510**	.539**	.605**	.359**	.396**	.392**	.384**	.484**	.519**	.543**	.419**	.612**	.599**	1					
Hhlh	.545**	.446**	.599**	.425**	.296*	.420**	.423**	.537**	.200	.225	.184	.279*	.292*	.308*	.348**	.351**	.526**	.423**	.652**	1				
Idwrf	.582**	.221	.334**	.352**	.330**	.169	.103	.266*	.342**	.237	.169	.353**	.306*	.285*	.205	.302*	.537**	.387**	.391**	.476**	1			
Idwlf	.474**	.181	.283*	.337**	.231	.055	.273*	.307*	.305*	.221	.229	.393**	.286*	.313*	.223	.328**	.346**	.244	.344**	.511**	.788**	1		
Idwrh	.502**	.149	.375**	.507**	.192	.016	.113	.284*	.246	.288*	.117	.415**	.297*	.353**	.252*	.288*	.346**	.315*	.327**	.516**	.599**	.729**	1	
Idwlh	.488**	.199	.508**	.562**	.288*	.154	.085	.349**	.270*	.219	.156	.396**	.328**	.402**	.275*	.333**	.412**	.364**	.352**	.610**	.552**	.617**	.859**	1

***Correlation is significant at the 0.01 level (2 tailed) and * correlation is significant at the 0.05 level (2 tailed)*

Further, the method of measurements involving different instruments (i.e.divider, meter ruler, flexible measuring tapes and vernier calliper etc.) in different studies can have an influence on these measurements and the present study involved the use of digital vernier calliper which have better precision in taking measurements and the measurements were taken by a single person throughout the study to avoid individual variation. It was observed in the present study that the lateral claws were wider than medial claws. Similarly, it was reported in the previous studies that lateral claws of the animals were generally longer, wider and had shallower hoof angle when compared to medial claws (Lohith *et al.,* 2016 and Telezhenko *et al*., 2009). In the present study the effect of claw traits on hoof disorders was found significant ($P < 0.01$) (Table 2). It was found that increased length, height, width, heel height and space between the claws of a cow affected with hoof disorder has a significant association of claw traits with hoof disorders. This finding of our study is in agreement with the findings of a study done by Lohith *et al*. (2016) who reported that as the length, height, width, heel height and space between the claws increases, hoof disorders also increases.

Conclusion

It can be concluded that the measurements for claw traits like claw length, claw height, lateral claw width and interdigital space width are significantly higher in case of cows affected with the hoof disorder in comparison to these claw traits of cows with normal hooves. However, the higher measurements of the medial claw width and heel height of affected hooves were non- significant in comparison to these claw traits of cows with normal hooves. It can also be concluded that increased length, height, width, heel height and space between the claws of a cow affected with hoof disorders has a significant association of claw traits with hoof disorders.

Ethical Permission

This study was approved by The Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) and Institutional Animal Ethics Committee (CPCSEA/IAEC/LA/SRS-ICAR-NDRI-2017/NO. 20).

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Conflict of Interests

There is no conflict of interest.

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