

How effective is individual claw trimming in cattle? An ex-vivo study



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SUMMARY

Claw trimming is an application to give a functional shape to the claws, to maintain foot weight distribution and to prevent foot diseases. Claw trimming should be done by experts. In this study, it was aimed to show the effectiveness of individual claw trimming applied in cattle claws by morphometric measurements.

As material, 85 ex-vivo cattle feet of different races were used. The feet were divided into four groups as right front (n=17), left front (n=17), right hind (n=24) and left hind (n=27). In addition, the claws were divided laterally and medially. After the mechanical cleaning of the claws, functional nail cutting (Dutch method) was applied by different people and morphometric measurements of the claws (claw angle, dorsal wall length, claw height, diagonal length, heel height, inner heel height, sole length, sole width, abaxial white line width and axial white line width).

The claw angle was 49° on the right hind lateral, 47° on the right hind medial, 49° on the left hind medial and within reference ranges on the other claws. Statistically, dorsal wall length of right anterior lateral ($p=0.006$) and left posterior medial ($p=0.01$) claws were significant. Significance was also detected left posterior lateral ($p=0.01$) and left posterior medial ($p=0.01$) claws in diagonal length. Inner heel height was significant on claws of left posterior lateral ($p=0.01$), and there was significant difference on right front lateral ($p=0.02$), left anterior medial ($p=0.03$) and left posterior medial ($p=0.002$) claws in terms of sole width. A positive correlation was found in the correlation analysis between all parameters except claw angle.

As a conclusion, the claw trimming is important manipulation in large animal practice, regardless of the applied claw trimming technique, individual claw trimming has some difference on morphometric shape of the claws, and it should be performed by masters on this.

KEY WORDS

Individual claw trimming, morphometry, claw, cattle.

INTRODUCTION

Chiropody (claw trimming) is a forming process of the claw by cutting its length parts to make functional shape¹. Chiropody also provides better body weight distribution in cattle^{1,2,3}. Claw trimming is applied for the purpose of both diagnostic and prophylactic as well as therapeutically. In herds with high rates lameness, functional or prophylactic claw trimming should be performed⁴.

Movement physiology of the extremities and foot biomechanics are only maintained with settled claw trimming in cattle. Improper claw trimming negatively affects the movement physiology⁵, and disrupts the physiological structures of the cattle. Irregular claw trimming is diagnosed if there is abnormal and asymmetrical appearance on heel horn and walls, axial and abax-

ial walls, toe, and soles⁴.

Hoof care in cattle is important for herd management. The morphometric properties of the claw may differ genetically in cattle, therefore claw morphology should be taken into consideration in terms of preventing foot diseases and determining selection strategies⁶.

By knowing the morphological features of the claw, structural differences that can affect the ability to absorb shock from the floor to the claw can be determined. In addition, the normal morphometric structure of the claws ensures optimum distribution of body weight on the base of the claw. Dorsal wall length, claw angle and heel height are generally expressed in claw morphometry. However, claw height, diagonal length, sole length and width are also important in terms of claw morphometry⁵. Weight distribution differs in cattle in front and hind legs. Body weight is more medial on the forelegs and lateral on the hind legs⁷. With the claw trimming, the broken weight distribution in the claw base is corrected, normal morphometric dimensions of the claw are provided, and better standing and walking of the cattle is ensured⁸.

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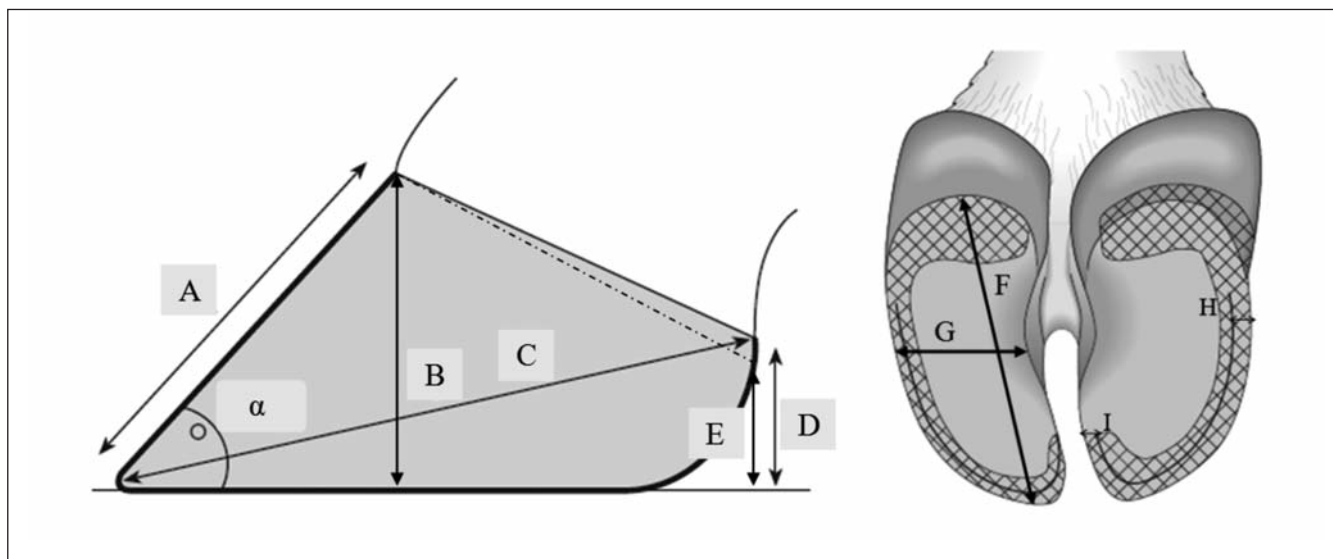


Figure 1 - Claws' morphometric parameters. α : claw angle, A: dorsal wall length, B: claw height, C: diagonal length, D: heel height, E: inner heel height, F: sole length, G: sole width, H: abaxial white line width and I: axial white line width.

The time for optimal claw trimming alters depending on the claw disorders and animal conformation. According to farming, housing system and individual features of animal qualities, chiropody time can be different. Thus, the periodically controls of claws is in a herd with higher lameness prevalence⁴. Generally, claw trimming is two times in a year for healthy herds⁸. The aim of this ex-vivo study is to show effectivity of the individual functional claw trimming by the morphometric measurements.

MATERIALS AND METHODS

In total, 85 different breed cattle feet taken from the slaughterhouse were materials of the study. All feet were removed from carpal and tarsal joints, which were divided into four different groups [right front (n=17), left front (n=17), right hind (n=24) and left hind (n=27)]. In addition, medial and lateral claws were determined as right front lateral claw (RFL), right front medial claw (RFM), left front lateral claw (LFL), left front

medial claw (LFM), right hind lateral claw (RHL), right hind medial claw (RHM), left hind lateral claw (LHL) and left hind medial claw (LHM).

Before trimming, the feet were mechanically cleaned and then all claws were trimmed according to Dutch method by different veterinary surgeons as described previously¹. Trimming of the claws were performed using right-left edged knife, hoof clippers, file and electrical cutting tools.

Calipers, ruler and a specific claw measuring device (Claw-Check®, Demotec, Germany) were utilized for morphometric measurements. Evaluated parameters pointed out in figure 1 were claw angle (α), dorsal wall length (A), claw height (B), diagonal length (C), heel height (D), inner heel height (E), sole length (F), sole width (G), abaxial white line width (H) and axial white line width (I) (Figure 1).

Minimum, maximum, mean and standard deviations of the parameters in each group were calculated and statistical significance ($p < 0,05$) between lateral and medial claws of fore and hindlimbs were analyzed using independent sample t-test for normal distribution and Man-Whitney U test for abnormal dis-

Table 1 - Morphometric measurements in right forelimb and P values ($p < 0,05$).

Parameter	Minimum		Maximum		Mean±Standart Deviations		P values	
	L	M	L	M	L	M	L	M
α (°)	40	40	55	56	47.05±4.16	46.82±4.57	0.722	0.56
A (cm)	4.3	5.1	8.9	9.1	7.51±1.03	7.75±0.98	0.006*	0.133
B (cm)	4.4	5	7.4	7.2	6.04±0.67	6.02±0.48	0.559	0.701
C (cm)	10	10.6	14.6	15.6	12.97±1.22	13.62±1.2	0.319	0.176
D (cm)	3.2	3.2	6.3	5.6	4.5±0.76	4.47±0.62	0.631	0.886
E (cm)	2	2	4.4	3.8	2.87±0.65	2.63±0.54	0.27	0.067
F (cm)	8	7.8	12.4	13.7	10.7±1.15	11.38±1.36	0.583	0.506
G (cm)	3.7	3.6	6	6.1	5.18±0.66	5.28±0.6	0.18	0.026*
H (cm)	0.1	0.1	0.6	0.8	0.46±0.13	0.52±0.17	0.001*	0.217
I (cm)	0.1	0.1	0.5	0.6	0.29±0.13	0.3±0.12	0.02*	0.132

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Significant difference.

Table 2 - Morphometric measurements in left forelimb and P values ($p < 0.05$).

Parameter	Minimum		Maximum		Mean±Standart Deviations		P values	
	L	M	L	M	L	M	L	M
α (°)	40	41	60	54	46.76±4.84	47±3.87	0.07	0.429
A (cm)	6.3	6.6	10.4	10.3	8.18±1.02	8.3±1.02	0.315	0.774
B (cm)	5.2	5.6	7.4	7	6.25±0.56	6.2±0.38	0.459	0.303
C (cm)	12.7	12.5	16.3	16.8	13.91±0.95	14.3±1.07	0.079	0.633
D (cm)	4.5	4.2	6.3	6	5.37±0.51	5.14±0.58	0.899	0.062
E (cm)	2.5	2.2	4.2	4.1	3.31±0.52	3.2±0.55	0.46	0.604
F (cm)	9	9.5	13.1	14.2	11.03±1.16	11.65±1.27	0.884	0.418
G (cm)	4.5	4.5	6.1	5.8	5.35±0.5	5.18±0.48	0.265	0.033*
H (cm)	0.3	0.3	0.8	0.7	0.54±0.13	0.51±0.1	0.291	0.194
I (cm)	0.2	0.2	0.6	0.6	0.33±0.09	0.34±0.11	0.003*	0.065

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Significant difference.

Table 3 - Morphometric measurements in right hind limb and P values ($p < 0.05$).

Parameter	Minimum		Maximum		Mean±Standart Deviations		P values	
	L	M	L	M	L	M	L	M
α (°)	40	39	60	60	49.66±4.97	49.87±5	0.628	0.597
A (cm)	6	6	9.5	9.3	7.75±0.79	7.76±0.7	0.798	0.722
B (cm)	4.8	4.8	7.6	7.8	6.45±0.71	6.39±0.79	0.516	0.281
C (cm)	11.4	11.1	14.8	13.8	12.57±0.82	12.33±0.69	0.264	0.347
D (cm)	2.3	1.5	5.7	5.3	4.06±0.81	3.76±0.94	0.931	0.587
E (cm)	1.4	1.5	3.4	3	2.42±0.44	2.26±0.4	0.542	0.37
F (cm)	9.3	9	12.1	12	10.42±0.8	10.19±0.8	0.323	0.252
G (cm)	4	3.8	6	5.4	5±0.48	4.64±0.38	0.058	0.879
H (cm)	0.2	0.2	0.9	0.9	0.5±0.15	0.45±0.17	0.056	0.101
I (cm)	0.1	0.1	0.7	0.6	0.34±0.16	0.33±0.17	0.082	0.028*

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Significant difference.

Table 4 - Morphometric measurements in left hind limb and P values ($p < 0.05$).

Parameter	Minimum		Maximum		Mean±Standart Deviations		P values	
	L	M	L	M	L	M	L	M
α (°)	38	40	56	57	47.81±4.27	49.11±4.43	0.361	0.487
A (cm)	6.7	6.5	10	10.2	7.89±0.77	7.82±0.74	0.082	0.011*
B (cm)	5.1	4.9	8.2	7.6	6.41±0.74	6.29±0.67	0.957	0.839
C (cm)	10.7	10.5	15.1	14.6	12.61±0.86	12.44±0.8	0.012*	0.015*
D (cm)	2.8	2.8	5.2	5.4	4.13±0.75	4.08±0.76	0.137	0.724
E (cm)	1.2	1.7	4.4	4	2.6±0.64	2.46±0.51	0.013*	0.933
F (cm)	8.6	8.4	12.5	11.5	10.45±1.02	10±0.97	0.053	0.149
G (cm)	3.5	3	5.9	5.2	4.85±0.54	4.56±0.47	0.19	0.002*
H (cm)	0.2	0.3	0.8	0.9	0.5±0.13	0.49±0.13	0.035*	0.001*
I (cm)	0.1	0.1	0.7	0.7	0.32±0.15	0.35±0.15	0.035*	0.136

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Significant difference.

tribution. Pearson correlation analysis was performed to determine the correlation between the morphometric parameters of the lateral and medial claws on the front and hind legs. Statistical calculations were made on software (SPSS version 23, IBM®, USA).

RESULTS

Minimum, maximum, mean, and standard deviations of the claw parameters were given in Table 1, 2, 3, and 4. Although the mean claw angles were found 49° in RHL and

Table 5 - Statistical findings between lateral and medial claws in fore-hind limbs ($p < 0.05$).

Parameter	RF	LF	RH	LH
α (°)	0.877	0.877	0.886	0.279
A (cm)	0.468	0.741	0.97	0.735
B (cm)	0.954	0.751	0.79	0.542
C (cm)	0.127	0.274	0.284	0.468
D (cm)	0.922	0.234	0.224	0.831
E (cm)	0.263	0.529	0.215	0.390
F (cm)	0.122	0.151	0.322	0.101
G (cm)	0.665	0.298	0.007*	0.05
H (cm)	0.17	0.492	0.348	0.632
I (cm)	0.737	0.811	0.546	0.476

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Significant difference, RF: right front, LF: left front, RH: right hind, LH: left hind.

RHM, 47° in LHL, 49° in LHM, angles of the other claws were normal. In terms of A parameters, there was a significant difference for RFL ($p=0.006$) and LHM ($p=0.01$). C parameters of the claws had significant difference LHL ($p=0.01$) and LHM ($p=0.01$). E parameters of LHL ($p=0.01$), G parameters of the RFL ($p=0.02$), LFM ($p=0.03$) and LHM ($p=0.002$) were also significant. The average value of H parameters was 0.46 cm in RFL, and lateral claw was thicker than medial claw at left hindlimb. The average value of I parameters were 0.29 cm in RFL, 0.33 cm in LFL, 0.33 cm in RHM and 0.32 cm in LHL. The fore and hind limb claws were grouped, statistical comparison results between lateral and medial claw parameters of these groups were given in Table 5. There were no significant difference between lateral and medial claws for right forelimb, left forelimb and left hindlimb ($p < 0.05$). However, it was determined that the values of G parameter between lateral and

medial claws at right hind limb had significant difference ($p=0.007$). G parameter of the lateral claw is larger than medial claw.

Correlation coefficient and p values between parameters are given in Tables 6, 7, 8 and 9.

Of all parameters, only the claw angle had a negative correlation with the other parameters. In the correlation analysis of the claw angle with the other parameters, it was observed that there was a negative correlation between the lateral and medial claws of the forelimbs, as well as the A, C, F and G parameters of the hindlimb lateral claws, and A, C and F parameters of the hindlimbs medial claws. In addition, a positive correlation of hindlimbs medial claw angles with B and E parameters was determined. A positive correlation was found in the correlation analysis between all parameters except claw angle.

DISCUSSION

Functional claw trimming helps to adjust weight distribution and balance on hooves in cows. Deformed or weakened claw horn is corrected with claw trimming. Routine claw trimming is an important manipulation for early diagnosis and treatment of the claw lesions as well as preventing the hoof diseases^{2,9}. Morphometric measurements made before and after claw trimming provides information about the suitability of trimming¹⁰. Claw trimming rearranges claw angles and prevents the hoof lesion and disorders^{2,3,4}. For this purpose, in this presented study, evaluation of the randomized individual functional hoof trimming were planned on cow claws and the morphometric measurements were taken on the claw to determinate whether how much individual claw trimming is functional or not.

The purpose of the claw trimming is to prevent the claw lesions, and improve the locomotion by shaping the claws properly⁸. In the functional claw trimming, medial claw length should be 7.5 cm, the shape of the sole and dorsal length are symmetri-

Table 6 - Correlation coefficient and p values between parameters in lateral claws at forelimbs.

Parameter	α (°)	A (cm)	B (cm)	C (cm)	D (cm)	E (cm)	F (cm)	G (cm)	H (cm)
A (cm)	-,450** ,008								
B (cm)	-,071 ,690	,204 ,248							
C (cm)	-,439** ,009	,866** ,000	,354* ,040						
D (cm)	,143 ,420	,246 ,160	,283 ,105	,398* ,020					
E (cm)	,017 ,923	,420* ,013	,273 ,118	,448** ,008	,691** ,000				
F (cm)	-,528** ,001	,648** ,000	,200 ,256	,749** ,000	,006 ,974	,043 ,808			
G (cm)	-,411* ,016	,509** ,002	,249 ,156	,682** ,000	,183 ,300	,241 ,170	,563** ,001		
H (cm)	-,018 ,918	,288 ,099	,145 ,412	,298 ,087	,028 ,875	,055 ,756	,244 ,165	,287 ,100	
I (cm)	,135 ,447	,065 ,714	-,006 ,972	,043 ,808	,242 ,168	,235 ,182	,030 ,866	-,028 ,873	,520** ,002

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Correlation is significant at the 0.05 level, (**): Correlation is significant at the 0.01 level.

Table 7 - Correlation coefficient and *p* values between parameters in medial claws at forelimbs.

Parameter	α (°)	A (cm)	B (cm)	C (cm)	D (cm)	E (cm)	F (cm)	G (cm)	H (cm)
A (cm)	-,524** ,001								
B (cm)	-,155 ,391	,322 ,064							
C (cm)	-,653** ,000	,820** ,000	,410* ,016						
D (cm)	,035 ,843	,449** ,008	,424* ,012	,461** ,006					
E (cm)	-,144 ,417	,552** ,001	,432* ,011	,503** ,002	,826** ,000				
F (cm)	-,531** ,001	,641** ,000	,325 ,061	,874** ,000	,334 ,053	,352* ,041			
G (cm)	-,381** ,026	,554** ,001	,253 ,148	,674** ,000	,043 ,809	,151 ,393	,725** ,000		
H (cm)	-,036 ,838	,307 ,077	,219 ,213	,233 ,185	,179 ,310	,219 ,214	,238 ,176	,312 ,072	
I (cm)	,256 ,144	,046 ,795	,183 ,300	,096 ,588	,405* ,018	,352* ,041	,258 ,141	,276 ,114	,306 ,078

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Correlation is significant at the 0.05 level, (**): Correlation is significant at the 0.01 level.

cally arranged. Solar surfaces in lateral and medial claw should be plain and axial wall should be concave⁹. In our study, although there was no significant difference between dorsal wall length of lateral and medial claws, there was a significant difference within the groups in terms of RFL ($p=0.006$) and LHM ($p=0.01$). A parameter of left forelimb was over 8 cm, and these results were close to normal value in the other limbs. No statistically difference was observed between D parameters.

There are different claw trimming methods in cattle and all methods are performed to reconstitute the weight distribution in the claw. Aim of the claw trimming is to balance weight distribution between lateral and medial claws, and hoof trimmers

should also consider the individual hoof shape for re-constituting of the weight balance¹¹. It has been informed that many claw trimming techniques (Dutch, white line method, Kansas and combine) are performed in the veterinary practice⁴. In the hoof trimming methods, Dutch method is the most commonly applied technique for functional claw trimming and this technique provides the best harmony among claws¹². Considering the literature data, here, we applied to Dutch method as claw trimming technique and evaluated the functionality of the individual application of this technique.

The reported morphometric measurements values of the claw parameters for about 500 kg cow are: claw angle (50° for

Table 8 - Correlation coefficient and *p* values between parameters in lateral claws at hindlimbs.

Parameter	α (°)	A (cm)	B (cm)	C (cm)	D (cm)	E (cm)	F (cm)	G (cm)	H (cm)
A (cm)	-,353* ,011								
B (cm)	,314* ,025	,213 ,134							
C (cm)	-,286* ,042	,781** ,000	,319* ,022						
D (cm)	,261 ,065	,151 ,290	,133 ,351	,289* ,040					
E (cm)	,301* ,032	,155 ,277	-,056 ,696	,190 ,181	,610** ,000				
F (cm)	-,423* ,002	,517** ,000	,155 ,276	,632** ,000	-,288* ,040	-,326* ,020			
G (cm)	,259 ,067	,019 ,897	,390** ,005	,287* ,041	-,092 ,523	,030 ,837	,324* ,020		
H (cm)	,209 ,141	-,019 ,895	,352* ,011	,050 ,725	,087 ,546	,017 ,907	,108 ,449	,429** ,002	
I (cm)	,105 ,465	-,060 ,675	428** ,002	-,038 ,794	-,107 ,457	-,300* ,032	,257 ,069	,188 ,187	,476** ,000

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Correlation is significant at the 0.05 level, (**): Correlation is significant at the 0.01 level.

Table 9 - Correlation coefficient and *p* values between parameters in medial claws at hindlimbs.

Parameter	α (°)	A (cm)	B (cm)	C (cm)	D (cm)	E (cm)	F (cm)	G (cm)	H (cm)
A (cm)	-,328 [*] ,019								
B (cm)	,431 ^{**} ,002	,023 ,871							
C (cm)	-,142 ,319	,693 ^{**} ,000	,109 ,447						
D (cm)	,348 [*] ,012	,101 ,480	,158 ,268	,339 [*] ,015					
E (cm)	,251 ,076	,060 ,673	,082 ,566	,112 ,433	,614 ^{**} ,000				
F (cm)	-,247 ,080	,419 ^{**} ,002	,135 ,345	,554 ^{**} ,000	-,313 [*] ,025	-,401 ^{**} ,004			
G (cm)	,117 ,415	,228 ,107	,360 ^{**} ,009	,294 [*] ,036	,128 ,371	,020 ,888	,521 ^{**} ,000		
H (cm)	,056 ,696	-,070 ,628	,375 ^{**} ,007	,064 ,654	-,001 ,992	-,111 ,440	,223 ,116	,374 ^{**} ,007	
I (cm)	,142 ,321	,042 ,771	,331 [*] ,018	,087 ,543	,021 ,883	-,215 ,129	,272 ,054	,228 ,107	,460 ^{**} ,001

α : Claw angle, A: Dorsal wall length, B: Claw height, C: Diagonal length, D: Heel height, E: Inner heel height, F: Sole length, G: Sole width, H: Abaxial white line width, I: Axial white line width, L: Lateral, M: Medial, (*): Correlation is significant at the 0.05 level, (**): Correlation is significant at the 0.01 level.

front limb and 50-55° for hindlimb), the ratio of dorsal wall length and heel height (2/1), sole length (14 cm), sole width (5 cm), dorsal wall length (6-8 cm), diagonal length (10-14.5 cm), heel height (2.5-3 cm) and distance between sole and capsule (5 mm)^{5,13}. However, it is informed that minimum dorsal wall length should be at least 9 cm for optimal claw weight distribution in cows¹². In this study, the morphometric measurements values of the claw parameters were close to reported values, and except sole width of right hindlimb ($p=0.007$), there was no significant difference between the medial and lateral claws (Table 5). A positive correlation was found in the correlation analysis between all parameters except claw angle. On the other hand, positive and negative effects of the claw trimming are given: positively, routine claw trimming helps to detect unremarkable claw lesions and allow to early manipulations; negatively, if the cow in lactation period, trimming and similar manipulations lead to stress on cow¹¹. Moreover, excessive shorting of the claws and inability to adjust the claw angle by trimming are the other negativities^{8,12,14}. The most common trimming faults of this study were irregular adjustment of the claw angles and very short dorsal wall length, which resulted in decreasing sole thickness. The heel height was about 1.5 cm in some claws, which could be responsible to occurrence of the possible foot diseases, if it is practiced in routine.

CONCLUSION

In conclusion, morphometric parameters of the nail we use in this study is an auxiliary measure in determining the difference between the individual claw trimming. Complying to morphometric measurements, claw trimming in cattle also contributes to the appropriate distribution of body weight to the claws. Even though the claw trimming is important manipulation in large animal practice, regardless of the applied claw trimming technique, individual claw trimming has some difference on morphometric shape of the claws, and it should be performed by masters on this.

References

- Raven T. (1989): Cattle Footcare and Claw Trimming. 2nd ed, Farming Press, Ipswich, United Kingdom.
- Fjeldaas T, Sogstad A.M., Osteras O., 2006: Claw trimming routines in relation to claw lesions, claw shape and lameness in Norwegian dairy herds housed in tie stalls and free stalls. *Prev Vet Med*, 73: 255-271.
- Stoddard G.C., Cramer G. (2017) A review of the relationship between hoof trimming and dairy cattle welfare. *Vet Clin Food Anim*, 33(2): 365-375.
- Mahendran S., Bell N. (2015) Lameness in cattle 2. Managing claw health through appropriate trimming techniques. *In Pract*, 37: 231-242.
- Görgül O.S., Seyrek-Intas D., Salcı H., Gül N.Y. (2002) Süt sığırlarında tırnak uzamasının morfometrik değerlendirilmesi ve tırnak biyomekaniğine etkisi. *Veteriner Cerrahi Dergisi*, 8(3-4): 57-62.
- Kasarda R., Vlcek M., Candrak J., Moravcikova N. (2018) Estimation of heritability for claw traits in Holstein cattle using Bayesian and REML approaches. *J Cent Eur Agric*, 19(4): 784-790.
- Raulkar R.V., Thorat M.G., Kuralkar S.V., Chepte S.D., Waghmare S.P., Kharwadkar M.D. (2016) Morphometric evaluation of hooves in different affections of hoof in cattle. *Int J Agric Sci*, 8(54): 2858-2861.
- Manske T., Hultgren J., Bergsten C. (2002) The effect of claw trimming on the hoof health of Swedish dairy cattle. *Prev Vet Med*, 54: 113-129.
- Van der Tol P.P.J., Van der Beek S.S., Metz J.H.M., Noordhuizen-Stassen E.N., Back W., Braam C.R., Weijs W.A. (2004) The effect of preventive trimming on weight bearing and force balance on the claws of dairy cattle. *J Dairy Sci*, 87: 1732-1738.
- Nuss K., Paulus N. (2006) Measurements of claw dimensions in cows before and after functional trimming: A post-mortem study. *Vet J*, 172: 284-292.
- Van Herterem T., Parmet Y., Steensels M., Maltz E., Antler A., Schlageter-Tello A.A., Lokhorst C., Romanini C.E., Viazzi S., Bahr C., Berckmans D., Halachmi I. (2014) The effect of routine hoof trimming on locomotion score, ruminating time, activity, and milk yield of dairy cows. *J Dairy Sci*, 97: 4852-4863.
- Archer S.C., Newsome R., Dibble H., Sturrock C.J., Chagunda M.G.G., Mason C.S., Huxley N. (2015) Claw length recommendations for dairy cow foot trimming. *Vet Rec*, 177(9): 222.
- Radisic B., Waticic D., Vnuk D., Lipar M., Balic I.M., Ditko B., Smolec O., Orak A., Capak H., Kos J. (2012) Measurements of healthy and pathologically altered hooves, their interrelation and correlation with body mass in Simmental breeding bulls. *Vet Arh*, 82(6): 531-544.
- Olechnowicz J., Jaśkowski J.M. (2010) Hoof measurements related to locomotion scores and claw disorders in dairy primiparous cows. *B Vet I Pulaw*, 54: 87-92.