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Effect of Hoof Trimming Intervention on Milk Yield and Composition in Dairy Lame Cows

Jettaboina Saikiran[1], S.B. Prasanna[1], Mahadevappa D. Gouri[2], G. Mahesh Kumar[3], B.C. Umashankar[4], G.K. Anil Kumar[5], A.M. Nagesh[6], Vivek M. Patil[2]

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ABSTRACT

Background: Hoof lesions and lameness in cattle is currently a serious problem in the dairy industry and significantly affects the health and welfare of animals. High milk yield has been associated with lameness and claw lesions. It was found that 87.5% of lame animals were suffered from claw lesions and hoof lesions were present in all the cows having lameness. Hoof trimming is performed to prevent hoof lesions and improve gait by correction and maintenance of the hoof symmetry and shape. Lameness caused by hoof disorders can be treated by correct hoof trimming. The aim of this study was to know the production performance in dairy cattle before and after hoof trimming.

Methods: In this study twenty lame cows were selected and lameness index score was given to them (0-5 score). The nutrient requirements of the animals were met as per ICAR (2013) through concentrate feed and *ad libitum* green fodder. Care was taken to ensure that feed was provided at same levels throughout the study period and to nullify any effects of feed on lameness. Milk yield in kg/day were recorded before week of hoof trimming (HT) and after hoof trimming intervention it was recorded on 0th day, 3rd day, 6th day, 8th day, 11th day, 14th day.

Result: Our results showed that significant difference (P≤0.05) in milk yield was on 0th day, 3rd day, 6th day and 8th day when compared with before week of HT (13.25±0.83). Significant increase in milk Fat % (P≤0.05) was observed on 11th day and 14th day (4.10±0.04), significant decrease (P≤0.05) in milk SNF % was observed on 0th day, 3rd day, 6th day and 8th day (8.45±0.03), whereas significant difference (P≤0.05) in milk protein % was observed on 0, 3 and 6th day (2.64±0.04) when compared with before week of HT. From this study it was concluded that the hoof trimming intervention has an immediate effect on production performance of dairy cows. Further this is a novel improved intervention using angle cutter modified to trim the hoof which is safe and painless compared to conventional Hoof cutter which caused a lot of cutting and bleeding hooves.

Key words: Dairy cows, Hoof trimming, Lameness, Milk composition, Milk yield.

INTRODUCTION

India is the leading milk producing country in the world with 209.96 million tons during 2020-2021, which was contributed by crossbreed cows (28%), indigenous/non-descript cows (20%), indigenous/non-descript buffaloes (49%), exotic cows (1%) and goats (3%). In spite of this increased cattle population, lameness and hoof lesions in cattle are currently a serious problem in the dairy industry and significantly affects the health, welfare of animals and milk production (Westin *et al*., 2016). Lameness is a painful and costly disease that affects the productivity of cows through its effects on milk production, culling and reproductive performance (Booth *et al.,* 2004). Lameness can be defined as the clinical manifestation of painful disorders, mainly related to the locomotors system, resulting in impaired movement or deviation from normal gait or posture. The severity of lameness can vary from stiffness or decreased symmetry of limb movement to an inability to bear weight on a limb, or even total recumbence. After udder health and fertility, hoof diseases were the third most important reason for culling (Landeskuratorium, 2015). Moreira *et al.* (2018) found that (87.5%) of lame animals suffered from claw lesions and hoof lesions were present in all the cows having lameness. Various researches has shown that Holstein and crossbred dairy cattle are more vulnerable to lameness

Department of Livestock Production Management, Veterinary College, Hebbal, Karnataka Veterinary, Animal and Fisheries Sciences University, Bengaluru-560 024, Karnataka, India.
[1]Department of Livestock Farm Complex, Veterinary College, Gadag-582 102, Karnataka, India.
[2]Department of Livestock Production and Management, Veterinary College, Hebbal, Bengaluru- 560 024, Karnataka, India.
[3]Department of Dairy Engineering, Dairy Science College, Hebbal, Karnataka Veterinary, Animal and Fisheries Sciences University, Bengaluru-560 024, Karnataka, India.
[4]Animal Husbandry Polytechnic College, Konehally, Tiptur-572 201, Karnataka, India.
[5]Department of Animal Sciences, College of Agricultural Sciences, University of Agricultural Sciences, Dharwad-580 007, Karnataka, India.
[6]Department of Animal Husbandry and Veterinary Services, Kengeri, Bengaluru-560 024, Karnataka, India.

Corresponding Author: S.B. Prasanna, Department of Livestock Farm Complex, Veterinary College, Gadag-582 102, Karnataka, India. Email: prasannalpm@gmail.com

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Some of the factors causing lameness are inherited factors (stance, weight, constitution, hoof characteristics), nutritional factors (proteins, minerals, vitamins, toxins), infectious causes (bacteria, virus and rickettsia), environmental factors (climate, housing, road wear and tear) and managemental practices play a major role in its incidence. Many researchers have also reported that age, parity, stage of lactation and breed will also show significant effect on lameness in dairy cows (Bran *et al.,* 2018). Trimming is now a fundamental part of lameness management programme in any dairy farms because of its high preventive effects. Trimming of hooves significantly affects the milk fat and milk protein compositions. HT is performed to prevent hoof lesions and improve gait by correction and maintenance of the hoof symmetry and shape, which ensures correct weight bearing. The therapeutic hoof trimming treats foot disorders and significantly effects milk production. HT has positive effects on decreasing the lameness incidence, reducing the incidence of hoof lesions and increasing fat and protein contents of milk. The higher incidences of lameness were reported in high yielding cross breed cows in Karnataka. Lameness can be reduced by proper hoof care management and hoof trimming. Thus, the present study was undertaken to know the effect of hoof trimming on milk production and composition of the dairy cows.

MATERIALS AND METHODS

Experimental design

An experiment was conducted in Bengaluru area by selecting the animals based on the required criteria. In this study twenty lame cows of mixed parity were selected for hoof trimming. The nutrient requirements of the animals were met as per ICAR (2013) through concentrate feed and *ad libitum* green fodder. Cows were offered 2-3 kg of concentrates during milking time at the rate of 400g per litre of milk produced. Around 20 kg of green fodder consisting of Maize and Napier crops and 3-5 kg of dry fodder consisting of ragi straw as dry fodder was offered daily. The feed was offered twice daily. Care was taken to ensure that feed was provided at same levels throughout the study period and to nullify any effects of feed on lameness. Lameness index score was allotted to the lame animals as mentioned by (Sprecher *et al.,* 1997) 1-5 score card. Milk yield was recorded and milk composition (fat, SNF, proteins, *etc*) was analyzed using automatic milk analyzer before hoof trimming prior to one week. After recording these parameters for one week, hoof trimming was performed on these animals. Then after performing hoof trimming these observations were recorded again. Milk yield and milk composition were recorded on 0^{th}, 3^{rd}, 6^{th}, 8^{th}, 11^{th} and 14^{th} day after hoof trimming. The recordings were compared before and after hoof trimming. Functional hoof trimming, also referred to as 'the Dutch method', was adopted in this study. The basic instruments used were hoof knives, chisel, hammer, Hoof cutter, hoof tester and long handle nippers and electric hand held angle cutter grinder and the specially designed travis for for restraining the animals and for hoof trimming has been shown in Plate 1. The data collected on parameters such as milk yield, milk fat and protein and SNF % were systematically classified and were analyzed using Paired test and statistical analysis was done with the help of SPSS 16.0 statistical software package.

Productive parameters

The productive parameters *viz*., Daily milk yield (kg) and milk compositions (%) were recorded for the throughout the study period. The cows were machine milked twice in a day; morning and evening milk yield recorded for individual cows were recorded by using digital weighing balance and the milk compositions *viz*., fat (%), protein (%), SNF (%), were analyzed one week before hoof trimming and after hoof trimming with the help of auto milk analyzer (KSHEERAA 270A).

RESULTS AND DISCUSSION

Incidence of hoof lesions in dairy cows

After hoof trimming, few claw diseases like sole hemorrhage, white line disease, sole ulcer, digital dermatitis, double hoof and overgrown hoofs were detected in animals. Out of the total claw lesions in the herd, (5%) were affected with double hoof, (5%) were affected with digital dermatitis, (5%) with sole hemorrhages, (20%) with white line disease, (30%) with sole ulcers and (35%) were effected with overgrown hoof. Incidence of hoof lesions is depicted in Fig 1.

Milk yield

The data on milk yield in kg/day for before week and after hoof trimming intervention under this study have been presented in Table 1. The mean milk yield (kg/day) of animals one week before the hoof trimming was 13.25±0.83, after hoof trimming mean milk yield on 0^{th} day was11.90±0.77, on 3^{rd} day it was 11.91±0.78, on 6^{th} day it was 12.16±0.79, on 8^{th} day it was 12.71±0.81, on 11^{th} day it was 12.98±0.84 and on 14 h day it was 13.38±0.85. There was an increase and a decrease of milk yield recorded in animals. The milk yield decreases were evident on hoof trimming day. The results showed that there was significant difference ($P \leq 0.05$) in milk yield on 0^{th} day, 3^{rd} day, 6^{th} day, 8^{th} day and 11^{th} day ($P=0.000$) when compared with before week of hoof trimming. Whereas on 14^{th} day there was no significant difference when compared with before week of hoof trimming. The milk yield was drastically reduced after hoof trimming in the initial days and again the increased trend was started from 11^{th} day onwards, finally reaching its normal on 14^{th} day which is similar to prior week before hoof trimming. Overall HT effected the milk yield in initial days and after this raise in milk yield is noticed which shows that HT has almost positive effect on milk yield in long term.

The results of the present study with respect to milk yield are in agreement with the findings of Erol *et al*. (2019), where they performed functional hoof trimming on twenty Simmental dairy cattle. Comfortable walking and standing, equal weight distribution on hooves and correct claw shapes

after hoof trimming increase the milk yield and it has positive effect on prevention of claw diseases (Izci *et al*., 2018).The results of our study are in accordance with the results of Nishimori *et al.* (2006) where they examined the effect of one-time hoof trimming on milk yield and found no increases in milk yield after hoof trimming. It decreased on the trimming day and after the trimming periods. This condition was correlated to the hoof trimming stress. However, the different

Right and left hoof knives

Specially designed travis for hoof treatment.

Traditional Hoof cutter

Electric angle grinder

Multipurpose grinder wheel

Plate 1: Equipments used for hoof treatment.

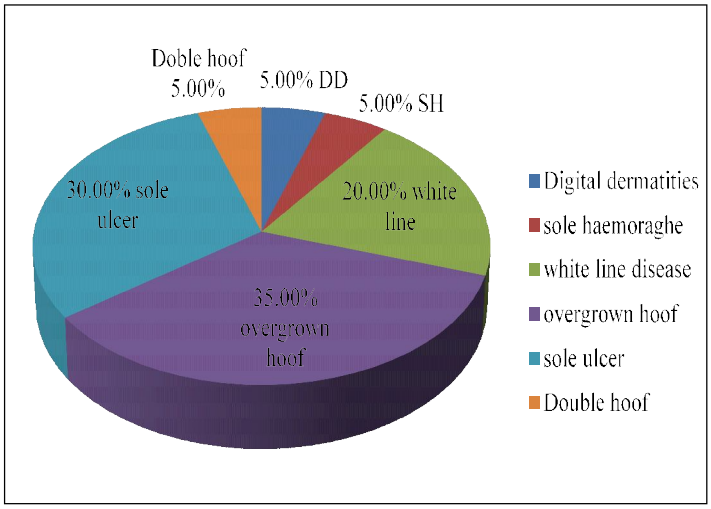

Fig 1: Incidence of hoof affections in dairy cows.

number of milkings and stage of lactation could affect milk production.

The results of our study are in agreement with the findings of Pesenhofer *et al*. (2006) where they compared the effect of functional hoof trimming with 2 different types of trimming set-ups, a mobile walk-in crush and a tilt table. In both groups milk yield was 0.6 L lower on the day of claw trimming and the day after. Milk yield reduction was significant on the day of hoof trimming and one day after hoof trimming which are in agreement with our study.

In contrast to our study, Sogstad *et al*. (2007) reported that cows started to give more milk after HT than before HT. In another study by Kibar and Caglayan (2016) they observed that one-time HT increased milk production in dairy cattle with hoof disorders in commercial dairy farms. Yakan (2021) objectified to reveal the importance of hoof trimming (HT) in cows by determining the changes in feed consumption and milk yield, in the days before and after HT in cows with hoof deformities. Daily feed consumption and milk yield findings were recorded on days the 1, 7 (before HT), 13 (on the day of HT), 19, 25 and 31 (after HT) of the study. According to the findings of this study, after HT increased feed consumption and milk yield in cows were noticed (P<0.05). Novotna *et al*. (2019) found that higher milk production was observed in dairy cows with locomotion score 2, 3 and 4 and a significant decrease was found in locomotion score 5. According to Gundelach *et al.* (2013), early hoof trimmer intervention in lame cows resulted in a tendency toward higher milk yield at 100 DIM.

Taguchi *et al*. (2001) reported a similar experiment, but no differences in milk production and composition were showed in their research. In another study by Tanaka *et al*. (1994), observed that HT slows down the rate at which milk production reductions in cows in the late lactation period.Van Hertem *et al.* (2014) reported that the effect of hoof trimming on milk yield for dairy cows tended to depend on the parity of the cows (P=0.068) and lactation stage (P< 0.001), activity level (P=0.002) and ruminating time (P<0.001). Each 1-min increase in daily ruminating time increased the milk yield by 3.1 kg/d. Each 1-bit increase in daily activity level increased the milk yield by 0.9 kg/d.

Many researchers have reported milk yield in the lactation stage is affected by herd factors such as management and nutrition and individual factors as genetics, parity and disease. Differences in the literature about the influence of lameness and hoof disorders on milk production are compared to the conclusion of these complex effects.

Milk composition

Milk fat percentage

The data on mean per cent of milk fat for before week and after hoof trimming intervention under this study have been presented in Table 2.

The mean Fat % of animals one week before HT was 3.72±0.03, after hoof trimming mean Fat % on 0th day was 3.54±0.05, on 3rd day it was 3.60±0.04, on 6th day it was 3.67±0.04, on 8th day it was 3.80±0.04, on 11th day it was 3.92±0.04 and on 14h day it was 4.10±0.04. The results showed that there was significant difference (P≤0.05) in milk fat % on 0th day and 3rd day, (P=0.000, P=0.006) when compared with before week of hoof trimming. Whereas on 6th day and 8th day there was no significant difference when compared with before week of hoof trimming. Significant increase (P≤0.05) was observed on 11th day and 14th day, (P=0.002, P=0.000). We observed that on the day of hoof trimming fat % was reduced. Then from 3rd day onwards we noticed increased fat %, this was continued upto14th day. On 8th, 11th and 14th day fat % was more when compared to the before week of hoof trimming. Overall HT effected the milk fat % in initial days and after this raise in milk fat% is noticed which shows that HT has almost positive effect on milk fat % which is higher than before HT.

The results of the present study were in agreement with the findings of Nishimori *et al.* (2006) where they examined the effect of one-time hoof trimming on milk fat composition and reported that, subsequently milk fat composition (4.4±0.4 to 4.6±0.5) were increased significantly after hoof trimming. Olechnowicz and Jaskowski (2010) reported that the month of lactation differentiated cows in terms of milk fat and protein yields. In the first months of the lactation, cows produced more milk fat than in the following months of early lactation (P<0.01). In contrast to our study Van Straten *et al*. (2011) reported reduced milk fat per cent. But in our study however, milk fat percentage decreased on day

Table 1: Paired t test analysis for milk yield kg/day in dairy cows one week before HT and after HT on day 0, 3, 6, 8, 11 and 14.

Days	Mean±SE	P value
One week before HT	13.25±0.83^{a}	
0th day	11.90±0.77^{b}	0.000
3rd day	11.91±0.78^{b}	0.000
6th day	12.16±0.79^{b}	0.000
8th day	12.71±0.81^{b}	0.000
11th day	12.98±0.84^{b}	0.002
14th day	13.38±0.85^{a}	0.127

Note: Means within a column bearing different superscripts differ significantly (P≤0.05).

Table 2: Paired t test analysis for milk fat % in dairy cows one week before HT and after HT on day 0, 3, 6, 8, 11 and 14.

Days	Mean±SE	P value
One week before HT	3.72±0.03^{a}	
0th day	3.54±0.05^{b}	0.000
3rd day	3.60±0.04^{b}	0.006
6th day	3.67±0.04^{a}	0.280
8th day	3.80±0.04^{a}	0.190
11th day	3.92±0.04^{b}	0.002
14th day	4.10±0.04^{b}	0.000

Note: Means within a column bearing different superscripts differ significantly (P≤0.05).

of HT and began to increasing on 11th day. On the 14th day, the overall milk fat percentage level increased, surpassing the previous week of HT. In contrast to our studies Taguchi *et al*. (2001) reported that after hoof trimming there was no change in milk fat composition. But in our study, after HT, the overall milk fat percentage level increased, surpassing the previous week of HT. In contrast to our studies Baek *et al.* (2016) mentioned that after hoof trimming there was decrease in milk fat composition. But in our study, after HT, the overall milk fat percentage level increased, when compared to the previous week of HT.

Milk solids not fat percentage (SNF %)

The data on mean per cent of milk SNF for before week and after hoof trimming intervention under this study have been presented in Table 3. The mean SNF % of animals one week before HT was 8.53±0.03, after hoof trimming mean SNF % on 0th day was 8.25±0.04, on 3rd day it was 8.26±0.02, on 6th day it was 8.34±0.02, on 8th day it was 8.45±0.03, on 11th day it was 8.49±0.03 and on 14 h day it was 8.48±0.03.The results showed that there was significant decrease (Pd"0.05) in milk SNF % on 0th day, 3rd day, 6th day and 8th day (P=0.000) when compared with before week of hoof trimming. Whereas on 11th day and 14th day there was no significant difference when compared with before week of hoof trimming (P=0.423, P=0.376). We observed that on the day of hoof trimming milk SNF % was reduced. Then from 3rd day onwards we noticed increased SNF %, which was continued upto14th day. This increased trend continued up to 14th day but which was less when compared to SNF % of the before week of hoof trimming. Overall HT effected the milk SNF % in initial days and after this raise in milk yield is noticed which shows that HT has almost positive effect on milk SNF % in long term from our study.

The results of Taguchi *et al.* (2001) are in agreement with our results where they reported that after hoof trimming there was no change in milk SNF composition. In our study, milk SNF percentage was decreased on the day of HT and reached normal level on 14th day, which is similar to before week of HT. The results of Baek *et al*. (2016) are in agreement with our results where they reported that after hoof trimming there was a decrease in milk SNF composition. In our study milk SNF percentage was decreased on the day of HT and reached normal on 14th day of HT.

Milk protein percentage

The data on mean per cent of milk protein for before week and after hoof trimming intervention under this study have been presented in Table 4. The mean protein % of animals one week before HT was 2.90±0.01, after hoof trimming mean on 0th day was 2.60±0.03, on 3rd day it was 2.58±0.04, on 6th day it was 2.64±0.04, on 8th day it was 2.84±0.04, on 11th day it was 2.92±0.03 and on 14th day it was 2.96±0.02. The results showed that there was significant difference (P≤0.05) in milk protein % on 0th day, 3rd day and 6th day (P=0.000) when compared with before week of hoof trimming. Whereas on 8th day, 11th day and 14th day there was no significant difference when compared with before week of hoof trimming (P=0.104, P=0.422, P=0.207).We observed that on the day of hoof trimming milk protein % was reduced. The reduction in milk protein % was also observed on 3rd day, 6th day. From 8th day onwards increase in milk protein % was observed and it continued up to 14th day. When compared with before week of hoof trimming milk protein % was more on 11th and 14th day after hoof trimming. Overall HT effected the milk protein% in initial days and after this raise in milk protein % is noticed which shows that HT has almost positive effect on milk protein% which is higher than before HT.

The results of the present study were in agreement with the findings of Nishimori *et al.* (2006) who examined the effect of one-time hoof trimming on milk protein composition and reported that, milk protein composition (3.4±0.2 to 3.6±0.3) increased significantly after hoof trimming. The month of lactation differentiated cows in terms of milk fat and protein yields. In the first months of the lactation, cows produced more milk, fat and protein than in the following months of early lactation. The increased protein % may be due to feeding management in the experimental animals and there may be influx of plasma proteins (Olechnowicz and Jaskowski, 2010).

In contrast to our studies Taguchi *et al.* (2001) reported that after hoof trimming there was no change in milk protein composition. But in our study, after HT, the overall milk

Table 3: Paired t test analysis for milk SNF % in dairy cows one week before HT and after HT on day 0, 3, 6, 8, 11 and 14.

Days	Mean±SE	P value
One week before HT	8.53±0.03 [a]	
0th day	8.25±0.04 [b]	0.000
3rd day	8.26±0.02 [b]	0.000
6th day	8.34±0.02 [b]	0.000
8th day	8.45±0.03 [b]	0.030
11th day	8.49±0.03 [a]	0.423
14th day	8.48±0.03 [a]	0.376

Note: Means within a column bearing different superscripts differ significantly (P≤0.05).

Table 4: Paired t test analysis for milk protein % in dairy cows one week before HT and after HT on day 0, 3, 6, 8, 11and 14.

Days	Mean±SE	P value
One week before HT	2.90±0.01 [a]	
0th day	2.60±0.03 [b]	0.000
3rd day	2.58±0.04 [b]	0.000
6th day	2.64±0.04 [b]	0.000
8th day	2.84±0.04 [a]	0.104
11th day	2.92±0.03 [a]	0.422
14th day	2.96±0.02 [a]	0.207

Note: Means within a column bearing different superscripts differ significantly (P≤0.05).

protein percentage level increased when compare to the previous week of HT. In contrast to our results, studies by Baek *et al.* (2016) reported that after hoof trimming there was a decrease in milk protein composition. But in our study, after HT, the overall milk protein percentage level increased when compare to the previous week of HT.

CONCLUSION

Taking in to consideration all the results recorded in the present study, it could be concluded that Hoof Trimming (HT) intervention in lame animals showed an increase in milk fat percentage. Though there was a decrease in milk yield in initial days, it reached a normal level on the 14th day. The hoof trimming process has a significant improvement on the cow's locomotion. So HT can be recommended for farmers when the animals are identified as lame as it shown positive effect towards increase in fat percentage. Apart from this hoof trimming time, environmental factors such as flooring system and management style and the animal related factors such as lactation period and stage, number of milking, breed and age affect the milk yield with hoof trimming either positively or negatively. It is recommended that these factors should be considered in future studies. In light of all this information, HT is necessary to ensure healthy claws, prevent lameness and increasing the performance of dairy cows. Further this is a novel improved intervention using angle cutter modified to trim the hoof which is safe and painless compared to conventional Hoof cutter which caused a lot of cutting and bleeding hooves.

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