The Occurrence of Teat Hyperkeratosis in Cows and Its Effect on Milk Somatic Cell Counts

İneklerde Meme Başı Hiperkeratozunun Rastlantısı ve Süt Somatik Hücre Sayısına Etkisi

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ABSTRACT Objective: In this study, the frequency of hyperkeratosis and its effect on milk somatic cell counts were researched. **Material and Methods:** A total of 2332 teats in 583 Holstein cows in different stage of lactation were evaluated on the base of the criteria of morphological structure of the teat end and teat length, milk yield and number of lactations. Macroscopic appearances of lesions on the teat orifice were classified and also were photographed. Somatic cell counts (SCC) were evaluated using the fossomatic method. **Results:** The SCC was determined to be less than 200.000 cells/mL in 72.8% of the quarters and greater than this in 27.2%. Forty-nine percent of the teat ends were normal while hyperkeratosis was identified in 51%. Hyperkeratosis degrees of 1, 2, 3, 4 and 5 was determined in 17%, 13.8%, 9.2%, 5% and 6% respectively. The study findings demonstrated that there was a significant rise in SCC parallel to increasing severity of hyperkeratosis ($p<0.001$) and that even mild hyperkeratosis could result in an increase in SCC ($p<0.05$). A significant correlation was determined between severe hyperkeratosis and pointed teat ends ($p<0.001$). The relationship between hyperkeratosis and milk yield was determined to be significant ($p<0.001$). However the connection between number of lactations and teat length with hyperkeratosis was not identified as statistically significant. **Conclusion:** It was concluded that pointed teat ends have a greater tendency to develop hyperkeratosis, the development of hyperkeratosis increased as milk yield dropped and hyperkeratosis could result in a significant increase in SCC and consequently pose a risk to udder health.

Key Words: Cattle; hyperkeratosis, epidermolytic

ÖZET Amaç: Bu çalışmada; hiperkeratozun rastlantısı ve süt somatik hücre sayısına etkisi araştırıldı. **Gereç ve Yöntemler:** Çalışma, laktasyonun farklı dönemlerinde bulunan 583 baş Holstein ineğe ait 2332 adet meme başında değerlendirildi. Çalışmada laktasyon sayısı, süt verimi, meme başı ucunun morfolojik yapısı ve meme başı uzunluğu kaydedildi. Meme başı deliğinde yer alan lezyonların makroskopik görünümleri sınıflandırıldı ve fotoğrafları kaydedildi. Somatik hücre sayımları (SHS) fossomatik yöntemiyle değerlendirildi. **Bulgular:** Somatik hücre sayısı meme loblarının %72,8'inde 200 000 hücre/mL'den düşük, %27,2'sinde ise yüksek olarak tespit edildi. Meme başlarının %49'u normal olup, %51'inde ise hiperkeratoz belirlendi. Bir, 2, 3, 4 ve 5. derece hiperkeratoz oranları sırasıyla %17; %13,8; %9,2; %5 ve %6 olarak tespit edildi. Çalışma bulguları, hiperkeratoz şiddetindeki artışa paralel olarak SHS'ında önemli bir yükselme olduğunu ($p<0,001$) ve orta derece hiperkeratozların da SHS'nda yükselmeye neden olabileceğini gösterdi ($p<0,05$). Şiddetli hiperkeratoz ile sivri tip meme başı uçları arasında önemli düzeyde bir ilişki tespit edildi ($p<0,001$). Süt verimi ile hiperkeratoz arasındaki bağlantı anlamlı ($p<0,001$) bulundu. Bununla beraber, meme başı uzunluğu ve laktasyon sayısı ile hiperkeratoz oluşumu arasında istatistiksel açıdan önemli düzeyde bir bağlantı saptanmadı. **Sonuç:** Sonuç olarak, sivri şekilli meme başlarının hiperkeratoz oluşumuna daha yüksek oranda eğilimli olduğu, süt verimindeki azalma ile beraber hiperkeratoz derecelerinin yükseldiği, hiperkeratozun yüksek SHS artışı ve dolayısıyla meme sağlığı yönünden bir risk oluşturabileceği kanısına varıldı.

Anahtar Kelimeler: Sığır; hiperkeratoz, epidermolitik

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The healthy condition of the teat end orifice is recognized as a significant factor in resistance to the mastitis pathogen, which is an important economic challenge in dairy herds.[1,2] The occurrence of hyperkeratosis, which is defined as slightly swollen tissue consisting of either smooth or rough keratin plaque in a ring that surrounds the teat end orifice, can progress in a natural process from mild to severe and from erosion to scabs.[3] A white ring 2 mm in diameter around the teat end is observed at the beginning of lactation and is an indication of the physiological adaptation that continues throughout lactation.[2,4] The primary factors that impact the development of hyperkeratosis are the milking process, machine factors and seasonal weather conditions.[5,6] Many researchers indicate that factors related to the cow such as the shape of the teat end, its position and length, milk yield, lactation period, and parity as well as factors such as length of milking period, empty milking and the milking machine have an impact on the development of hyperkeratosis.[4,6-8] Changes to the skin at the teat end due to chemical irritation or bad weather conditions can be observed within a few weeks. Hyperkeratosis is said to increase noticeably in the first 2-8 weeks of lactation.[5,8]

Gleeson et al. demonstrate that hyperkeratosis in cows that are not disinfected after milking causes a significant increase in the somatic cell count.[9] Neijenhuis et al. report that there is a significant connection between clinical mastitis and hyperkeratosis and that hyperkeratosis poses a risk for mastitis.[10] However, there are other studies which report that there is no connection.[4,6,11]

The purpose of this study is to identify the frequency and variety of lesions forming on the teat end orifice in dairy cows and to research the effect these lesions have on milk somatic cell counts.

MATERIAL AND METHODS

HERDS AND COW SELECTION

This study was carried out at commercial dairy farms in Konya and Ankara between March 2008 and February 2009. The animal material consisted of 583 Holstein milk cows ranging from 3-12 years of age. The cows in the study were being milked with a milking machine twice a day and were sheltered in half-open, free-range barns in winter, spring/fall and summer. The cows in all of the enterprises were being raised with appropriate shelter and care. Milking management and hygiene conditions of enterprises included use of post-milking teat disinfection, milking hygiene, culling for chronically infected animals, antibiotic treatment for dried cows off and clinical events.

DATA

A one-time evaluation of the cows was made on visits to the enterprises during the study. This evaluation recorded the morphological structure of the teat end and the length of the teat, as well as the macroscopic appearance of lesions on the teat end orifice and photographs were taken (Figure 1). Hyperkeratosis (HK) which forms around the teat end orifice was evaluated with the six-point scoring system described by Shearn and Hillerton.[6] In addition, HK1 and HK2 were defined as mild hyperkeratosis while HK3, HK4 and HK5 were defined as advanced/severe.

In this study the teat morphologies, lactation number and daily milk yield were evaluated according to the following groupings (Table 1). Teat length was measured using a digital caliper in vertical position against the teat wall. The teat length was calculated as follows Britt and Farnsworth.[12] Teat end shape was classified as cylindrical, pointed and flat according to Britt and Farnsworth.[12]

COLLECTION OF MILK SAMPLES

Milk samples were taken from the cows prior to the morning milking for the purpose of obtaining the somatic cell count and then sent to the laboratory in accordance with cold chain rules.* Somatic cell counts were taken with the BENTLEY, Bactocount IBC-M device. The threshold value for the somatic cell count was accepted as 200 000 cells/mL.[13-16] In the milk samples taken from each quarter, a SCC less than 200 000 cells/mL was considered normal

*International Dairy Federation. Bovine mastitis. Definition and guidelines for diagnosis. Bulletin of the IDF No. 211, Brusells, Belgium. 1987.

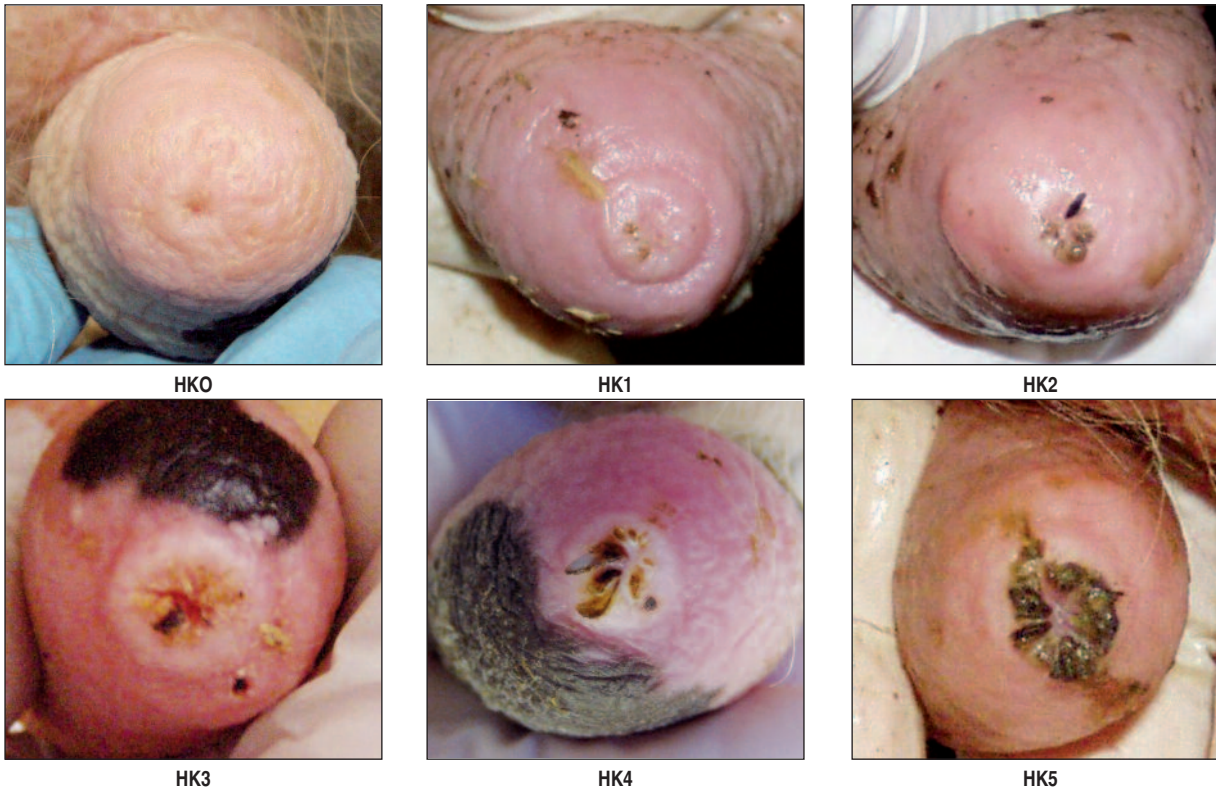

FIGURE 1: Macroscopic view of hyperkeratosis scores.
HK0: Normal teat-end orifice, HK1: Smooth ring, HK2: Slightly rough ring of keratin, HK3: Moderate raised, smooth ring, HK4: Rough ring, HK5: Very rough ring.

and samples higher than the threshold (SCC> 200 000) were regarded as posing a risk to the udder.[1]

STATISTICAL ANALYSES

Statistical calculations of the findings was conducted using SPSS® (Statistical Package for the Social Sciences, 15.0). The results were provided as average value±standard error (X±SE). "Pearson's Chi-square" test was used to identify statistical differences between the two groups. Values of $p<0.05$ and $p<0.001$ were considered significant in statistical evaluations.

RESULTS

The somatic cell count was determined to be normal in 72.8% and higher than normal in 27.2% of the total of 2256 quarters. Somatic cell count was not evaluated in 76 (2.63%) of the quarters for a variety of reasons (lactation period, postpartum day, applications of antibiotics during the examination etc.). Forty-nine percent of the teat ends were evaluated as normal while 51% were determined to have hyperkeratosis and 30.8% of these cases were mild (HK1 and HK2), while 20.2% were severe hyperkeratosis (HK3, HK4 and HK5) (Figure 2).

TABLE 1: Evaluation of teat morphology, lactation number and milk yield.

Lactation number	Milk yield (lt)	Teat length	Teat end shape
1-2	1-15	≤ 5,1 (Short)	Cylindrical
3-4	16 - 30	5,1 - 7,6 (Medium)	Pointed
≥ 5	≥ 31	≥ 7,6 (Long)	Flat

The study determined that there was a significant increase in SCC in parallel with an increase in the severity of hyperkeratosis ($p<0.001$). A statistical difference was identified between normal teat ends and teat ends with hyperkeratosis and it was determined that hyperkeratosis could result in a more significant rise in SCC ($p<0.05$) (Figure 3).

Teat end shape was classified as cylindrical, flat, pointed and their distribution was 80%, 11.2%

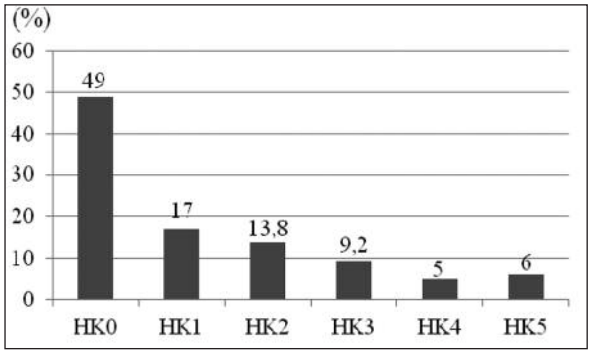

FIGURE 2: The incidence of hyperkeratosis (HK) at different scores (%).

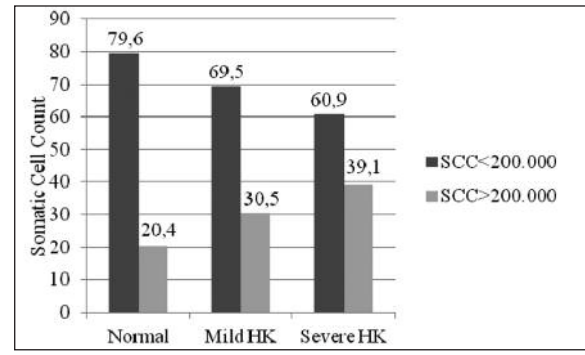

FIGURE 3: Evaluation of the relationship between hyperkeratosis (HK) and somatic cell count (p<0.05).

and 8.8% respectively. A statistically significant correlation (p<0.001) was demonstrated between the shape of the teat end and hyperkeratosis. Mild hyperkeratosis was more prevalent in flat teat ends while severe hyperkeratosis was extremely frequent in pointed teat ends (Figure 4).

The average length of each teat in the study was measured as 4.74±1.39 cm. Even though there was an increase in the occurrence of lesions on the teat end which correlated with teat length, a statistically significant relationship was not identified (p>0.05). The connection between number of lactations and hyperkeratosis was not found to be statistically significant (p>0.05). However, the development of hyperkeratosis was more prevalent in lactation groups 5 and above. Average daily milk yield was determined to be 15.77±1.94 kg. The relationship between hyperkeratosis on the teat end and the groups formed on the basis of milk yield was determined to be statistically significant (p<0.001). It was determined that the development of hyperkeratosis in the teat end orifice increased as milk yield dropped (Figure 5).

DISCUSSION

Studies have reported that the likelihood of hyperkeratosis on the teat end orifice in cows that are milked by machine varies from 22% to 54%.[5,9,13,17-19] In this study, 49% of the teat ends were normal while hyperkeratosis was identified in 51%. Of these, 38.8% consisted of mild hyperkeratosis (HK1 and HK2) while 20.2% were defined as severe (HK3, HK4 and HK5). The occurrence of hyperkeratosis was determined to fall within limits similar to the other studies. However, compared to other studies, there was a higher incidence of HK5

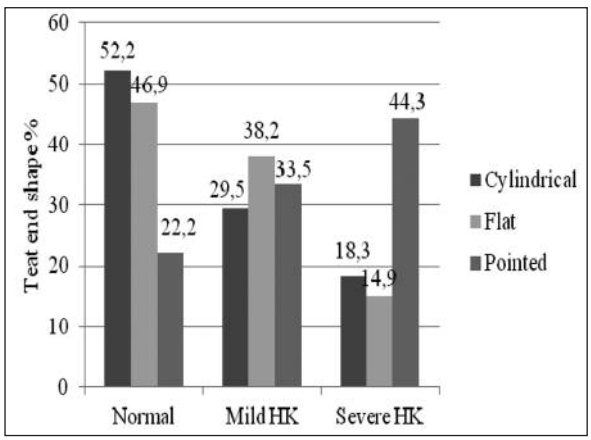

FIGURE 4: The incidence of hyperkeratosis (HK) at different teat morphologies (p<0.001).

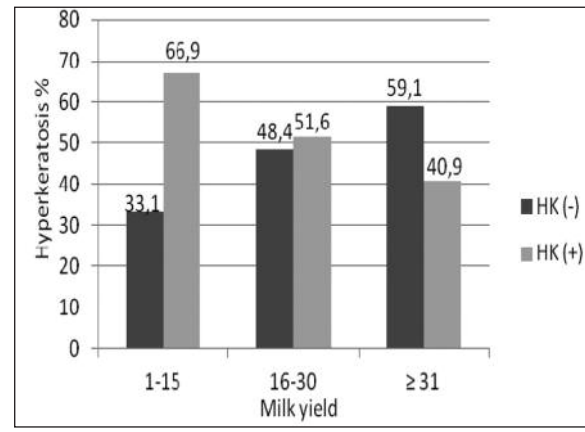

FIGURE 5: The incidence of hyperkeratosis (HK) in cattle grouped by variable milk yields (%) (p<0.001).

(6%).[9,19] It was concluded that technical inspection of the milking machines should be conducted more frequently and with great care in the enterprises.

In many studies, a significant connection was identified between hyperkeratosis and SCC, but there are studies in which no such connection was found.[4,9-11] It is commonly held that mild hyperkeratosis is not connected with clinical infection. Severe hyperkeratosis (rough and ulcerative lesions) is most likely associated with a mastitis infection.[2,17] Findings of this study showed that there was a significant increase in SCC in parallel with an increase in the severity of the hyperkeratosis. Also it showed that mild and severe cases of hyperkeratosis could cause a rise in SCC. It is thought that the disparity between the results may be caused by factors related to the cows, and in particular the milking technique and mismanagement. In light of this information, it is necessary to keep in mind that hyperkeratosis could pose a risk to udder health due to high SCC.

Similar to that of other researchers teat end shape was predominately cylindrical.[7,10,11] Studies reported that pointed teat ends have a greater tendency to develop hyperkeratosis compared with flat teat ends.[7,10,20] The results of the aforementioned researchers have likewise indicated a significant relationship between cases of hyperkeratosis and the shape of the teat end. In addition, it was observed that flat teat ends had mild hyperkeratosis while pointed ones had a higher incidence of severe hyperkeratosis.

Many studies of hyperkeratosis have failed to provide data regarding the length of the teat. Similar to the study by Neijenhuis et al. a significant connection between teat length and hyperkeratosis was not found.[10] However, a statistically insignificant increase was recorded in the progression of hyperkeratosis parallel to the length of the teat.

Development of hyperkeratosis was observed less frequently in cows lactating for the first time than it was in older cows (>2).[8] Chrystal et al. have reported that number of lactation has no effect on the development of hyperkeratosis.[11] Similar to the results of these researcher, a statistically significant connection between number of lactations and hyperkeratosis was not found. However, the development of hyperkeratosis was more prevalent in lactation groups 5 and above.

A positive relationship has been found between the severity of hyperkeratosis and milk yield and it has been reported that hyperkeratosis forms as a result of longer milking times associated with higher milk yield.[7,8] However, Seykora and McDaniel, found a negative correlation between milk yield and hyperkeratosis in a study based on milk flow rates for milk yield.[21] In this study, a significant increase was observed in the degree of hyperkeratosis and a decrease in milk yield. It was concluded that the reason for this might be connected to the fact that milking finishes earlier in quarters with less or no milk compared with those that have high milk yield and therefore the teats are subjected to the vacuum for longer.

CONCLUSION

Finally, it was concluded that hyperkeratosis should be viewed as a serious problem in addition to the other factors that create a predisposition to mastitis. In light of this information, identifying lesions that form on the teat end orifice and classifying them using a variety of methods, as well as periodically determining both the individual and tank somatic cell count could demonstrate compatibility between udder health and milking machines and reveal problems as well as providing important clues regarding a mastitis prevention program in dairy herds.

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