Chronic caprine mastitis in Nigerian goat breeds: microbiological flora and histopathological findings

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Abstract

In a study involving lactating does with normal-sized and enlarged pendulous udders, 85.5\% of milk samples obtained from does with unilateral udder enlargement and 84.8\% of samples from bilaterally enlarged udders indicated the presence of intramammary inflammation based on results of the modified Whiteside test. In contrast, only 47.6\% of milk samples obtained from normal-sized udders showed evidence of intramammary inflammation. Bacterial cultures were performed on all milk samples which showed evidence of intramammary inflammation. 16 species of bacteria and other microorganisms were cultured from these samples. Bilaterally enlarged udders collectively yielded 13 different microbial isolates, while unilaterally enlarged udders yielded 11, and normal-sized udders yielded 9. The most frequent isolates in all groups were \textit{Staphylococcus} \textit{spp.} and \textit{Corynebacterium} \textit{spp.} On histopathologic examination, severe pathological changes in the teat and udder tissues of enlarged pendulous udders were observed. Lesions in parenchymatous tissues showed mild to severe inflammation with involution of the parenchyma of glands. This led to shrinkage of the alveoli and in severe cases, their complete disappearance and replacement by fibrous connective tissue which was observed to have a high degree of proliferation. Sections of non-pendulous udder tissue showed proper arrangement of alveoli with hypertrophic epithelial cells, indicating active secretory activity. The results provide some definitive evidence that enlarged pendulous udder development in some Nigerian breeds of goats is not spontaneous but occurs largely as a result of incursion of the mammary glands by pathogenic organisms which may cause mastitis resulting in progressive dysfunction of mammary tissue. In chronic cases, there is severe atrophy of glandular tissue leading to fibrosis. © 2000 Published by Elsevier Science B.V. All rights reserved.

Keywords: Caprine mastitis; Microbiological flora; Histopathological changes

1. Introduction

In a previous demographic study, Alawa et al. (1996) observed that the occurrence of enlarged pendulous udders in some savanna breeds of goats may not in all cases be hereditary, as suggested by Twiwo and Buvanendran (1985) who observed significant positive correlations of udder dimensions of dams and their daughters. For highly selected dairy breeds, any such correlation for udder size would be expected. However, in non-dairy breeds, such as the Red Sokoto goat, the correlation of udder size of dams to those of their daughters, is less predictable.
Results obtained in the study by Alawa et al. (1996) indicated that the development of enlarged pendulous udders starts after first kidding and that lactation or the presence of milk in the udder of the doe is a prerequisite for its development. Milk is a good medium for bacterial multiplication, and udder infection is likely to occur in situations where health management is substandard. Such infection, if not detected quickly and treated appropriately, may become chronic causing morphological alterations in udder tissue. Previous studies (Addo et al., 1980) suggest that does which developed enlarged pendulous udders invariably suffered from mastitis.

The present study was designed to investigate the microbiological flora and histopathology of enlarged pendulous udders with the aim of providing evidence of a pathological basis for udder enlargement.

2. Materials and methods

21 does with normal udders and 40 does with unilaterally enlarged udders as well as 40 does with bilaterally enlarged udders were obtained by random selection from among locally raised herds in Zaria locality in Kaduna State (Nigeria) for the study. All the does were of the Red Sokoto and Kano Brown breeds and were lactating at the time of selection. Normal sized udders were measured in the range of 10–14 cm from tip of teat to the point of udder attachment on the animal’s body. Enlarged, pendulous udders measured at least 22 cm from tip of teat to the point of udder attachment.

2.1. Bacteriological examination of milk

The udder and teats of each doe were washed with lukewarm water after which the teats were cleaned with cotton soaked in 70% alcohol. Following this, 202 milk samples, one sample per udder half, were collected into sterilised screw cap sample bottles. In some cases, teats had to be rolled between the fingers for the teat canal to open and release milk but where such action failed to cause milk release, the animal was abandoned. The samples were immediately taken in a container containing ice cubes to the laboratory for examination.

2.2. Test for mastitis and culture of causative organisms

Milk samples were tested for mastitis using the modified Whiteside test (Murphy and Hanson, 1941). Those that tested positive for mastitis were cultured using a wire loop to inoculate the sample into 5% defibrinated blood agar (Unipath, Basingstoke, Hampshire, UK) and nutrient agar and MacConkey agar (Oxoid, Basingstoke, UK). Plates were subsequently incubated at 37°C for 24–72 h. Plates were examined daily for bacterial growth. Further inoculations and incubations were done for organisms with obvious staphylococcal morphology, while other organisms were subsequently grown in pure culture and biochemically tested according to standard procedures (Carter, 1973).

2.3. Histopathological examination of tissues

Two does with normal udders, two does with unilaterally enlarged udders and four does with bilaterally enlarged udders were taken to the abattoir where they were slaughtered. Udder and teat tissue samples were collected for histopathological studies. Each doe had kidded at least once.

The udders and teats were examined for gross pathological lesions before the does were slaughtered and the udders excised and immediately fixed in 10% buffered formalin solution. Tissue samples collected from various areas of gland and teat cisterns and their associated parenchymatous tissues were processed for paraffin embedding, sectioned and stained with haematoxylin and eosin and mounted (Luna, 1968).

3. Results

3.1. Milk quality and bacterial isolates

Table 1 shows results of the modified Whiteside test. While both udder halves of all the normal-sized udders yielded milk, four of the 80 unilaterally enlarged and one of the 80 bilaterally enlarged udder halves did not yield any milk.

Intramammary inflammation was much more common in enlarged, pendulous udders than in normal-
sized udders. Negative reactions to the modified Whiteside test were obtained from 52.4% of the milk samples from normal-sized udders as compared to negative reactions from 14.5% of the samples from unilaterally enlarged, pendulous udders and from 15.2% of the samples from bilaterally enlarged, pendulous udders.

16 species of microorganisms were isolated from the various milk samples (Table 2). Bilaterally enlarged udders collectively yielded 13 different microbial isolates, while unilaterally enlarged udders yielded 11, and normal-sized udders yielded 9. Coagulase-positive \textit{Staphylococcus aureus}, while those which gave coagulase-negative results were grouped as \textit{Staphylocooccus} spp. Together, the coagulase-positive and coagulase-negative \textit{Staphylococci} were the most frequent isolates from unilaterally and bilaterally enlarged udders as well as from normal-sized udders. The next most frequent isolates from all groups were the \textit{Corynebacterium} spp. \textit{Streptococcus} spp. was the next most frequent isolate from unilaterally enlarged udders, but \textit{Bacillus} spp. were more frequently identified from bilaterally enlarged udders than \textit{Streptococcus} spp. Other less common isolates and their frequency of isolation are given in Table 2.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Normal sized udder (ng = 21, nm = 42)</th>
<th>Enlarged udder</th>
<th>Bilateral (ng = 40, nm = 79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative for mastitis</td>
<td>22 (52.4)</td>
<td>11 (14.5)</td>
<td>12 (15.2)</td>
</tr>
<tr>
<td>Positive for mastitis</td>
<td>1+ (7.1)</td>
<td>14 (18.4)</td>
<td>16 (20.3)</td>
</tr>
<tr>
<td></td>
<td>2+ (28.6)</td>
<td>23 (30.3)</td>
<td>25 (31.6)</td>
</tr>
<tr>
<td></td>
<td>3+ (7.1)</td>
<td>17 (22.4)</td>
<td>12 (15.2)</td>
</tr>
<tr>
<td></td>
<td>4+ (4.8)</td>
<td>7 (9.2)</td>
<td>10 (12.7)</td>
</tr>
<tr>
<td></td>
<td>5+ (0.0)</td>
<td>4 (5.3)</td>
<td>4 (5.1)</td>
</tr>
</tbody>
</table>

\textsuperscript{a} ng – No. of goats, nm – No. of milk samples; 1+ to 5+ indicate degree of reaction to Whiteside test; figures in parenthesis are percentages.

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>Normal (n = 20)</th>
<th>Unilateral (n = 65)</th>
<th>Bilateral (n = 67)</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{Staphylococcus aureus}</td>
<td>3 (15.0)</td>
<td>26 (26.4)</td>
<td>30 (27.7)</td>
</tr>
<tr>
<td>\textit{Staphylococcus} spp.</td>
<td>5 (25.0)</td>
<td>20 (20.1)</td>
<td>20 (18.4)</td>
</tr>
<tr>
<td>\textit{Corynebacterium} spp.</td>
<td>4 (20.0)</td>
<td>16 (16.2)</td>
<td>10 (9.2)</td>
</tr>
<tr>
<td>\textit{Streptococcus} spp.</td>
<td>2 (10.0)</td>
<td>18 (18.2)</td>
<td>5 (4.7)</td>
</tr>
<tr>
<td>\textit{Bacillus subtilis}</td>
<td>1 (5.0)</td>
<td>8 (8.1)</td>
<td>12 (11.1)</td>
</tr>
<tr>
<td>\textit{Bacillus} spp.</td>
<td>1 (5.0)</td>
<td>3 (3.0)</td>
<td>12 (11.1)</td>
</tr>
<tr>
<td>Yeast cells</td>
<td>–</td>
<td>2 (2.0)</td>
<td>7 (6.5)</td>
</tr>
<tr>
<td>Fungal growth</td>
<td>1 (5.0)</td>
<td>2 (2.0)</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td>\textit{Staphylococcus epidermidis}</td>
<td>–</td>
<td>–</td>
<td>4 (3.8)</td>
</tr>
<tr>
<td>\textit{Klebsiella} spp.</td>
<td>–</td>
<td>2 (2.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>\textit{Actinobacillus lignieresi}</td>
<td>–</td>
<td>–</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td>\textit{Micrococcus} spp.</td>
<td>–</td>
<td>–</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td>\textit{Alcaligenes} spp.</td>
<td>2 (10.0)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>\textit{Pseudomonas} spp.</td>
<td>–</td>
<td>1 (1.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>\textit{Pasteurella} spp.</td>
<td>1 (5.0)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>\textit{Actinobacillus} spp.</td>
<td>–</td>
<td>1 (1.0)</td>
<td>–</td>
</tr>
<tr>
<td>Total frequency</td>
<td>20 (100)</td>
<td>99 (100)</td>
<td>108 (100)</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Figures in parenthesis = % frequency of isolates; n represents number of milk samples on which bacterial cultures were carried out.
3.2. Histopathological changes

Sections of udder tissue taken from does with normal udders showed the alveoli properly arranged with secretory epithelial cells which were hypertrophic indicating active secretory activity.

In contrast, parenchymatous glandular tissue lesions observed in pendulous udder tissues showed mild to severe inflammation. There was involution of the parenchyma of glands in does with unilaterally or bilaterally enlarged udders, but especially in cases of bilateral enlargement. This led to shrinkage of the alveoli and in severe cases, their complete disappearance and replacement by fibrous connective tissue. The degree of fibrosis was observed to be high in does with grossly enlarged pendulous udders. In does with unilateral udder enlargement, tissue obtained from the normal (unenlarged) udder half showed the alveoli to undergo gradual involution.

4. Discussion

The present study shows that most of the milk samples obtained from unilaterally (85.5%) and bilaterally (84.8%) enlarged pendulous udders tested positive for mastitis compared to fewer milk samples from normal-sized udders which tested positive for mastitis (47.6%). The failure of a few halves from enlarged pendulous udders to yield milk is probably indicative of mammary dysfunction associated with chronic infections.

Subclinical infections, which are fairly common in goats with apparently normal udders (Addo et al., 1980), appeared to account for the occurrence of positive reactions in the modified Whiteside test in goats with visually normal udders in the present study. The most predominant isolates from milk in the present study — *Staphylococcus* spp., *Corynebacterium* spp., and *Streptococcus* spp. were the most frequent species in the microbiological flora of caprine mastitis studied by Chineme and Addo (1984), Kawu et al. (1992) and Egwu et al. (1994). These three isolates were also the predominant organisms isolated in the present study. The most prevalent bacterial isolate in the present study — *S. aureus* — has been considered the major causative agent in mastitis (NIRD, 1979, 1980; Blood et al., 1989) especially in Nigerian breeds of goats (Addo et al., 1980; Chineme and Addo, 1984). This bacterial species predominated in milk obtained from both unilaterally and bilaterally enlarged udders.

The lesions and histopathologic changes in parenchymatous glandular tissue of unilaterally and bilaterally enlarged udders are similar to those observed by Chineme and Addo (1984). It would appear that the lesions in parenchyma of enlarged udders were associated with and caused by the bacterial isolate in milk obtained from enlarged udders.

The process of involution of parenchyma, shrinkage of alveoli and proliferation of connective tissues in severe cases observed in enlarged pendulous udder tissue in the present study is a common observation in bovine mastitis (Schalm, 1977; Smith and Roguinsky, 1977; Chineme and Addo, 1984).

Despite more than two decades of investigations into the nature of chronic mastitis in Savanna breeds of goats in Nigeria, it has been difficult to explain its widespread and seemingly spontaneous nature. Carrol (1977) indicated that nearly every factor of the environment and management including feeding, housing, bedding and climate have been implicated at one time or the other in causing mastitis.

The Red Sokoto and Kano Brown goats and their crosses are relatively high milk yielders (0.46–0.55 kg/day) in Nigeria (Akinsoyinu et al., 1982; Ehoche and Buvanendran, 1983), compared to dwarf breeds. Kawu et al. (1992) suggested that Savanna Brown goats, have large udders with long lactiferous sinuses which are prone to blockage with infected residual milk. Since they are relatively high milk yielders, and may not be completely stripped out, there is an increased likelihood of frequent lactiferous sinus blockage which may lead to the damming of milk in the udder during lactation. Such milk accumulation encourages bacterial proliferation especially in the presence of a residual infection, a factor that has been reported as the main source of infection in goats (Blood et al., 1989).

These goats are rarely milked by people and their milk is rarely tested for quality and other physical characteristics. Therefore, it is difficult to detect subclinically infected animals or early cases of mastitis, with no swelling of the mammary glands (Addo et al., 1980). With time, these undetected early cases would become clinical in very high numbers and subsequently develop into chronicity. In the absence of
segregation and/or routine culling of goats with clinical and subclinical mastitis, the numbers of new cases could increase steadily.

Kawu et al. (1992) reported peak occurrence of clinical mastitis in does examined over a 5-year period to coincide with the hot dry to early humid season (May–September), a period noted for high kidding rate and reduced hygienic status of the environment.

The present study indicates a high level of clinical mastitis in does that develop enlarged pendulous udders. The pathological changes that characterize such enlargement lead to atrophy and fibrosis in severe cases. The subclinical cases of mastitis observed in does with apparently normal-sized udders would conceivably develop into clinical cases in the absence of drug administration, leading to morphological changes including enlargement. Further development would lead to chronicity and partial or complete dysfunction of the mammary gland.

5. Conclusion

The frequency of enlarged pendulous udders and mastitis among Red Sokoto goats in Nigeria is likely to remain high unless an appropriate management strategy is adopted. This could be based on a combination of frequent milking with occasional testing of milk, culling and selection. Frequent milking of lactating does and occasional milk testing would lead to early detection and treatment of subclinical cases of mastitis while culling of advanced and chronic cases would reduce the prevalence and spread of these conditions. Selection against pendulousness would reduce the chances of dams with pendulous udders mothering future generations of this breed.

References


