Effect of Bismuth Subnitrate Teat Canal Sealant with Ampicillin-Cloxacillin Combination in Control of Bovine Mastitis in Selected Farms in Kenya

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ABSTRACT

This study presents the results of effect of a combination of bismuth subnitrate teat canal sealant (Boviseal® -Bimeda® Animal Health, Ireland) and the antibiotic Ampicillin & Cloxacillin (Bovaclox®-DC-Norbrook Laboratories Ltd-UK) when used during the dry period on occurrence of mastitis 100 days post-calving. The objectives of this study were: to determine the effect of Boviseal® teat canal sealant in combination with Bovaclox® DC in control of dairy cow mastitis 100 days after calving; to determine bacterial pathogens causing mastitis in the selected farms and to determine risk factors for occurrence of dairy mastitis in the selected farms. This controlled field trial was carried out in two Kenyan dairy farms: Chemusian Farm in Nakuru County and Gicheha Farm in Kiambu County. 156 dairy cows were used in the study. Healthy cows with no history of mastitis in their current lactation were recruited. They were randomly placed into either of the two study groups: the control and the test group. The Control group received Bovaclox® DC while the Test group received the Bovaclox® DC followed by Boviseal®. The cows were followed during the entire dry period and 100 days post-calving monitoring for mastitis occurrence. Cows in the control group were more susceptible to mastitis 100 days post-calving compared to cows in the treatment group (P<0.001, RR=4.4, OR=17.7). Of the bacterial pathogens, coagulase negative Staphylococci (CNS) were the most common pathogens isolated from mastitic milk at 34.6 % followed by Micrococcus spp. (9.0%). Other bacteria isolated were Staphylococcus agalactiae (3.8%), Staphylococcus aureus (1.9%); Escherichia coli (0.6%) and various bacterial mixtures. Results of logistic regressions at P≤0.05 showed that farm, position of the quarter, type of barn floor and type of treatment were significantly associated with occurrence of mastitis. Cows in Gicheha farm whose barn floor was earthen, those cows in the control group and hindquarters were risk factors for mastitis (RR=1.5, 4.4 and 1.18 respectively). The results of this study showed that Bovaclox® DC + Boviseal® teat canal sealant combination applied during the dry period is more effective in controlling bovine mastitis 100 days post-calving compared to the use of Bovaclox® DC alone. The study thus recommends the use of Bovaclox® DC + Boviseal® dry cow combination for control of bovine mastitis.

Key words: Dry cow mastitis; Teat sealant-antibiotic; Kenya

INTRODUCTION

The livestock industry contributes to the growth of the economy of not only Kenya, but the globally (Muthami, 2011; Mihret et al., 2017). Kenya has approximately 17.5 million cattle, with approximately 3.5 million Bos taurus cows and 14 million Bos indicus cows (KNBS, 2010). Growth of the dairy sector is limited by various factors including: diseases, poor access to the market, inadequate veterinary and livestock extension service providers and poor cattle nutrition among others (Munyori and Karanja, 2014). One of the major production diseases affecting the dairy cattle is mastitis (Barlow, 2011, Gitau et al., 2014; Gomes and Henriques, 2016).

Mastitis is defined as persistent inflammation of the udder tissues due to trauma or infection by microorganisms. In the dairy industry, mastitis is the most costly production disease (Gomes and Henriques, 2016; Viguier et al., 2009; Youssif et al., 2020). Microorganism- caused-mastitis can be attributed to various pathogens, ranging from bacterial, fungal to viral organisms. Of major importance are the bacteria, both gram positive (such as Staphylococcus and Streptococcus

species) and gram-negative including the coliforms such as *Escherichia coli* (Belayneh et al., 2013; Blowey and Edmondson, 2010; Girma et al., 2012). Viral infections such as foot and mouth disease and bovine herpes directly cause mastitis or erode the skin of the udder and predispose it to secondary bacterial infections resulting in mastitis (Wellenberg et al., 2002). Based on clinical features, mastitis can be classified as either clinical or subclinical (Fox, 2009; Mdegela et al., 2009). Mastitis can also be classified either as environmental or contagious mastitis (Fox, 2009; National Mastitis Council, 2015). Environmental mastitis is caused by pathogens commonly isolated from the environment of the cow, which includes milking machine, barn floor, soil, walkways, pasture and any surface with which the cow may be in contact with. Organisms that cause environmental mastitis include *Staphylococcus* species (excluding *Staphylococcus aureus*), *Streptococcus* species (excluding *Streptococcus agalactiae*), coliforms such as *Escherichia coli* and *Enterobacter* species, *Pseudomonas*, *Proteus*, *Yeast* and *Prototheca* among others. Contagious mastitis is caused by pathogens that spread from cow to cow. These pathogens primarily inhabit the udder and teat of cows. The major pathogens responsible for this type of mastitis are *Streptococcus agalactiae*, *Corynebacterium bovis*, *Staphylococcus aureus* and *Mycoplasma* (Gonzalez and Wilson, 2003; Breen et al., 2009; Erskine, 2016; Sonmez and Erbas, 2017). Common predisposing factors for bovine mastitis are breed, high milk production, parity of the cow, poor hygienic status of the cow environment among others (Breen et al., 2009; Ramirez et al., 2014).

Mastitis not only reduces milk quality and quantity during lactation, but may occasionally result in fatalities of the affected animal (Gomes and Henriques, 2016a). Moreover, some mastitis-causing microorganisms such as *Mycobacterium tuberculosis*, *Staphylococcus aureus* and *Listeria monocyto
gen* are zoonotic (Mwinyelle and Alhassan, 2014; Vishnupriya et al., 2014; Sharma et al., 2017).

Commonly employed mechanisms for management of mastitis include the use of antimicrobials such as tetracyclines, sulphonamides and lincosamides among others (Oliver and Murinda, 2012). Prolonged use and misuse of these agents has contributed to antimicrobial resistance (AMR) in both livestock and humans (Oliver and Murinda, 2012; WHO, 2014). To mitigate the AMR challenge, there has been a shift to the use of more environmentally friendly interventions such as vaccines, internal teat sealants, recombinant mucolytic proteins e.g. lysostaphin and nanoparticles (Sankar, 2016).

Usually the teat canal remains patent during the early dry period, regardless of antibiotic use during this period. Provided the canal is open, pathogens easily enter the udder usually resulting into an infection. The use of internal teat sealant containing bismuth substrate in controlling bovine mastitis has been practiced in various places worldwide. Several studies have shown its efficacy in reducing prevalence of mastitis in dairy cows. The product is efficacious against clinical and subclinical mastitis as well as reducing the level of milk somatic cell counts (Cook et al., 2005; Compton et al., 2014). Rabiee and Lean (2013) demonstrated that use of bismuth subnitrate alone or in combination with antibiotic dry cow therapy pre-calving reduces incidence of clinical mastitis post-calving by 29% and 48% respectively.

To the authors’ knowledge, there are no documented studies in the efficacy of using bismuth subnitrate or its combination with an antibiotic containing dry cow intramammary in prevention and control of mastitis in Kenya. The objective of this study was to determine the effect of bismuth subnitrate teat canal sealant in combination with Ampicillin & Cloxacillin dry cow therapy in controlling bovine mastitis in selected farms in Kenya. More specifically this study aimed to determine the effect of bismuth subnitrate teat canal sealant in combination with Ampicillin & Cloxacillin dry cow therapy on control of dairy cow mastitis 100 days after calving, determine bacterial pathogens causing mastitis in the selected farms and identify risk factors associated with mastitis in dairy cows in the selected farms.

**MATERIALS AND METHODS**

**Study area**

The study was carried out in two dairy farms in Kenya, namely Chemusian and Gicheha. These farms were conveniently selected because they were willing to participate in the study, had a structured record keeping system and routinely had dairy cows for drying, which were target animals for this study. In both farms, records on individual animals including age, parity, barn floor type and disease management were computer-stored thus easily retrievable. Both farms had a resident veterinarian and animal health assistants who helped in monitoring of animal health during the entire study period. Chemusian farm, located in Rongai Constituency, Nakuru County is approximately 19.7 km West of Nakuru Town and 200 kms west of the capital city, Nairobi. The farm has about 1000 dairy cows mainly of two breeds, Friesian and Ayrshire. Gicheha farm, which is in Kiambu County, is approximately 25kms north of the capital city of Nairobi. The farm has about 500 dairy cows predominantly Friesians and a few Ayrshire and Guernsey breeds.

**Study design**

The study was a randomized controlled field trial.

**Sample size determination and allocation into study groups**

Sample size was calculated as follows, using the formula by Naing et al. (2006):

\[
\text{n} = \frac{Z^2 P(1-P)}{d^2}
\]

Where:

- \(n\) = sample size
- \(Z\) = \(Z\) statistic for a level of confidence (which is 1.96 at 95% CL)
- \(P\) = expected prevalence or proportion (which is estimated at 0.5 since no study has been conducted on prevalence of mastitis in both farms).
- \(d\) = precision (\(\pm 0.05\)).

Using this formula, the sample size for each farm was 384 animals. However, since the farms had a finite population of lactating cows for dry off at 200 for...
Chemusian and 50 for Gicheha, the sample size was adjusted using the formula by Naing et al., (2006): 

\[ n' = \frac{Z^2\pi(1-\pi)}{d^2(N-1)+Z^2\pi(1-\pi)} \]

Where

\( n' \) = sample size with finite population correction
\( N \) = Population size (200 for Chemusian and 50 for Gicheha)
\( Z \) = \( Z \) statistic for a level of confidence (1.96 at 95% CL),
\( P \) = Expected proportion (0.5)
\( d \) = Precision (0.05).

The calculated values were 133 and 44 cows for Chemusian and Gicheha farms respectively. In total 177 cows were included in the study. In each farm, the cows were randomly allocated to different treatment groups.

Criteria for cow selection into the study

All the cows in the study were healthy on physical and historical assessment. The animals were in their first or subsequent lactation with no case of mastitis in the current lactation. The California Mastitis Test (CMT) was used to check the health status of the udder and only the animals with a score of 0, indicating absence of mastitis were included in the study. The cows were in their dry period (60 days to calving) as indicated in the farm records.

Udder and hind leg hygiene scoring

Before administration of the study products, the cleanliness of individual cow’s hind leg and udder were scored using the method proposed by Schreiner and Ruegg (2010). In this study, scores 1 and 2 were merged to indicate a clean score while 3 and 4 were merged to indicate a dirty udder and hind leg (Fig. 1).

Administration of Reference and Test products

A simple random approach was used for allocation of cows into either group. For each farm, the cows were allocated into either of the two study groups: Test group or Control group. The test group received bismuth subnitrate (Boviseal® - Bimeda® Animal Health, Ireland) and antibiotic Ampicillin & Cloxacillin (Bovaclox® DC-Norbrook Laboratories Ltd-UK) while the control group received the antibiotic Ampicillin & Cloxacillin alone. These products were infused aseptically.

Animal follow-up

Animals in the study were monitored for development of mastitis from the day of dry off to 100 days post-calving. Each quarter was examined for any clinical abnormalities including signs of inflammation of teat canal / teat cistern/udder cistern on the following occasions: prior to the administration of Test and Reference Products; study Day 7, 14, 30 (post administration of the Test and Reference Product); immediately prior to calving and on each day post calving until day 100. Any abnormal clinical observation including signs of inflammation was recorded in the data capture form. In the event that a case of clinical mastitis was suspected, such that clots or abnormalities are found in the foremilk, 8 squirts were stripped to empty the teat cistern. At this stage milk would be coming from the udder tissue. If at this stage the abnormalities / clots had disappeared, then this was not clinical mastitis. If the abnormalities persisted, the cow was deemed to have clinical mastitis and treated by the farm veterinarian using recommended farm specific protocols.

Milk sample collection and transportation

Milk samples were collected for bacteriological examination if quarter or udder was clinically diagnosed as having mastitis through CMT and visual examination of the milk. Milk was also collected from each cow in the study at any day after calving (within 100 days post-calving) to determine the prevalence of subclinical mastitis for those animals which had not developed clinical mastitis. The milk sample was collected aseptically as per the National Mastitis Council (2015). Five milliliters composite milk was stripped into a properly labeled sterile test tube for each cow. The samples were transported in a cool box with ice packs to the University of Nairobi, Department of Public Health, Pharmacology and Toxicology laboratory for immediate bacteriological culture or stored at 4°C for culture within 48 hours.

Culture and identification of bacteria

The milk samples were inoculated on blood agar and bacteria identified morphologically and biochemically by coagulase and catalase production, indole, methyl red, Voges-Proskauer, citrate and Christie–Atkins–Munch-Petersen tests (Phillips, 2007).

Data management and analysis

All data collected were entered, cleaned and stored in MS Excel 2010 (Microsoft, Sacramento, California, USA). The data were analysed using Stata13.1 software (StataCorp LLC, College station, Texas, USA). The outcome of the study was presence/absence of bovine mastitis while the explanatory variables included type of treatment during dry period, animal age, barn floor type, breed, farm, and lactation number, daily milk production, milking frequency, management system, hind leg and udder hygiene score. Descriptive data analysis was performed, and summary statistics were presented in form of proportions of various variables such as microorganisms causing mastitis, breed, milking frequency, management system and mastitis cases. Chi square tests were used to evaluate level of association for each independent variable and the outcome using statistical frequency tables. The factors influencing occurrence of mastitis under the study were subjected to a univariate logistic regression at P<0.2 to accomodate as many relevant factors in the multivariable logistic model. Those variables with significant association with mastitis at P≤0.2 were subjected to multivariate logistic regression at P≤0.05 in order to get a parsimonious model. Odds ratios and relative risks were calculated from the frequency tables in order to find out if a variable was a risk factor for mastitis at P value ≤0.05.

RESULTS

Incidence of mastitis

Table 1 summarises the incidence of various categories of mastitis in Chemusian and Gicheha farms. In
The results of subclinical mastitis indicated significant difference in the incidence between test and control groups at $P<0.05$ (Table 2). Animals in the control group were 2 and 2.2 times more likely to develop subclinical mastitis in Chemusian and Gicheha farms respectively compared to those in the test group. Hindquarters were 1.1 to 1.5 times more likely to develop mastitis compared to forequarters in Chemusian and Gicheha farms respectively.

Factors influencing the occurrence of mastitis in the selected farm

From univariable analysis, factors significantly associated with mastitis were farm, breed, barn floor and quarter position. These variables were fitted in the multivariable model from which barn floor and group were the two variables that significantly explained the difference in the incidence of mastitis. The variable farm and barn floor were collinear, since cows in Chemusian farm slept on a concrete floor while those in Gicheha farm slept on a earthen floor (Table 4).

Bacterial pathogens causing mastitis

The most common bacterial pathogens isolated from mastitic milk were coagulase negative Staphylococci (CNS) (34.6%) and Micrococcus spp. (9.0%). Other bacteria isolated were Streptococcus agalactiae, Staphylococcus aureus; Escherichia coli and various bacterial mixtures as shown in Table 5. Pathogen distribution differed between the test and control groups. More bacteria pathogens were isolated from the control group than the test group ($P=0.001$).

DISCUSSION

From this study, a combination of Ampicillin & Cloxacillin (Bovaclox® DC) and bismuth subnitrate was more effective in controlling bovine mastitis 100 days post-calving compared to Bovaclox® DC alone. These findings were in agreement with studies done by Newton et al., (2008), Runciman et al. (2010), Berry and Hillerton, 2010, Golder et al. (2016) and Bates et al. (2016) who used the sealant with other antibiotics. In this study, animals in the control group were 4.4 times more likely to develop mastitis within 100 days post-calving compared to 1.9 times obtained from a study by Golder et al., (2016). Bismuth subnitrate closes the teat canal during the dry period thus limiting entry and colonisation of mastitis causing pathogens in the udder. This greatly reduces incidence of both dry cow and post-calving mastitis (Woolford et al., 1998). The teat sealant complemented the antibiotic function of Bovaclox® DC. It seals the teat canal thus limiting the number of bacteria and other mastitis causing pathogens entering the udder tissue. This explains why the test group animals (received both bismuth subnitrate and Bovaclox® DC) had a lower prevalence of mastitis compared to the control group.

The incidence of mastitis (clinical and subclinical) from this study was 51.8% (47.58% in Chemusian and 65.63% in Gicheha), slightly lower than that documented by Mekibib et al., (2010) of 71.0% in Holeta town of Ethiopia and 74.7% reported by Abebe et al., (2016). The difference in prevalence could be attributed to differences

Clinical mastitis and Subclinical mastitis

The incidence of clinical mastitis was 10.48% and 25% in Chemusian and Gicheha respectively (Table 2). There was a significant difference in the incidence of clinical mastitis between the test and control group in Chemusian farm ($P=0.001$). Cows in the control group were 1.2 times more likely to develop clinical mastitis compared to those in the test group. In Gicheha farm, there was no significant difference in the incidence of clinical mastitis between the test and control group ($P=0.072$).

Factors influencing the occurrence of mastitis in the selected farm

From univariable analysis, factors significantly associated with mastitis were farm, breed, barn floor and quarter position. These variables were fitted in the multivariable model from which barn floor and group were the two variables that significantly explained the difference in the incidence of mastitis. The variable farm and barn floor were collinear, since cows in Chemusian farm slept on a concrete floor while those in Gicheha farm slept on an earthen floor (Table 4).

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Table 2: Comparison of mastitis in the Test and Control groups in Chemusian and Gicheha farms in 2017/2018

<table>
<thead>
<tr>
<th>Farm</th>
<th>Category of mastitis</th>
<th>Group</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
<th>Pearson χ²</th>
<th>P-value</th>
<th>Relative risk (odds ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemusian</td>
<td>Overall</td>
<td>Control</td>
<td>49</td>
<td>13</td>
<td>62</td>
<td>49.18</td>
<td>&lt;0.001</td>
<td>4(19.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test</td>
<td>10</td>
<td>52</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>59</td>
<td>65</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clinical</td>
<td>Control</td>
<td>12</td>
<td>50</td>
<td>62</td>
<td>10.40</td>
<td>0.001</td>
<td>1.2(14.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test</td>
<td>1</td>
<td>61</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>13</td>
<td>111</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subclinical</td>
<td>Control</td>
<td>36</td>
<td>26</td>
<td>62</td>
<td>25.43</td>
<td>0.001</td>
<td>2(8.2)</td>
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<tr>
<td></td>
<td></td>
<td>Test</td>
<td>9</td>
<td>53</td>
<td>62</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>45</td>
<td>79</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gicheha</td>
<td>Overall</td>
<td>Control</td>
<td>15</td>
<td>1</td>
<td>16</td>
<td>11.22</td>
<td>0.001</td>
<td>10(25)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test</td>
<td>6</td>
<td>10</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>21</td>
<td>11</td>
<td>32</td>
<td></td>
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<td></td>
<td>Clinical</td>
<td>Control</td>
<td>5</td>
<td>11</td>
<td>16</td>
<td>0.685</td>
<td>0.414</td>
<td></td>
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<td></td>
<td></td>
<td>Test</td>
<td>3</td>
<td>13</td>
<td>16</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>8</td>
<td>24</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subclinical</td>
<td>Control</td>
<td>10</td>
<td>6</td>
<td>16</td>
<td>6.35</td>
<td>0.012</td>
<td>2.2(7.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test</td>
<td>13</td>
<td>3</td>
<td>16</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Total</td>
<td>23</td>
<td>9</td>
<td>32</td>
<td></td>
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</tr>
</tbody>
</table>

Table 3: Comparison of occurrence of mastitis between hind and forequarters for cows in Chemusian and Gicheha farms in 2017/2018

<table>
<thead>
<tr>
<th>Farm</th>
<th>Quarter</th>
<th>Mastitis</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
<th>Pearson χ²</th>
<th>P value</th>
<th>Relative risk (odds ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemusian</td>
<td>Hind</td>
<td></td>
<td>81</td>
<td>167</td>
<td>248</td>
<td>5.78</td>
<td>0.016</td>
<td>1.1(1.6)</td>
</tr>
<tr>
<td></td>
<td>Fore</td>
<td></td>
<td>57</td>
<td>191</td>
<td>248</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hind</td>
<td></td>
<td>38</td>
<td>26</td>
<td>64</td>
<td>4.5</td>
<td>0.034</td>
<td>1.5(2.1)</td>
</tr>
<tr>
<td>Gicheha</td>
<td>Fore</td>
<td></td>
<td>26</td>
<td>38</td>
<td>64</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Multivariate analysis of various factors influencing occurrence of mastitis in Chemusian and Gicheha Farms in 2017 and 2018

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>95% confidence interval</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td>Friesian</td>
<td>reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>0.348</td>
<td>-1.042</td>
</tr>
<tr>
<td>Barn floor</td>
<td>Earthen</td>
<td>reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete</td>
<td>-1.221</td>
<td>-2.252</td>
</tr>
<tr>
<td>Group</td>
<td>Test</td>
<td>reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.057</td>
<td>2.189</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>-1.744</td>
<td>-3.468</td>
</tr>
</tbody>
</table>

Table 5: Table showing proportion of various bacteria isolated from mastitic milk from Chemusian and Gicheha Farms in 2017/2018.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS</td>
<td>54</td>
<td>34.6</td>
</tr>
<tr>
<td>Micrococcus spp.</td>
<td>14</td>
<td>9.0</td>
</tr>
<tr>
<td>Streptococcus agalactiae</td>
<td>6</td>
<td>3.8</td>
</tr>
<tr>
<td>S.aureus</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>CNS+Strep. Agalactiae</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>E.coli</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Micrococcus+E.coli</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Micro+Strep. Agalactiae</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>No growth</td>
<td>73</td>
<td>46.8</td>
</tr>
<tr>
<td>Total</td>
<td>156</td>
<td>100</td>
</tr>
</tbody>
</table>

in production systems among other management factors. The prevalence of subclinical and clinical mastitis was 37.18% (36.29% in Chemusian and 40.63% in Gicheha) and 14.74% (10.48% in Chemusian and 25% in Gicheha) respectively. This observation concurred with several studies previously done in that showed that prevalence of subclinical mastitis is usually higher compared to clinical mastitis in a ratio of even up to 1:40 (Shaheen et al., 2016). Mureithi and Njuguna (2016) had reported a prevalence of 64% for subclinical mastitis in herds within Thika sub county of Kenya. In a study by Gitau et al., (2014) in Mukurweini and Nakuru Districts of Kenya, the prevalence of clinical and subclinical mastitis was 0.7% and 32.4% respectively. Ndirangu et al. (2017) reported the prevalence of clinical and subclinical mastitis in Sahiwal cows of Kenya Agricultural and Livestock Research Organization (KALRO)-Naivasha as 6% and 54% respectively. Prevalence of subclinical mastitis is higher than that of clinical mastitis because subclinical mastitis is not easily detected at farm level by both farmers and animal health care providers. Therefore, most farms do not pay attention to subclinical mastitis because there are no obvious financial costs attributed to it thus limited control measures are implemented to curb it.

From this study, the most prevalent bacteria isolated from mastitic milk were the Coagulase-negative staphylococci. The high prevalence of CNS was also observed in studies by Pitkälä et al. (2004), Pyörälä and Taponen, (2009) and Vakkamäki et al. (2017) in Finland and Mpatswenumugabo et al., (2017) in Ethiopia showing that the group is an emerging cause of subclinical mastitis. According to (del Pilar et al., 2018) coagulase negative staphylococci are the most prevalent mastitis causing pathogens in Anaime Canyon, a dairy region in Colombia. This disagreed with a study done by Gitau et al. (2014) whose findings showed that Staphylococcus aureus is the commonest bacteria causing bovine mastitis in Mukurweini and Nakuru Districts of Kenya. Generally organisms in the staphylococcal group are the main pathogens causing mastitis in dairy cows as also documented by Ndirangu et al. (2017) in a study carried out at KALRO in Naivasha, Kenya. Coagulase negative staphylococci are emerging mastitis causing pathogens that are becoming the most prevalent pathogens isolated in mastitic milk in many countries (Taponen and Pyörälä, 2009).
From this study, the hind quarters were more likely to develop both clinical and subclinical mastitis compared to forequarters. This predisposition of the hind quarter was also observed by Vulić, (2000) and Khan and Muhammad (2005) in Faisalabad in Pakistan, Joshi and Gokhale, 2006, Tripathi et al. (2018) in India on cross breed cows, Hussain et al. (2018) in a study on dairy buffaloes in Pakistan. The increased risk of hind quarters may be partly because hind quarters are more frequently dirtied from dung and the floor. Furthermore, hind quarters are more vulnerable to direct trauma due to their closeness to the floor compared to forequarters.

This study showed that cows sleeping on concrete floor are less susceptible to mastitis compared to those sleeping on earthen floors. This is in agreement with a study by Hardenberg (2016) in Bihar, India. Kayesh et al., (2014) reported 36.69% and 23.7% prevalence in subclinical mastitis for cows sleeping on earthen and concrete floors respectively in Bangladesh. This difference could be because concrete floors are easier to clean, thus environmental pathogens are washed off more easily than earthen floors.

Conclusions

Use of bismuth subnitrate teat canal sealant and Ampicillin & Cloxacillin combination during the dry period significantly reduces occurrence of mastitis compared to use of Ampicillin & Cloxacillin dry cow therapy alone. Subclinical mastitis is more common than clinical mastitis in both Chemusian Gicheha Farms. In these farms, earthen floor predisposes cows to mastitis more than concrete floors. Coagulase negative staphylococci pathogens are the most common mastitis causing pathogens in both Gicheha and Chemusian farm.

REFERENCES


Mureithi DK and Ngunga MN, 2016. Prevalence of subclinical mastitis and associated risk factors in dairy farms in urban and peri-urban areas of Thika Sub County, Kenya.


