METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) IN FRESH AND FERMENTED MILK IN ZARIA AND KADUNA, NIGERIA

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ABSTRACT

Methicillin-resistant Staphylococcus aureus (MRSA) is of public health and veterinary concern globally and mastitic milk is one of the sources. In this study, 372 milk samples comprising of raw milk, bulk milk, yogurt and ‘kindirmo’ (locally fermented milk) obtained from Kaduna and Zaria, Nigeria were examined for the prevalence of MRSA and their antibiotic resistance profile. Out of the 372 milk samples examined, 195 staphylococci were isolated and out of which 47 (12.6%) were coagulase positive and 18 (4.8%) were methicillin resistant. There was no significant difference (P > 0.05) between the occurrence of both coagulase positive S. aureus and MRSA in Kaduna (13.4% and 5.1%) and Zaria (11.4% and 4.5%). The occurrence of coagulase positive S. aureus was significantly higher (P < 0.05) in raw milk (22.2%) than bulk milk (0.8%), pasteurized milk (.3%) and ‘kindirmo’ (0.3%). However, no significant difference (P > 0.05) exists between the occurrences of MRSA among the study variables. No coagulase positive S. aureus and MRSA was detected in any of the yogurt samples examined. A decrease in the prevalence was observed from raw milk to the final yogurt and ‘kindirmo’ products indicating that pasteurization and fermentation eliminated the organisms. Very high percentages of the MRSA isolates were resistant to oxacillin (100.0%), penicillin (100.0%), tetracycline (55.6%), and vancomycin (44.6%) while sulfamethoxazole/trimethoprim and gentamicin recorded the least levels of (11.1%) and (5.6%) respectively. The mec A was detected by polymerase chain reaction in 4 of the 18 MRSA isolates (3 in raw milk and 1 in ‘kindirmo’ samples). The study recommends proper pasteurization and fermentation of milk to eliminate MRSA before human consumption.

Keywords: Prevalence, Methicillin-resistant Staphylococcus aureus (MRSA), Fresh milk, Fermented milk, Antimicrobial resistance.

INTRODUCTION

There is increasing global concern for the spread of antibiotic resistant bacteria particularly multi-drug resistant zoonotic pathogens (Mansori and Khaleghi, 1997; Lee, 2003; Ikeagwu et al., 2008). Associated with this concern is the mutual assertion that both medical and veterinary use of antimicrobial agents in promoting the emergence and rise in the prevalence of these resistant pathogens. Many researchers have investigated the role of animal food products such as meat (Bargagaya, 2011) and milk (Strastkova et al., 2009; Virgin et al., 2009; Türkyilmaz et al., 2010) as sources of resistant zoonotic bacteria. The larger focus was directed at the actual agricultural and animal husbandry practices that favor the colonization
of poultry (Persoons et al., 2009) and livestock (Beth et al., 2006; Daquette and Nuttal, 2009; Garcia-Alvaarez et al., 2011) with the resistant bacteria. Evidence of transfer of resistant bacteria from such animals to man under farm conditions have been demonstrated (Huber et al., 2009; Cunny et al., 2010; van Duijkeren et al., 2011). The complete cycle of transmission of resistant bacteria between animals and man and vice versa is best exemplified by the emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) in domestic animals (Huber et al., 2009; Cunny et al., 2010; van Duijkeren et al., 2011).

MRSA is a problematic pathogen in human medicine and appears to be an emerging problem in veterinary medicine (Kesah et al., 2003; Huber et al., 2009; Cunny et al., 2010; van Duijkeren et al., 2011). As infection and colonization have been widely reported in animals such as horses, dogs, cat, birds, cattle and most recently milk (Kwon et al., 2006; Strastkova et al., 2009). The African data on *S. aureus*, particularly on antibiotic susceptibility, are limited (Ghebremedhin et al., 2009), although MRSA has disseminated in African countries. Between 1996 and 1997, the prevalence of MRSA, determined in eight African countries were relatively high in Nigeria, Kenya and Cameroon (21 to 60%) and were below 10% in Tunisia and Algeria (Olonitola et al., 2007; Okon et al., 2007; Ghebremedhin et al., 2009; Fadeyi et al., 2010; Nwanko et al., 2010). The transition of this infection from a nosocomial problem into the community and subsequently to livestock population has not been clearly elucidated under the prevailing animal production conditions in developing countries. Characteristically, animal rearing is mostly semi-intensive to extensive and involving copious interaction between animals and humans. It is essential to investigate the occurrence of MRSA in various components of human-animal interface.

In Nigeria MRSA colonization and infection has been reported in humans with varying prevalence of between 20 to 60% (Olonitola et al., 2007; Okon et al., 2007; Ghebremedhin et al., 2009; Fadeyi et al., 2010; Nwanko et al., 2010). However literature is scarce on the prevalence in animals and edible animal products such as milk, which is known to have a high potential for causing epidemics. This study provides a preliminary report on the prevalence of MRSA in both fresh and fermented milk in Nigeria, the presence of the gene encoding methicillin resistance and recommendation on the possible ways of preventing hazard to public health.

**MATERIAL AND METHODS**

**The Study Areas**

The study was carried out in Kaduna and Zaria, Kaduna State, Nigeria. Kaduna State is located at the centre of Northern Nigeria with the coordinate’s 10°31′N 7°26′E 10.517°N 7.433°E. The state shares boundaries with Niger state to the west, Zamfara, Katsina and Kano States to the north, Bauchi and Plateau States to the east and FCT Abuja and Nasarawa States to the south (Kaduna State, 2010). Agriculture is the mainstay of the economy with about 80% of the people actively engaged in farming. Cash and food crops cultivated and produced include: cotton, groundnut, tobacco, maize beans, guinea corn, millet, ginger, rice and cassava. Another major occupation of the people is animal rearing, namely cattle, sheep, goat and pig rearing. **Kaduna** is the state capital and the largest city with very high agricultural activities while **Zaria** is the second largest town. In each of these cities, there is a peri-urban dairy group namely MILCOPAL and NAPRI that served as a sampling frame.

**Sample Collection**

Information on the animal and management practices including the breed, age, parity, antibiotic administration and problems of mastitis were collected prior to sampling. Milk samples were collected using cluster sampling in which the villages covered were considered as clusters. In each cluster, four (4) herds were selected and ten (10) milking cows identified by simple random sampling without replacement.
The herds were visited during milking time, where 5ml of composite fresh milk samples were collected directly from milking cows and placed into sterile sample bottles. Bulk fresh milk samples were collected after all the milk has been collected and pooled before transporting to the plants. Milk products (Pasteurized milk and yogurt) were collected from the processing plants and ‘kindirmo’ (locally fermented milk) from the village. All the samples collected were placed on ice and transported to the laboratory for analysis.

Isolation of Staphylococci from Milk Samples

All the samples were inoculated onto Baird Parker Medium (Oxoid, Basingstoke, England), and incubated aerobically at 37°C four 24 hours (Baird- Parker, 1962). The isolates were identified using established microbiological methods which included colony morphology, gram staining characteristics and biochemical tests [catalase, coagulase and sugar fermentation (glucose, sucrose, lactose, mannitol)] (Baur et al., 1996; Cheesbrough, 2003; Japoni et al., 2004).

Antimicrobial Resistance Testing of Coagulase Positive S. aureus

Antimicrobial resistance was performed by Kirby- Bauer disk diffusion method as recommended by Clinical Laboratory Standards Institute (CLSI) (CLSI, 2006). All isolates were grown in Brain Hearth Infusion broth (Biotech Laboratories, United Kingdom) and incubated at 37°C for 6 hours until the turbidity of 0.5 McFarland standards was achieved. The isolates were then swabbed onto Muller Hinton Agar (Oxoid, England) and incubated aerobically at 37°C for 18 hours. The bacterial suspension was swabbed on triplicate soy agar (Oxoid, England). Vancomycin discs (3 discs for each plate) were placed on the surface of the medium and incubated over night. The bacterial colonies from edges of the zones of inhibition around the vancomycin discs were then resuspended in sterile distilled water and matched to 0.5 McFarland standards (approximately 10^8 cfu/ml). The bacterial suspension was then heated at 95°C for 15 minutes and cooled at room temperature. Crude lysate mixture (2.5 μl) was used as a DNA template for the PCR analysis.

Amplification of the mec A gene

The polymerase chain reaction (PCR) procedure used was adopted from the method of Strommenger et al. (2003) (Strommenger et al., 2003). The presence of mec A gene was verified in the meticillin–resistant isolates using the primers mecA1 5’-AAAATCGATGGTAAAGGTTG-3’ and mecA2 5’-AGTTCTGCAATCCGGATTTGC-3’ (Inqaba, South Africa) that are expected to yield a PCR product of 533 bp (Strommenger et al., 2003; El-Zubeir et al., 2007). PCR was performed in a 50 μl of reaction mixture with a PCR buffer containing 200 μM concentration of each deoxynucleoside triphosphate (dNTP), 10 mM Tris-Hcl (pH 8.3), 50 mM KCl, 2.5 mM MgCl2, 1.25 unit of Taq polymerase (Promega,
Germany). 0.25 μM concentration of each primer and 2.5 μl of DNA template. DNA amplification was carried out for 50 cycles in 50 μl of reaction mixture as follows: denaturation at 95°C for 30 seconds, annealing at 55°C for 30 seconds and extension at 72°C for 1 minute with a final extension at 72°C for 5 minutes. PCR products (10 μl) were analyzed in 1.5% agarose gel. The gel containing amplified DNA was stained with ethidium bromide solution (10 mg/ml) for 10 minutes and destained with distilled water for 10 minutes. The 533 bp PCR products were visualized under automatic UV transiluminator (Uvtec, Sigma, Germany). The image was stored in the computer for further analysis. DNA from a known mec A carrying Staphylococcus aureus ATCC 33591 strain (Courtesy of Prof. B. Ghebremedhin, Germany) was used as PCR positive control.

Data Analysis
Data obtained from the study were analyzed statistically using Statistical Package for Social Sciences (SPSS) Version 13 software. Frequencies were obtained and percentages for study variables were calculated. Chi-square and Fisher’s exact tests at 5% level of confidence were used to performed categorical comparisons and determination of significance. A P value < 0.05 was considered significant for all comparisons.

RESULTS
Out of the 372 samples collected, 196 were from Kaduna and 176 were from Zaria. The samples comprised 300 raw milk, 18 bulk milk, 17 each of pasteurized milk and yogurt, and 20 ‘kindirmo’. All the 300 milking cows sampled had been treated with at least one antibiotic within four weeks prior the sample collection. Also, significant number (23.0%) of the cows had history of mastitis at some point in the past (Table 1).

Isolation of Coagulase Positive S. aureus
A total of 47 coagulase S. aureus were isolated from the 372 milk samples, with Kaduna having 13.8% and Zaria 11.4%. No significant difference was observed in the isolation rate between the two groups (P > 0.05). The distributions of S. aureus among the different types of milk samples examined are as follows: raw milk, 9.7%; bulk milk, 2.4%; pasteurized milk, 0.3%; yogurt, 0% and ‘kindirmo’ (locally fermented milk), 0.3% (Table 2).

Isolation of MRSA among the Coagulase Positive S. aureus isolates
Out of the 47 coagulase positive S. aureus detected, 18 were found to be resistant to methicillin, which gave an overall prevalence of 4.8% (Table 2). The distribution of the MRSA among the different types of samples revealed that 4.7% occurred in raw milk, 11.1% in bulk milk and 1 each in pasteurized and ‘kindirmo’ (locally fermented milk) respectively. No MRSA was detected in yogurt samples examined (Table 3). There was no significant difference (P > 0.05) between the occurrences of MRSA in samples examined.

Antibiotic Resistance Profile of Coagulase Positive S. aureus
The antibiotic resistant profile of the 47 positive S. aureus isolates to other antibiotics was as follows: amikacin (2.1%), amoxicillin (44.8%), chloramphenicol (4.3%), ciprofloxacin (14.9%), erythromycin (31.9%), gentamycin (25.9%), methicillin (38.3%), oxacillin (46.8%), penicillin (100%), sulphamethoxazole/trimethoprim (6.4%), tetracycline (31.9%) and vancomycin (42.6%) (Table 4). The results showed that ciprofloxacin, chloramphenicol, amikacin and sulphamethoxazole/trimethoprim showed low resistant pattern. However, penicillin recorded the highest resistance with all the isolates (100%) resistant to it (Tables 4).

Antibiotic Resistance Profile of MRSA Isolates
The resistant profile of the 18 MRSA isolates are, amoxicillin (38.9%), chloramphenicol (5.6%), ciprofloxacin (38.9%), erythromycin (27.8%), gentamycin (11.1%), oxacillin (100.0%), penicillin (100%), sulphamethoxazole/trimethoprim (11.1%), tetracycline (55.5%), and vancomycin (44.4%). All the MRSA isolates were susceptible to...
amikacin (Table 4). Out of the 18 MRSA isolates, 16 were found to be resistant to more than one antibiotic (multi-drug resistant pattern), while two were resistant to one antibiotic only (Table 4).

**Molecular Detection of mec A Gene in the MRSA Isolates**

The presence of methicillin-resistance gene was confirmed by PCR. Four of the 18 MRSA isolates (2 each from Kaduna and Zaria) were mec A positive as evidenced by the amplification of mec A gene specific amplicon of 533bp (Figure 1). Three of the mec A positive isolates were detected in raw milk while 1 was in the ‘kindirmo’ samples examined. No amplicon were produced by the remaining 14 MRSA isolates.

**DISCUSSION**

The study was designed to determine the prevalence and antimicrobial resistant profile of *S. aureus* and MRSA isolated from fresh and fermented milk products. The 4.8% prevalence of MRSA recorded in this study was higher than 0.18% recorded in bovine milk in Korea,5 1.7% in bovine milk in Turkey, 0% US bulk tank milk in U.S.A. and 1.4% in raw milk in Switzerland (Kwon et al., 2005; Huber et al., 2009; Türkyılmaz et al., 2010). However, the present prevalence is lower than 29.3% in raw milk in Republic of Korea and 14.7% in raw goat’s milk in Czech Republic (Lee, 2003; Strastkova et al., 2009). The paucity of local studies on MRSA in milk and foods in general makes it difficult to make any comparisons and to assess the MRSA status in milk in Nigeria.

It was noted that out of the 18 MRSA isolates, 14 were detected in raw milk, 2 in bulk milk, 1 each in pasteurized milk and ‘kindirmo’ while none was detected in the yogurt samples examine. This trend of occurrence of MRSA suggests that dilution, pasteurization and fermentation eliminated most of the organisms from the milk samples, and could prevent the spread of the organisms to humans. This has already been documented that fermented foods are not a good media for *S. aureus* survival and growth (Umoh, 1989). Although not categorically determined; the occurrence of this organism albeit at low level in these processed products could imply recontamination during or after processing. The possible explanation for the significant occurrence of MRSA in raw milk studied may be due to unrestricted and uncontrolled use of antibiotics in animals and farming, unsatisfactory health status of cattle herds. Secondly, a greater percentage of cattle herds are extensively managed, which exposed them to contaminated environment (Strastkova et al., 2009).

The antibiotic resistance profile results of the MRSA isolates from this study is not encouraging and not in agreement with the studies from Republic of Korea, Turkey, Switzerland and Czech Republic (Lee, 2003; Virgin et al., 2009; Huber et al., 2009; Türkyılmaz et al., 2010). The MRSA isolates from this study were resistant to most of the antibiotics tested except amikacin which recorded 100% susceptibilities. This connotes that in the event of outbreak of MRSA, amikacin could be reliably effective. The most striking difference between the present study and others is the observed resistance to vancomycin, which is the drug of choice for the treatment of MRSA. Vancomycin resistance was recorded in 44.4% of the isolates which is surprising and of serious concern.

There are several studies suggesting the possible transfer of *S. aureus* between humans and cattle (Lee, 2003). The present information also suggested that infection of humans through milk contaminated with animal MRSA may be possible. The animal MRSA may have originated from humans, considering the reported high prevalence of MRSA (> 50%) in humans in Nigeria (Okon et al., 2007; Ghebremedhin et al., 2009; Fadaye et al., 2010; Nwanko et al., 2010). The incidence of MRSA in animals or foods is yet to be known. Once the transfer between humans and animals occurred, these isolates can become widespread in the animal environment of Nigeria, where antibiotics such as vancomycin and amikacin (which are effective against MRSA) are hardly used for
animals. This may lead to an increasing prevalence and endemicity of the organism. Molecular analysis of the MRSA isolates by polymerase chain reaction (PCR) was carried out to detect mec A, which is the gold standard for methicillin-resistance. Four of the isolates (3 from raw milk and 1 from kindirmo) were mec A positive indicating that methicillin-resistance in these isolates was due to mec A gene. This is in agreement with studies such as that of Adesida et al. (2005) who screened MRSA for mec A gene by PCR in Nigeria and detected the gene in 1.4% of hospital isolates in South Western and North Central regions of Nigeria. It was noted that PCR assays for detection of MRSA do not always give indisputable results, some isolates have been found to be mec A negative in the PCR, but resistant to methicillin/oxacillin. Also, some isolates have been found to be mec A positive, but susceptible to both methicillin and oxacillin (Olonitola et al., 2007).

CONCLUSION
This study established the presence of MRSA and mec A positive-MRSA in both raw and fermented milk with a prevalence of 4.8%. The low prevalence in pasteurized milk, yogurt and ‘kindirmo’ (locally fermented milk) may be due to effectiveness of pasteurization and fermentation in eliminating most organisms from milk. Therefore, the study recommends proper pasteurization and fermentation of milk before human consumption, and also the practice of proper hygienic measures during milking procedures to limit the spread to humans.

ACKNOWLEDGEMENTS
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Table 1: History of antibiotic administration and mastitis in dairy herds in Kaduna and Zaria

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of animals</th>
<th>Antibiotic Yes</th>
<th>No</th>
<th>Mastitis Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaduna</td>
<td>160</td>
<td>160(100)</td>
<td>0</td>
<td>39(24.4)</td>
<td>121(75.6)</td>
</tr>
<tr>
<td>Zaria</td>
<td>140</td>
<td>140(100)</td>
<td>0</td>
<td>30(21.4)</td>
<td>110(78.6)</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>300(100)</td>
<td>0</td>
<td>69(23.0)</td>
<td>231(77.0)</td>
</tr>
</tbody>
</table>

N.B.: Numbers in parenthesis indicate percentages

Table 2: Prevalence of staphylococci and methicillin-resistant *Staphylococcus aureus* (MRSA) in fresh and fermented milk in Kaduna and Zaria, Kaduna State.

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of samples</th>
<th>No. (%) Coag. negative staphylococci</th>
<th>No. (%) Coag. positive staphylococci</th>
<th>No. (%) MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaduna</td>
<td>196</td>
<td>49(25.0)</td>
<td>27(13.8)</td>
<td>10(5.1)</td>
</tr>
<tr>
<td>Zaria</td>
<td>176</td>
<td>31(17.6)</td>
<td>20(11.4)</td>
<td>8(4.5)</td>
</tr>
<tr>
<td>Total</td>
<td>372</td>
<td>80(21.5)</td>
<td>47(12.6)</td>
<td>18(4.8)</td>
</tr>
</tbody>
</table>
Table 3: Prevalence of staphylococci and methicillin-resistant Staphylococcus aureus (MRSA) according to the type of sample examined in Kaduna and Zaria.

<table>
<thead>
<tr>
<th>Type of sample</th>
<th>No. of sample Tested</th>
<th>No. (%) Coag. negative staphylococci</th>
<th>No. (%) Coag. Positive staphylococci</th>
<th>No. (%) MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw milk</td>
<td>300</td>
<td>75(20.2)</td>
<td>36(9.7)</td>
<td>14(3.8)</td>
</tr>
<tr>
<td>Bulk milk</td>
<td>18</td>
<td>3(0.8)</td>
<td>9(2.4)</td>
<td>2(0.5)</td>
</tr>
<tr>
<td>Pasteurized Milk</td>
<td>17</td>
<td>1(0.3)</td>
<td>1(0.3)</td>
<td>1(0.3)</td>
</tr>
<tr>
<td>Yogurt</td>
<td>17</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>Kindirmo*</td>
<td>20</td>
<td>0(0.0)</td>
<td>1(0.3)</td>
<td>1(0.3)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>372</strong></td>
<td><strong>80(21.5)</strong></td>
<td><strong>47(12.6)</strong></td>
<td><strong>18(4.8)</strong></td>
</tr>
</tbody>
</table>

* Local processor

Table 4: Antimicrobial resistance profile of S. aureus and MRSA isolated from fresh and fermented milk in Kaduna and Zaria, Nigeria

<table>
<thead>
<tr>
<th></th>
<th>TE</th>
<th>P</th>
<th>E</th>
<th>SXT</th>
<th>AK</th>
<th>C</th>
<th>OX</th>
<th>VA</th>
<th>CIP</th>
<th>AMC</th>
<th>CN</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em></td>
<td>15</td>
<td>47</td>
<td>15</td>
<td>15</td>
<td>2</td>
<td>2</td>
<td>22</td>
<td>20</td>
<td>7</td>
<td>21</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>N= 47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>MRSA</em></td>
<td>10</td>
<td>18</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N=18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N.B.: Numbers in parenthesis indicate percentages.

**Key:**
- TE-Tetracycline
- P-Penicillin
- E-Erythromycin
- SXT-Sulphamethoxazole/Trimethoprim
- AK-Amikacin
- C-Chloramphenicol
- OX-Oxacillin
- VA-Vancomycin
- CIP-Ciprofloxacin
- AMC-Amoxicillin
- CN-Gentamycin
- MET-Methicillin

Figure 1: PCR result showing four amplicon produced by four isolates plus positive control at 533 bp

M- 100 bp Molecular marker N- Negative control P- Positive control.

1-KuF 10 3-KF 21 5-JAF 2 6-JAK 6
F- Fresh milk  K- ‘Kindirmo’
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ABSTRACT

Methicillin-resistant Staphylococcus aureus (MRSA) is of public health and veterinary concern globally and mastitic milk is one of the sources. In this study, 372 milk samples comprising of raw milk, bulk milk, yogurt and ‘kindirmo’ (locally fermented milk) obtained from Kaduna and Zaria, Nigeria were examined for the prevalence of MRSA and their antibiotic resistance profile. Out of the 372 milk samples examined, 195 staphylococci were isolated and out of which 47 (12.6%) were coagulase positive and 18 (4.8%) were methicillin resistant. There was no significant difference (P > 0.05) between the occurrence of both coagulase positive S. aureus and MRSA in Kaduna (13.4% and 5.1%) and Zaria (11.4% and 4.5%). The occurrence of coagulase positive S. aureus was significantly higher (P < 0.05) in raw milk (22.2%) than bulk milk (0.8%), pasteurized milk (.3%) and ‘kindirmo’ (0.3%). However, no significant difference (P > 0.05) exists between the occurrences of MRSA among the study variables. No coagulase positive S. aureus and MRSA was detected in any of the yogurt samples examined. A decrease in the prevalence was observed from raw milk to the final yogurt and ‘kindirmo’ products indicating that pasteurization and fermentation eliminated the organisms. Very high percentages of the MRSA isolates were resistant to oxacillin (100.0%), penicillin (100.0%), tetracycline (55.6%), and vancomycin (44.6%) while sulfamethoxazole/trimethoprim and gentamicin recorded the least levels of (11.1%) and (5.6%) respectively. The mec A was detected by polymerase chain reaction in 4 of the 18 MRSA isolates (3 in raw milk and 1 in ‘kindirmo’ samples). The study recommends proper pasteurization and fermentation of milk to eliminate MRSA before human consumption.

Keywords: Prevalence, Methicillin-resistant Staphylococcus aureus (MRSA), Fresh milk, Fermented milk, Antimicrobial resistance.

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