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Occurrence and Antibiotic Susceptibility Profile of *Staphylococcus aureus* Isolated from Dairy Products in Pastoral Communities in Niger State, Nigeria

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Abstract

Staphylococcus aureus is a significant cause of food poisoning in dairy products around the world. This study investigates the prevalence and antibacterial susceptibility profile of S. aureus obtained from dairy products and possible dairy products contaminating sources in pastoral communities of Niger State, Nigeria. A total of 2760 samples, comprising of 360 each of Ghee (Maishanu), Cheese (Awara), Local Yoghurt (Kindirmo), Raw Milk (Madara), and Fermented Milk (Nono), and 240 each from contaminating sources (such as handler's hands, containers, udders, and water), were randomly obtained from various pastoral communities in Niger State, Nigeria. Isolation and identification of S. aureus was carried out according to standard microbiological methods. The results revealed a total of 204 (7.4%) S. aureus strains were isolated from the collected samples. Among the dairy products, raw milk accounted for the highest frequency of S. aureus 31 (8.6%), while cheese and ghee had 4.4% and 4.7% S. aureus, respectively. While from the possible contaminating sources, the handler's hand the highest percentage of occurrence (4.2%), while the least (1.1%) was recorded from water. The S.aureus isolates showed >80% susceptibility to ceftazidime, cefuroxime, ciprofloxacin, vancomycin, minocycline, and trimethoprim/sulfamethoxazole. The isolates were resistant to oxacillin (31.4%), cefoxitin (29.4%), gentamicin (23.5%), ampicillin (20.6%), and ceftazidime (18.6%). Moreover, 87.5% of the S. aureus exhibit multidrug resistance. The presence of multidrug-resistant S. aureus in dairy products is of great public health concern; therefore, appropriate food safety measures should be implemented to improve the conditions under which these products are processed and sold.

Keywords: Antibacterial Susceptibility, Staphylococcus aureus, Pastoral communities, Dairy Products.

INTRODUCTION

Staphylococcus aureus is a well-known cause of food poisoning and is a frequent dairy product contaminant worldwide, especially in resource-limited nations like Nigeria (Diep *et al.*, 2006). This is due to the fact that it can thrive at temperatures between 15 and 45 °C and at 15% NaCl concentrations (Behling *et al.*, 2010), allowing for rapid toxin generation and multiplication at room temperature. Although *S. aureus* is found everywhere in nature, food is the main sourceof *S. aureus* infection. *S. aureus* was attributed to over 241,000 foodborne disease illnesses annually in the United States (Scallan *et al.*, 2011; Wu *et al.*, 2019), while in China, *S. aureus* caused 12.5% of foodborne bacterial outbreaks in 2013 (Wei-Wei *et al.*, 2018). However, because there is often a lack of coordinated national surveillance, it is difficult to determine the size of foodborne bacterial outbreaks in underdeveloped nations like Nigeria.

Dairy products are among the foods frequently linked to Staphylococcal food poisoning (SFP) because they are an excellent substrate for *S. aureus* development SFP. Since enterotoxigenic *S. aureus* strains are frequently found in raw cow milk and items made from milk processing, they play a significant role in SFP (Normanno *et al.*, 2007; Junaidu *et al.*, 2011). In many Northern Nigerian states, fresh milk and other dairy products like kindrimo, nono, and ghee (milk fat) are typically sold and consumed. Undoubtedly, the quality and safety of diary products are difficult to accomplish in underdeveloped nations (Tassew and Seifu, 2011; Bereda *et al.*, 2014). Dairy products are exposed to potentially toxic organisms and contaminating bacteria due to the processing and distribution methods used in the tropics (Ezeonu and Ezurike, 2007).

Additionally, contamination occurs due to lack of access to portable water. This is because pastoralists live in rural and distant places, in order to have access to pasture. There are poor sanitary conditions in pastoralist communities because they lack social amenities and reliable health care facilities (Gammino *et al.*, 2020).
Several researches have reported *S. aureus* strains from dairy products sold in northern Nigeria over the past ten years (Junaidu *et al.*, 2011; Okpo *et al.*, 2016; Usman and Mustapha, 2016; Yakubu *et al.*, 2016; Maduka *et al.*, 2017; Asiimwe *et al.*, 2017). However, in Niger State, Nigeria there are significant gap in surveillance of community acquired *S. aureus* among dairy products from these communities. Therefore, this study set to identify the occurrence of *S. aureus,* and its antibacterial susceptibility profiles among dairy products from pastoral communities from Niger State, Nigeria.

MATERIALS AND METHODS

Description of Study Area

This study was carried out in Niger State, in North-central, Nigeria. The state's capital, Minna, is situated at Latitude: 9.6139° N and Longitude: 6.5569° E. The Federal Capital Territory of Abuja is 150 miles away. The wet (rainy) and dry seasons are two separate time periods in the state. The state has the largest land mass among all states in the nation with a total area of 76,363 km^2. The state is home to various indigenous tribes; among these are the Nupe, Gbagyi, Kamuku, Kambari, Dukawa, Hausa, and Koro. The state is also home to a sizable population of Fulanis, who live in pastoral villages.

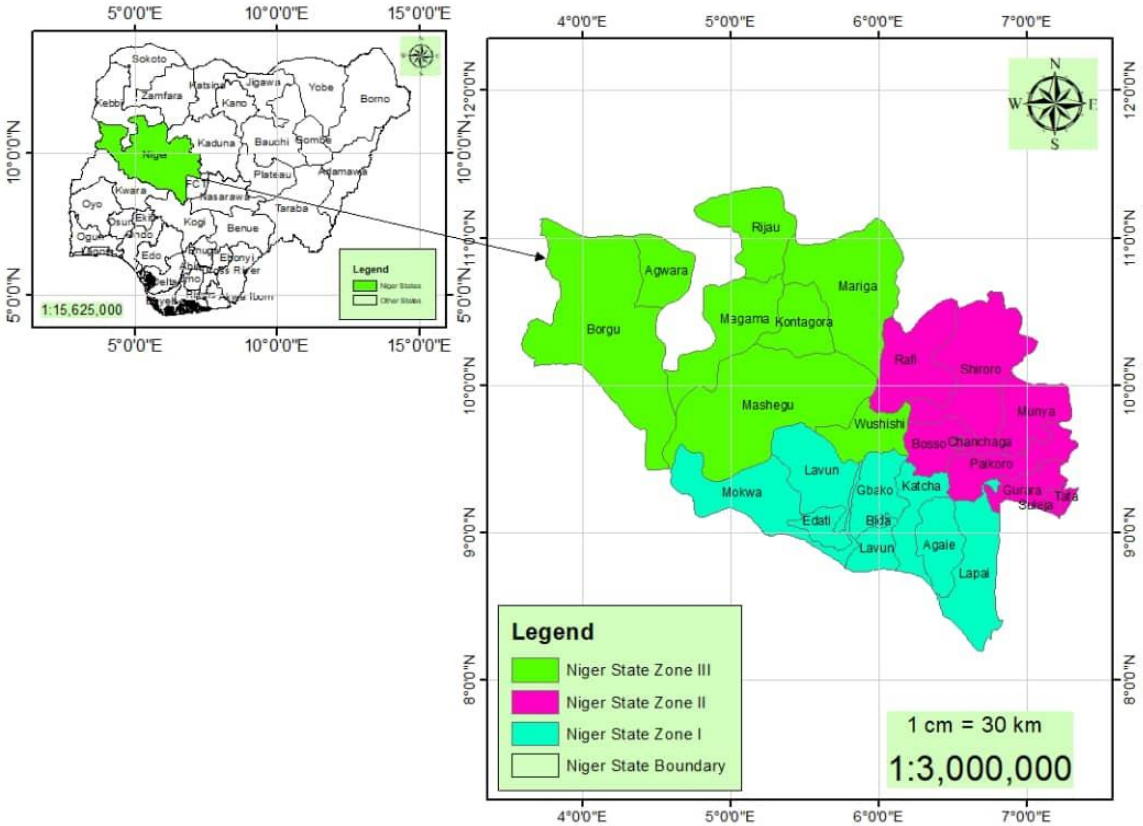

Figure 1: Map of Niger State indicating the study sites

Sample Collection

A total of 2760 samples were collected using sterile methods from different pastoral communities in Niger State, Nigeria. The samples comprised of: 360 of each Ghee (Maishanu), Cheese (Awara), Local Yoghurt (Kindirmo), Raw Milk (Madara), and Fermented Milk (Nono), as well as 240 samples of each potential contaminating source (i.e., handler's hands, containers, udders, and water). The state is divided into 3 zones; Zones 1, 2, and 3 and samples were collected from each as shown in Table 1.
Samples were transported to "Step B" Laboratory of the Center for Vaccine and Drug Development at the Federal University of Technology Minna, Nigeria, using ice-filled bags and processed within six hours of collection for isolation of *S. aureus*.

Isolation of *Staphylococcus aureus*

Isolation and identification of *S. aureus* from the samples was carried out according to the methods of Cheesbrough, (2006). In 9 mL of distilled water, one (1) mL/gm of the samples was homogenized and serially diluted up to a factor of 10^3. One (1) mL of 10^3dilution was cultured on both Nutrient Agar and Mannitol Salt Agar (MSA) plates and incubated at 37°C for 24 hours. After 24 hours of incubation, colonies that were golden yellow in color were subcultured on nutrient agar slants and kept in the fridge for future analysis.

Presumptive Biochemical Screening

Colonies presumptively identified as *S aureus* identity were confirmed using Gram staining and biochemical tests that include catalase test and coagulates test as described by Cheesbrough, (2006).

Table 1: Collected samples per zone for this study

Zone 1									
LGA	**Ghee**	**Cheese**	**LY**	**RM**	**FM**	**Hands**	**C**	**Udder**	**Water**
Agaie	15	15	15	15	15	10	10	10	10
Bida	15	15	15	15	15	10	10	10	10
Edati	15	15	15	15	15	10	10	10	10
Gbako	15	15	15	15	15	10	10	10	10
Katcha	15	15	15	15	15	10	10	10	10
Lapai	15	15	15	15	15	10	10	10	10
Lavun	15	15	15	15	15	10	10	10	10
Mokwa	15	15	15	15	15	10	10	10	10
Total	**120**	**120**	**120**	**120**	**120**	**80**	**80**	**80**	**80**
ZONE 2									
Bosso	15	15	15	15	15	10	10	10	10
Gurara	15	15	15	15	15	10	10	10	10
Munya	15	15	15	15	15	10	10	10	10
Paikoro	15	15	15	15	15	10	10	10	10
Rafi	15	15	15	15	15	10	10	10	10
Shiroro	15	15	15	15	15	10	10	10	10
Suleija	15	15	15	15	15	10	10	10	10
Tafa	15	15	15	15	15	10	10	10	10
Total	**120**	**120**	**120**	**120**	**120**	**80**	**80**	**80**	**80**
ZONE 3									
Agwara	15	15	15	15	15	10	10	10	10
Borgu	15	15	15	15	15	10	10	10	10
Kontagora	15	15	15	15	15	10	10	10	10
Magama	15	15	15	15	15	10	10	10	10
Mariga	15	15	15	15	15	10	10	10	10
Mashegu	15	15	15	15	15	10	10	10	10
Rijau	15	15	15	15	15	10	10	10	10
Wushishi	15	15	15	15	15	10	10	10	10
Total	**120**	**120**	**120**	**120**	**120**	**80**	**80**	**80**	**80**

Key: Local Yoghurt (FM), Raw Milk (RM), Fermented Milk (FM), Container (C)

Antibacterial Susceptibility testing of the *S. aureus* isolates

The *S. aureus* isolates from the various samples were evaluated for antibiotics susceptibility using Kirby Bauer's agar disc diffusion method, according to the method by Cheesbrough, (2006). Antibiotics disks (Oxoid, UK) used were listed in Table 2).

Individual colonies were suspended in normal saline and the inoculum was adjusted to match 0.5 McFarland standards, and the suspensions were then inoculated on Muller-Hinton agar for using sterile swabs. The antibiotic discs were placed on the inoculated plate and the plates were incubated at 37°C for 18 hours. German sterile Whatman filter paper No. 3 (6 mm) was utilized as a control.

Bacteria were categorized as susceptible, intermediate, or resistant to a particular antibiotic using the CLSI antibiotic susceptibility interpretive chart based on the diameter of the zones of inhibition surrounding the antibiotic discs. Term "Multidrug resistance" (MDR) refers to an isolate's resistance to three or more different antibiotics (Lambert, 2003; Osundiya *et al.*, 2013).

Table 2: Antibiotics used in this study with their different classes

Antibiotics	Disc Codes	Potency (µg)	Zones of Inhibitor'sDiameter	Classes of antibiotics
Ampicillin	AMP	10	≤28	Beta-lactam
Oxacillin	OX	1	≤10	Beta-lactam
Ceftazidime	CAZ	30	≤14	Beta-lactam
Cefuroxime	CXM	30	≤14	Beta-lactam
Cefoxitin	FOX	30	≤21	Beta-lactam
Ciprofloxacin	CIP	5	≤15	Fluoroquinolones
Vancomycin	VA	30	≤14	Glycopeptides
Gentamicin	CN	10	≤12	Aminoglycosides
Minocycline	MH	30	≤14	Tetracyclines
Tetracycline	TE	30	≤14	Tetracyclines
Trimethoprim/Sulfamethoxazole	SXT	25	≤10	Folate pathway antagonist
Erythromycin	E	15	≤13	Macrolides

Statistical Analysis

The data generated for this study was inputted into IBM SPSS software version 26. Chi-square was employed for the comparison of the rates of *S. aureus* and MRSA amongst dairy products and potential contaminating sources sampled at 95% confidence intervals. The antibiogram were presented in rates. All computed results with p value ≤0.05 were considered statistically significant. Z-test was applied to test for significance between column percentages.

RESULTS

Distribution of *S. aureus* in dairy products and possible contaminating source sampled in Niger State, Nigeria

Out of the 2760 samples analyzed, a total of 204 *S. aureus* isolates were recovered from both the dairy products and the potential contamination sources. Of these, 112 *S. aureus* were isolated from the dairy products, and raw milk accounted for the highest frequency of occurrence of *S. aureus* 31(8.6%), followed by fermented milk (8.1%) while Ghee had the least S. aureus isolates recovered (Table 3). Similarly, a total of 92 *S. aureus* were recovered from possibly contaminating sources, and out of these, the highest *S. aureus* isolates were recovered from the Handler's hand 40 (4.2%), followed by 21 (2.2%) from udder and the least number of *S. aureus* were isolated from water (Table 4).

Antibiogram of the *S. aureus* isolated from dairy products and possible contaminating sources

The antibiogram of the 204 isolates is shown in Table 5. The isolates showed >80% susceptibility to Ceftazidime, Cefuroxime. Ciprofloxacin, Vancomycin, Minocycline, and Trimethoprim/Sulfamethoxazole. The least susceptibility (68.6%) was observed with Oxacillin.

Table 3: Frequency of occurrence of *S. aureus* in dairy products in the study areas

Dairy products	No. of *S. aureus* recovered	% *S. aureus* recovered	P- value
Ghee *(Manshanu)* (n=360)	16	4.4[a]	0.05
Cheese *(Awara)*(n=360)	17	4.7[a]	
Local Yoghurt (*Kindirmo*) (n=360)	19	5.3[a]	
Raw Milk (*Madara*) (n=360)	31	8.6[b]	
Fermented Milk (*Nono*) (n=360)	29	8.1[a]	
Total tally the numbers above	112	6.2	

Each subscript letter denotes a subset of Staphylococcus categories whose column proportions do not differ significantly from each other at the .05 level according to z-test
The occurrence of S. aureus is dependent of dairy products in Niger State, Nigeria and is significantly higher in raw milk ($p \leq 0.05$).

Table 4: Frequency of contamination of *S. aureus* among contaminating sources in the study areas

Potential contamination sources	**Number of *S. aureus* recovered**	**% *S. aureus* recovered**	**P-value**
Handler's Hands (n=240)	40	4.2[b]	0.000
Containers (n=240)	20	2.1[a]	
Udders (n=240)	21	2.2[a]	
Water (n=240)	11	1.1[b]	
Total	**92**	**9.6**	

Each subscript letter denotes a subset of Staphylococcus categories whose column proportions do not differ significantly from each other at the .05 level according to z-test
The occurrence of S. aureus is dependent of potential contaminating source in Niger State, Nigeria and is significantly higher on hands in contact with, and water used in the processing of dairy products ($p \leq 0.05$).

Table 5: Antibiogram of *Staphylococcus aureus* isolates from this study

		No. of *S. aureus* =204	
Antibiotics	Potency (µg)	No. of Resistant isolates (%)	No. of susceptible (%)
AMP	10	42(20.6)	162(79.4)
OX	1	64(31.4)	140(68.6)
CAZ	30	38(18.6)	166(81.4)
CXM	30	26(12.8)	178(87.3)
FOX	30	60(29.4)	144(70.6)
CIP	5	31(15.2)	173(84.8)
VA	30	33(16.2)	171(83.8)
CN	10	48(23.5)	156(76.5)
MH	30	23(11.3)	181(88.7)
TET	30	60(29.4)	144(70.6)
SXT	25	23(11.3)	181(88.7)
E	15	25(12.3)	179(87.7)

Key: Ampicillin (AMP), Oxacillin (OX), Ceftazidime (CAZ), Cefuroxime (CXM), Cefoxitin (FOX), Ciprofloxacin (CIP), Vancomycin (VA), Gentamicin (CN), Minocycline (MH), Tetracycline (TET), Trimethoprim/Sulfamethoxazole (SXT), Erythromycin (E)

Table 6 shows the 107 antibiotic resistance patterns observed in this study. Ninety-five (95) antibiotic resistance phenotypes was observed, 87.5% were from the multiple resistance types with varying combinations of three 3 to 8 different antibiotics. Similarly, 4.2 % and 8.3% antibiotics resistance phenotype were found with a single and two antibiotics. The highest frequency (30isolates exhibits resistance to a combination of 6 antibiotics. Multiple antibiotics resistance index (MARI) ranged from 1 (0.1) to 8 (0.7).

Table 6: Multiple antibiotic resistance (MAR) pattern of *S. aureus* isolated from dairy products and possible contamination sources

ID	Resistant pattern	MDRI	ID	Resistant pattern	MDRI	ID	Resistant pattern	MDRI
GH95	CAZ/CN/E	0.3	H113	AMP/OX/CAZ/FOX/TE	0.4	LY45	AMP/OX/CXM/FOX/VA/CN	0.5
GH32	OX/CAZ/MH	0.3	H167	OX/FOX/CN/MH/SXT	0.4	LY76	OX/CAZ/FOX/CN/MH/TE	0.5
CS10	CXM/TE/E	0.3	FM67	OX/FOX/CIP/VA/MH	0.4	RM98	OX/FOX/CIP/CN/TE/E	0.5
LYI	CN/MH/TE	0.3	GH89	OX/FOX/VA/TE/SXT	0.4	RM100	AMP/OX/CAZ/FOX/CN/E	0.5
FM80	CIP/CN/TE	0.3	CS23	AMP/OX/CAZ/FOX/E	0.4	RM114	OX/CIP/VA/TE/SXT/E	0.5
FM40	AMP/CN/TE	0.3	CS19	OX/FOX/CIP/VA/TE	0.4	RM119	AMP/OX/CXM/FOX/SXT/E	0.5
FM100	CXM/VA/CN	0.3	LY12	AMP/OX/FOX/CN/SXT	0.4	RM29	OX/CAZ/FOX/VA/CN/TE	0.5
H19	CXM/CN/SXT	0.3	LY17	OX/CXM/FOX/TE/E	0.4	FM45	AMP/OX/CXM/FOX/CIP/CN	0.5
C47	CAZ/CIP/CN	0.3	RM46	AMP/OX/CXM/FOX/CN	0.4	FM29	OX/FOX/VA/MH/TE/E	0.5
U83	AMP/CN/TE	0.3	RM8C	OX/CAZ/FOX/CN/MH	0.4	FM36	OX/CXM/FOX/CIP/CN/MH	0.5
H40	AMP/CAZ/CIP/TE	0.3	RM129	AMP/OX/FOX/CIP/TE	0.4	FM57	AMP/OX/FOX/CIP/SXT/E	0.5
RM1	OX/FOX/MH/TE	0.3	RM156	OX/CAZ/FOX/CN/TE	0.4	FM120	AMP/OX/CAZ/CXM/FOX/CN	0.5
RM93	CXM/CIP/TE/E	0.3	FM87	OX/CAZ/FOX/CIP/TE	0.4	FM52	OX/FOX/VA/MH/TE/E	0.5
RM33	AMP/CAZ/VA/SXT	0.3	HB6	OX/FOX/VA/CN/MH	0.4	H34	OX/CAZ/FOX/CIP/CN/TE	0.5
GH4T	CXM/CIP/VA/TE	0.3	CGE	OX/FOX/VA/CN/SXT	0.4	H47	AMP/OX/CXM/FOX/VA/TE	0.5
GH28	OX/CXM/FOX/CN	0.3	C73	AMP/OX/CXM/FOX/VA	0.4	H90	AMP/OX/CAZ/FOX/CN/MH	0.5
CS2	CAZ/VA/TE/SXT	0.3	C36	OX/CXM/FOX/CIP/TE	0.4	H69	AMP/OX/FOX/VA/TE/E	0.5
CS29	AMP/CIP/CN/TE	0.3	U09	AMP/CAZ/CXM/CIP/TE	0.4	H84	AMP/OX/FOX/CN/TE/E	0.5
CS32	AMP/CXM/VA/SXT	0.3	U91	AMP/OX/FOX/TE/SXT	0.4	C60	OX/CAZ/FOX/CIP/MH/TE	0.5
LY90	CXM/CIP/CN/TE	0.3	U82	OX/CIP/VA/TE/SXT	0.4	C69	OX/CAZ/FOX/CN/TE/SXT	0.5
LY85	OX/FOX/TE/E	0.3	U67	AMP/OX/FOX/CN/TE	0.4	C21	AMP/OX/FOX/CIP/VA/TE	0.5
LY42	AMP/OX/FOX/SXT	0.3	U32	AMP/OX/CAZ/FOX/SXT	0.4	W37	AMP/OX/FOX/VA/MH/S	0.5
H4R	OX/CAZ/FOX/TE	0.3	H114	AMP/OX/FOX/CIP/CN/TE	0.5	W82	AMP/OX/CAZ/FOX/CN/TE	0.5
U78	CXM/CIP/CN/MH	0.3	GH39	AMP/OX/CXM/FOX/VA/CN	0.5	H15	AMP/OX/FOX/CIP/CN/TE	0.5
U70	CAZ/CIP/VA/TE	0.3	GH81	AMP/OX/CAZ/FOX/VA/TE	0.5	FM19	AMP/OX/CAZ/FOX/CN/TE/E	0.6
LY50	OX/FOX/TE/E	0.3	GH62	AMP/OX/FOX/CN/MH/SXT	0.5	W25	OX/CAZ/FOX/CN/TE/SXT/E	0.6
H14	OX/CAZ/FOX/VA/MH	0.4	GH110	OX/FOX/CIP/CN/MH/TE	0.5	H42	OX/FOX/CIP/VA/CN/MH/SXT	0.6
H32	AMP/CAZ/CIP/TE/SXT	0.4	LY23	OX/CAZ/FOX/CIP/VA/MH	0.5	W30	AMP/OX/CXM/FOX/MH/TE/SXT/E	0.7

Key: No. of antimicrobials to which isolates were resistant (NAR); Multiple antibiotics resistance index **(MARI),** Ampicillin (AMP), Oxacillin (OX), Ceftazidime (CAZ), Cefuroxime (CXM), Cefoxitin (FOX), Ciprofloxacin (CIP), Vancomycin (VA), Gentamicin (CN), Minocycline (MH), Tetracycline (TET), Trimethoprim/Sulfamethoxazole (SXT), Erythromycin (E), Fermented Milk (FM), Raw milk (RM), Local Yoghurt (LY), Cheese (C), Ghee (GH), Water (W), Udder (U), Container (CS), hand (H)

DISCUSSION

The study revealed a high prevalence of *S. aureus* (7.4%) in dairy products retailed in Niger State, Nigeria. The presence of *S. aureus* in cow milk's products in the study area is a threat to public health as *S.aureus* has been identified as a leading bacterial pathogen in outbreaks associated with food poisoning of milk and dairy products (Junaidu *et al.*, 2011). Hence, its presence in the dairy products studied render the product unsafe even though it appears pleasant to the eyes.

The occurrence of *S. aureus* in the studied samples was found to be insignificantly associated with the product type, though raw milk had higher rates. Products such as ghee, cheese, local yoghurt and fermented milk recorded lower rates of *S. aureus* compared with the raw milk. The observation may not be unconnected with the fact that the processed products had undergone processes like fermentation and/or pasteurization that could have lower the contamination rate. This observation was in agreement with Okpo *et al.* (2016) who reported such varied bacterial count from dairy products consumed in Kaduna, Nigeria.

The study established that, *S. aureus* was present in all potential contaminating sources of dairy products sampled in Niger State, Nigeria. A significant relationship ($p<0.05$) was established between the water used in processing dairy products as well as handler's hands and the occurrence of *S. aureus* in dairy products in Niger State, Nigeria. (Table 4). These observations might be related to inadequate water sources and unhygienic practices of handlers of the products.

Additionally, the nascent means of transport and marketing system of dairy products are predisposing factors besides, *S. aureus* may have been introduced from mastitic animals or humans (Oliver *et al.*, 2005; Akram *et al.*, 2013). The findings of this study give credibility to the assertion that, handler's hands and water used in handling of dairy products are the mainroutes for the spread of *S. aureus* to dairy products in Niger State, Nigeria.

Similarly, the occurrence of *S. aureus* is dependent on potential contaminating source in Niger State, Nigeria as revealed by the findings of this study and is significantly higher on hands in contact with, and water used in the processing of dairy products ($p\leq0.05$). This pin pointed the poor hygiene of the handlers and/or health condition of the dairy animals in the study areas. Therefore, potential cross contamination of dairy products is possible since most of the handlers of dairy products are unaware of hygienic protocols to avoid contamination.

Staphylococcus aureus isolates from this study demonstrated high susceptibility (>68%) to the 12 antibiotics examined. Thus, owing to the increasing global awareness of the emergence of resistant by bacterial strains to major antibiotics, the observation of these study becomes a matter of concern for humans, livestock disease management and production. Overall, this suggests the ineffectiveness of the local use of antibiotics in animal production as well as national antibiotics resistance control programs.

The ability of *S. aureus* strains to acquire antimicrobial resistance is well documented. Multidrug, methicillin resistant strains and vancomycin resistant *S. aureus* strains have received unprecedented attention in the past decade (Yakubu *et al.*, 2020; Can *et al.*, 2017 and Chaalal *et al.*, 2016). Significant resistance to antibiotic was observed among *S. aureus* isolates in dairy products and possible contaminating sources of dairy products in the present studywith high rate of resistance to oxacillin (31.4%), tetracycline (29.4%), cefoxitin (29.4%) and ampicillin (20.6%). This outcome call for proactive approach considering the fact that, tetracycline and ampicillin are first-line drug in Nigeria. Comparable higher resistance rates to oxacillin, tetracycline and cefoxitin have been previously reported from dairy products by Umaru *et al.*, (2013); Anueyiagu and Isiyaku (2015); Yakubu *et al.*, (2020); Can *et al.*, (2017) and Chaalal *et al.*, (2016) in Zaria, Jos, Nassarawa, Turkey and Algeria respectively. This most likely may be due to routine usage of *β*-lactams and tetracycline resulting to resistant strains emergence and spread in the study areas. Similar high resistance rates to *β*-lactams and tetracycline in the present and previous studies may be a reflection of misuse of these antibiotics for both the treatment, prevention of infection in both human and animals as well as to boost production of animal in the study area (Ayele *et al.*, 2017).

In contrast to the observation of the present study, Jamali *et al.* (2015) reported lower levels of antibiotic resistance to oxacillin and cefoxitin at 13% and 4.9%, respectively. In tandem to this report, the levels of oxacillin, ampicillin, tetracycine and gentamicin resistance in Jordan were found to be lower than this present study (Obaidat *et al.*, 2018). Comparing the findings, it might be inferred that the type of antibiotics in use for animal treatment is responsible for the varied results between countries. However, the proximity of human with the animal population is no doubt the drivers of resistant bacteria of human origin infection. The high rate of resistance to cefoxitin observed in the present study is unanticipated considering the fact that

this antibiotic is not commonly used for animal breeding in Nigeria.

This infers cross contamination of the dairy products by handlers and/or water source used in their preparation with the drug-resistant bacteria pathogens. The high rate of multiple antibiotics resistance (MAR) (87.5%) amongst the isolated *S. aureus* may have occurred in the course of self-medication and/or over the counter usage of antibiotics, a practice not uncommon in low-income countries. Also, the use of antibiotics repeatedly to treat non-responsive infections constitute this menace (Ezenduka *et al.*, 2012). This actions ultimately result in antibiotic selective pressure in both humans and livestock fueling the dissemination of multi-drug resistance determinants in a region or between regions.

CONCLUSION

The presence of Multidrug resistant *Staphylococcus aureus* in milk and dairy products as well as possible contamination source in pastoral communities in Niger state is of serious health concern and poses a great danger to the herdsmen and the consumers of the milk and dairy products as well as the communities at large. Its consumption present a public health risk due to the spread of drug-resistant zoonotic and ultimately may predispose the consumers to staphylococcal food poisoning.

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