Original Research Article

ANTIBIOTIC SUSCEPTIBILITY PROFILE OF BACTERIA ISOLATED FROM KENYAN BANK NOTES CIRCULATING IN NYERI TOWN.

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ABSTRACT

Aims: The aim of this study was to characterize bacteria isolated from circulating Kenyan banknotes and also antibiotic susceptibility profiles within Nyeri County.

Study design: The study used crossectional sampling design to get 25 of each paper currency denomination notes collected at random.

Place and Duration of Study: Outspan Teaching and Referral Hospital (OTRH) laboratory, between March, 2019 and April, 2019.

Methodology: Total of 125 currencies of five~~5~~ different denominations were collected from different marketing sources such as Butcheries, Restaurants, Health facilities, Mpesa outlets and Transport Saccos and dropped in sterile bags. The bacterial isolates were characterized on the basis of their morphology, staining and biochemical tests. Antibiotic sensitivity tests were done by Kirby Bauer disc diffusion technique.

Results: Total of 19 different bacterial species were isolated from five Kenyan Bank note currencies. Of these~~m~~, xx (52.2%) was *Staphylococcus aureus* followed by *Staphylococcus sciuri ssp.lentus* yy (9.9%), *Staphylococcus gallinarum* vv (2.8%), *Staphylococcus intermedius* (8.5%), *Micrococcus sp.* (1.4%), *Staphylococcus schleiferi ssp.coagulans* (2.8%), *Staphylococcus sciuri ssp.rodentium* (1.4%), *Kluyvera ascorbata* (1.4%), *Proteus penneri* (1.4%), *Aeromonas media* (4.2%), *Burkholderia cepacia ssp.komplex* (1.4%), *Aeromonas enteropelogenes* (1.4%), *Enterobacter cloacae* (1.4%), *Klebsiella oxytoca* (2.8%), *Leclercia adecarboxylata* (1.4%), *Raoultella ornithinolytica* (1.4%), *Vibrio metschnikovii* (1.4%), *Myroides odoratus* (1.4%) and *Yersinia pestis* (1.4%). Overall gram positive and gram negative bacterial isolates exhibited resistance to vancomycin, clindamycin and amoxycilin with percentages 40%, 37%, 31% and 64%, 50%, 34% respectively.

Conclusion: This study revealed that Kenyan banknote currencies circulating in Nyeri County were contaminated with different pathogenic and potential pathogenic bacteria including multi drug resistant strains. Hence, great care must be taken while handling money during the preparation and handling of food to avoid cross contamination.

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Key: Antibiotic, Susceptibility, Kenyan, Banknotes, contamination.

1. INTRODUCTION

Money is any medium of exchange that is widely accepted in payment for goods, services and in settlements of debts. Paper currency is widely exchanged for goods and services in countries worldwide [1, 2]. It also serves as a standard of value for measuring the relative worth of goods and services [2]. Modern scientific techniques have confirmed these theories and have shown that viable pathogenic organisms (viruses, bacteria, and fungi) can be isolated on the surfaces of both paper and coin currency [3]

Contamination of materials by pathogenic microorganisms is of public health concern as contaminated materials could be a source of transmitting microbial pathogens [4]. Movement of materials from hand to hand makes it more prone to contamination by pathogenic organisms. Polymer currency therefore, poses a serious threat to public health since communicable diseases could also be contracted through formites [3]. Currency is handled by all categories of people and may be contaminated during coughing, sneezing, touching with hands and placement on dirty surfaces. Many people tongue-wet their fingers when counting money and contaminate their fingers as well as currency notes. So, it is obvious that gets on hands may be transferred to money and vice-versa [5]. The environment plays a critical role in transmission to humans, with many environmental materials serving as vehicles. Microbial contaminants may be transmitted directly, through hand- to-hand contact, or indirectly, via food or other inanimate objects like fomites [4]. Microbes may persist on it for longer periods [6, 4].

Previous studies have shown that paper currency serves as an ideal breeding ground for microorganisms for several reasons. First, the paper bills offer a large surface area for organisms and organic debris to collect [7]. Secondly, folds and/ or deliberate depressions or projections specifically engineered into the bills' design as anti - counterfeiting methods serve as settling sites for both organisms and debris, which allow the microorganisms to live longer [8]. Lastly, banknotes weave their way through the population for many years before they come to rest. Studies indicate that the age and denomination of a bill have a direct correlation with the contamination observed [3]. That is the older the paper note, the more accumulation of microbes occurs [4].

Various pathogens which may cause throat infection, pneumonia, peptic ulcers, tonsillitis, urino-genital tract infections, gastro enteritis and lung abscess had been reported [9]. Studies in different parts of India show that predominant organisms isolated from contaminated currency are *Bacillus sp*. followed by Coagulase negative *Staphylococci* (CNS) and *Micrococcus sp*. Other pathogenic bacteria present in the currency are Klebsiella *pneumoniae, Escherichia coli, Staphylococcus aureus*, [10, 11] Pseudomonas sp, *Salmonella sp, Proteus sp*. But in a study conducted in Nagpur, *Escherichia coli* was found to be the most common organism [6]. According to a study 100% notes were contaminated with E*. coli, Klebsiella pneumonia, Pseudomonas aeruginosa* and *Staphylococcus aureus* [3] and similar bacteria also found on the currency notes of Coimbatore city, Tamil Nadu [12]. Orukotan and Yabaya [13] also surveyed naira notes, comprising of all the denominations for microbial contamination in Kaduna metropolis. The microorganisms recovered from these notes included *Escherichia coli*, *Bacillus*, *Salmonella*, *Streptococcus*, *Staphylococcus aureus*, *Proteus*, *Klebsiella*, *Micrococcus*, *Fusarium*, *Penicillium*, *Aspergillus* and *Rhizopus*. Knowledge of the microbial diversity of currency notes in circulation can provide the basis for raise health consciousness in people during currency handling and effective control of

infection transmission. The aim of this study was to characterize bacteria isolated from circulating Kenyan banknotes and also antibiotic susceptibility profiles within Nyeri County.

2. MATERIAL AND METHODS

2.1 Study area

Nyeri County is a county in the central region of Kenya. Nyeri town is the capital and largest town is Nyeri County. It has a population of 661,156 and an area of 3,356 km² making it one of the most densely populated areas in Kenya.

2.2 Sample collection and transport

The study currency notes were collected during period between March, 2019 and April, 2019. The control sample bank notes were collected at random from the tellers in the Central Bank Nyeri. The experimental sample notes were collected from different marketing sources such as Butcheries, Restaurants, Health facilities, Mpesa outlets and Transport Saccos. To collect the currency notes, the individuals were asked to drop the currency into a sterile zipped plastic packet, which were sealed and immediately transported to the Outspan Teaching and Referral Hospital (OTRH) laboratory for microbial analysis [9].

2.3 Study design

This was a cross-sectionale study and simple random sampling was used ~~crossectional sampling design~~ to collectget 25 of each paper currency denomination ~~notes collected at random~~.

2.4 Sample size

The currency notes studied were fifty, one hundred, two hundred, five hundred and one thousand Kenyan shillings notes. The study had a total sample size of 125 bank notes and five~~5~~ control bank notes, one from every denomination.

2.5 Isolation of Microbes

The currency notes were dipped in sterile normal saline and vigorously shaken for 3 minutes. A sterile cotton swab was dipped and inoculated in blood agar and Mac Conkey agar for each note. The plates were incubated at 37°C for 18- 24 hours. After 18-24 hours the plates were observed for bacterial colonies [14].

2.6 Morphological and biochemical characterization of the isolates

The bacterial isolates were characterized on the basis of their morphology, staining and biochemical tests. Gram staining was done as described by Barrow and Feltham [15]. All isolated microorganisms were subjected to microscopic examination and the shape, arrangement and Gram's reaction were detected and recorded. This study used cypress diagnostic Bacterial Identification System: gram positive/ anaerobes (Bis-Plus) and Gram negative (Bis-Neg) for standardized identification panel for common gram positive (gram positive cocci|), corynebacteria (Gram positive rods), and anaerobes (both Gram positive and Gram negative anaerobes), consisting of 24 miniaturized biochemical tests.

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2.7 Susceptibility studies on the bacteria isolates

The Kirby-Bauer Disc Diffusion Method (Struve et al., 2003) was used to test the in vitro susceptibility of the identified isolates to Ceftriaxone 30µg, Tetracycline 30µg, Amoxycilin 30µg, Ciprofloxacin 5µg, Gentamycin 10µg, Clindamycin 2µg, Vancomycin 30µg and Erthromycin 15µg. A sterile platinum loop was used to pick overnight bacterial colonies from the culture plate and emulsified in 4 ml of sterile peptone water to match with 0.5 McFarland turbidity standards (1.0x108 cfu/ml). Using a sterile swab, the surface of Mueller Hinton agar (Oxoid, Basingstoke, UK) was evenly inoculated with the suspension and allowed~~let~~ to air dry for 10 minutes. Using multichannel disc dispenser (Oxoid, Basingstoke, UK) antibiotics discs were deposited onto the surface of the inoculated medium and plates incubated at 37 °C for 24 hours. The exercise was replicated and the results compared with chart provided by the Clinical and Laboratories Standards Institute. *E. coli* (ATCC 25922) and *S. aureus* (ATCC 25923) were used as control.

2.8 Data analysis

Descriptive statistics~~cal technique~~ was used to analyze various data from the laboratory. These included averages, percentages and frequencies. Continuous data were expressed as means and categorical data expressed as proportions. Statistical analysis was performed using statistical package for social sciences (SPSS) software for Windows, ver. 21 (SPSS, IBM, USA).

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3. RESULTS AND DISCUSSION

3.1. Types of bacterial contaminants in bank notes.

The experimental sample notes were collected from different marketing sources such as butcheries, restaurants, health facilities, Mpesa outlets and transport saccos. Control for each currency note was collected from Nyeri Central Bank. The currency notes studied were fifty, one hundred, two hundred, five hundred and one thousand Kenyan shillings notes. The sample currency notes collected from five sources were sorted and put under 2 categories. From the study xx (55.2 %) were dirty and yy (44.8%) were clean. 100% of the currency notes used as control from Nyeri Central Bank were mint. It is worth noting that bacterial growth was not detected in 5 samples of mint "newly printed" banknotes. Lack of growth in these notes might be attributed to the fact that they had not been in circulation that exposed them to usage and handling. However, some researchers believed that uncirculated notes are contaminated with fastidious organisms and the media or culture conditions employed were inappropriate for their isolation [16].

Out of the 125 currency notes of five different denominations obtained from the five sources, 88% in blood agar and 76% in MacConkey showed growth in plates; whereas all (5) notes obtained from the bank were sterile. A total of 71 isolates were obtained from contaminated currency notes with 78.9% being Gram's positive and 21.1% being Gram's negative. In the present study, the isolation of Gram's positive as well as Gram's negative bacteria from currency notes confirmed that currency might be playing an important role as a vector in the transmission of pathogenic bacteria in the community. In the current study, the identification and enumeration of various types of pathogenic microorganisms that were obtained from the Kenyan banknotes were contaminated with some strains of the pathogen~~s~~ bacteria. These results were compatible with previous researchers from other countries which elucidated that currency banknotes are usually contaminated by pathogenic microorganisms [17, 18].

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Of the 71 isolates, 56 (78.9%) were Gram positive bacteria isolated from banknotes ~~include~~: *Staphylococcus aureus* xx (66.1%), *Staphylococcus sciuri ssp.lentus* yy (12.5%), *Staphylococcus intermedius* zz (10.6%), *Staphylococcus schleiferi ssp.coagulans* (3.6%), *Micrococcus sp.* (1.8%), *Staphylococcus gallinarum* (3.6%) and *Staphylococcus sciuri ssp.rodentium* (1.8%) as shown in Figure 1. Different species of bacteria isolated in this current study are almost similar to the studies done in Saudi Arabia, Pakistan, Ghana, Nigeria, and US [19, 20, 21, 22, 23]. All these studies established gram positive bacteria as the major isolates from the contaminated currencies which agrees with our current study.

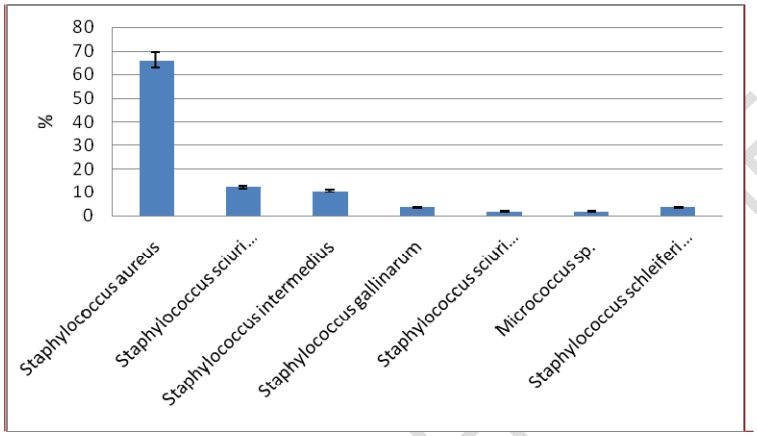

Figure 1. Gram positive bacteria isolated from Kenyan bank notes

The most common Gram positive bacterial isolates from this study was *Staphylococcus aureus* xx(66.1%). *Staphylococcus aureus on* the currency notes could have been contamination from the normal skin flora [24, 25] and from the soil [26]. The coagulase-negative *staphylococci* are part of the normal human flora and sometimes cause infections such as food poisoning [27] and other diseases often associated with implanted appliances and devices [27], especially in very young, old, and immunocompromised patients. Though *Staphylococcus aureus* are part of the normal flora of the skin and mucous membrane, their high incidence has clinical significance and they are considered well-recognized pathogen. A number of studies have documented the clinical significance of *S. aureus* as a causative agent of urinary tract infections [28]. *S. aureus* is also associated with toxic shock syndrome, skin infections e.g. frunculosis and respiratory tract infections. From this study, the bacterial isolates that were isolated from this study were associated with oral, nasal and skin contamination. This is an indication that money contamination is associated with~~to~~ unhygienic practice of people. These practices include indiscriminate sneezing, coughing and defecation with indecent handling of currency notes [29, 30].

Of the 71 isolates, 15 (21.1%) ~~were~~ Gram negative bacteria isolated from Kenyan bank notes include: *Burkholderia cepacia ssp.komplex* n (6.67%), *Aeromonas enteropelogenes* (6.67%), *Kluyvera ascorbata* n (6.67%), *Aeromonas media* n (20.0%), *Raoultella ornithinolytica* (6.67%), *Enterobacter cloacae* (6.67%), *Klebsiella oxytoca* (13.3%), *Leclercia adecarboxylata* (6.67%), *Vibrio metschnikovii* (6.67%), *Proteus penneri* (6.67%), *Myroides odoratus* (6.67%) and *Yersinia pestis* (6.67%) as shown in figure 2.

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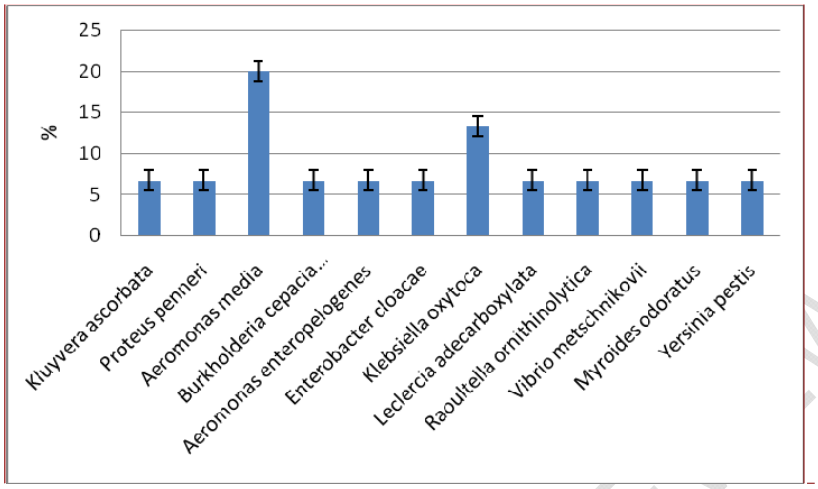

Figure 2. Gram negative bacteria isolated from Kenyan bank notes

The dominant gram negative bacterial isolates from this study was *Aeromonas media* xx (20.0%) followed by *Klebsiella oxytoca* (13.3%) as shown by figure 2. *A study by* Elumalai *et al.* [31] isolated eight different types of bacterial species *E. coli, Proteus mirabilis, Vibrio spp., S. aureus, Pseuodomonas spp., Salmonella spp., Bacillus spp.*, and *Klebsiella spp*. from 30 Indian currency notes consisting of five notes each of Indian Rupee □ 5 and □ 10 denominations. The current study agrees with a study done by Ahmed *et al* [32] in India that, found *Proteus* sp. to be one of the predominant organisms isolated from contaminated currency.

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Table 1. Relative occurrence of bacterial species on currency notes of different denominations

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Currency Denomination (Ksh)	50	100	200	500	1000	Number (%)
No. of Currency	N=25	N=25	N=25	N=25	N=25	
Staphylococcus aureus	10	6	5	8	8	37 (52.2%)
Staphylococcus sciuri ssp.lentus	2	2	2	1	0	7 (9.9%)
Staphylococcus gallinarum	1	0	1	0	0	2 (2.8%)
Staphylococcus intermedius	0	2	0	3	1	6 (8.5%)
Micrococcus sp.	0	0	1	0	0	1 (1.4%)
Staphylococcus schleiferi ssp.coagulans	1	0	0	0	1	2 (2.8%)
Staphylococcus sciuri ssp.rodentium	0	0	1	0	0	1(1.4%)
Kluyvera ascorbata	0	1	0	0	0	1(1.4%)
Proteus penneri	1	0	0	0	0	1(1.4%)
Aeromonas media	1	0	1	0	1	3 (4.2%)
Burkholderia cepacia ssp.komplex	1	0	0	0	0	1(1.4%)
Aeromonas enteropelogenes	0	1	0	0	0	1(1.4%)
Enterobacter cloacae	1	0	0	0	0	1(1.4%)
Klebsiella oxytoca	0	1	0	1	0	2 (2.8%)
Leclercia adecarboxylata	0	1	0	0	0	1(1.4%)
Raoultella ornithinolytica	0	0	1	0	0	1(1.4%)
Vibrio metschnikovii	0	0	0	1	0	1(1.4%)
Myroides odoratus	0	0	0	0	1	1(1.4%)
Yersinia pestis	1	0	0	0	0	1(1.4%)
Total	*19*	*14*	*12*	*14*	*12*	*71(100%)*

Table 1, Shows that total of 19 different bacterial species were isolated from five Kenyan Bank note currencies. Of thesethem,xx (52.2%) was *Staphylococcus aureus* followed by *Staphylococcus sciuri ssp.lentus* yy (9.9%), *Staphylococcus gallinarum* (2.8%), *Staphylococcus intermedius* (8.5%), *Micrococcus sp.* (1.4%), *Staphylococcus schleiferi ssp.coagulans* (2.8%), *Staphylococcus sciuri ssp.rodentium* (1.4%), *Kluyvera ascorbata* (1.4%), *Proteus penneri* (1.4%), *Aeromonas media* (4.2%), *Burkholderia cepacia ssp.komplex* (1.4%), *Aeromonas enteropelogenes* (1.4%), *Enterobacter cloacae* (1.4%), *Klebsiella oxytoca* (2.8%), *Leclercia adecarboxylata* (1.4%), *Raoultella ornithinolytica* (1.4%), *Vibrio metschnikovii* (1.4%), *Myroides odoratus* (1.4%) and *Yersinia pestis* (1.4%). This current study agrees with the study by Tagoe *et al*. [21], that *staphylococcus* is the most observed isolate from currency notes. Studies in different parts of India show that predominant organisms isolated from contaminated currency were *Bacillus sp* followed by Coagulase negative Staphylococci (CNS) and *Micrococcus sp* [32]. Orukotan and Yabaya [13] also surveyed naira notes, comprising of all the denominations for microbial contamination in Kaduna metropolis. The microorganisms recovered from these notes included *Escherichia coli, Bacillus, Salmonella, Streptococcus, Staphylococcus aureus*, *Proteus, Klebsiella, Micrococcus, Fusarium, Penicillium, Aspergillus* and Rhizopus. Ahmed *et al.* [32] suggested that the Bangladesh paper currency commonly contaminated with pathogenic microorganisms and this contamination may play a significant role in the transmission of potentially harmful microorganisms or different diseases such as cholera, diarrhea, skin infections and also poses antibiotic resistant. *Klebsiella* species are enteric

microorganisms that are potential pathogens especially when they change their habitat [10, 26] and may cause significant infections in those with depressed immune systems [33]. Ready-to-eat food sellers should be educated to avoid possible cross contamination between currency notes and food by avoiding handling currency notes as they sell [34,35]. There should be public awareness of the fact that currency notes could be a source of infection and could be dangerous to health [30, 36].

Mohamed *et al.* [37] in a sStudy of bBacterial cContamination on Libyan pPaper bBanknotes in cCirculation found *Enterobacter cloacae* (11%), Klebsiella *pneumonia* and *Enterobacter, Kluyvera* spp (4%) which is a lower percentage from our current study that found *Enterobacter cloacae* (1.4%), *Klebsiella oxytoca* (2.8%), *Kluyvera ascorbata* (1.4%). The presence of these pathogenic bacteria~~l~~ in this current study reveals that the majority of people are exposed to contaminated currency notes. Keeping money in dirty places and as a habit, wetting fingers with saliva while counting currency notes suggests that humans are the major source of microorganisms on currency. As damaged or soiled notes are contaminated, they are particularly dangerous to health. Additionally, unwashed fingers contained many microorganisms, of which could be transient or resident [28]. These practices, including indiscriminate coughing, sneezing and defecation with indecent handling of currency notes were the most common sources of contamination [4, 9]. Furthermore, the materials of which the currency was manufactured are probably a factor that affects the survival of microorganisms on the banknotes [3].

Generally, lower value denomination currencies 50sh and 100sh were more contaminated with bacterial species than higher value denomination ones like 500sh and 1000sh. The current study agrees with other studies by Lamichhane *et al.,* [8]; Ayandele and Adeniyi, [7], that currency notes of lower denominations were the most contaminated, presumably because lower denomination notes pass through more hands in their lifetime than the higher denomination notes. A study by Pavani and Srividya [38] established that most prevalent contamination (100%) was found among the Rupees 10 notes and coins and least prevalent contamination was found in Rupees 50 and 100 currency which was in accordance with the study by Umeh *et al* [39] which revealed more contamination of Rupee 10 currency (75.2%) and least contamination among the Rupees 500 and 1000 currency (20%). The denomination notes which receive most handling and exchanged many times are more prone for contamination than other notes. The lower denomination currency notes are frequently circulated for daily activities where notes get tattered and dirty, therefore become more contaminated [39]. Similar results were stated in other studies by Abid [40], Azza *et al* [41] that found large denominations for their savings either at home or in banks which may keep them away from hand contamination for a period of time.

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3.2. Antibiotic Susceptibility~~Resistance~~ Testing

Table 2. Antibiotic susceptibility patterns of Gram positive bacterial isolates (No. of R or S isolates/ n)

Bacteria	CRO	TE	AML	CIP	CN	CD	VA	E
Staphylococcus aureus (n=37)	S (36/37)	S (35/37)	R (20/37)	S (36/37)	S (37/37)	R (24/37)	R (26/37)	S (21/37)
Staphylococcus intermedius	S (5/6)	S (6/6)	R (4/6)	S (6/6)	S (6/6)	R (4/6)	R (5/6)	R (3/6)
Staphylococcus sciuri ssp.lentus	S (7/7)	S (7/7)	S (6/7)	S (7/7)	S (6/7)	R (4/7)	S (5/7)	S=(5/7)
Staphylococcus gallinarum	S (2/2)	S (2/2)	R (2/2)	R (2/2)	S (2/2)	R (2/2)	R (2/2)	S (2/2)
Staphylococcus sciuri ssp.rodentium	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	R (1/1)	R (1/1)	S (1/1)
Micrococcus sp.	S (1/1)	S (1/1)	R (1/1)	S (1/1)	S (1/1)	R (1/1)	R (1/1)	R (1/1)
Staphylococcus schleiferi ssp.coagulans	S (2/2)	S (2/2)	S (2/2)	S (2/2)	R (1/2)	R (1/2)	R (1/2)	S (2/2)

S=Sensitive, R=Resistant, CRO= Ceftriaxone, TE= Tetracycline, AML= Amoxycilin, CIP= Ciprofloxacin, CN= Gentamycin, CD= Clindamycin, VA= Vancomycin, E= Erthromycin.

Table 3. Antibiotic susceptibility patterns of Gram negative bacterial isolates (No. of R or S isolates/ n)

BACTERIA	CRO	TE	AML	CIP	CN	CD	VA	E
Kluyvera ascorbata	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	R (1/1)	S (1/1)	S (1/1)
Proteus penneri	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)
Aeromonas media	S (3/3)	S (3/3)	S (2/3)	S (3/3)	S (3/3)	S (2/3)	R (2/3)	S (3/3)
Burkholderia cepacia ssp.komplex	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	R (1/1)	S (1/1)
Aeromonas enteropelogenes	S (1/1)	S (1/1)	R (1/1)	S (1/1)	S (1/1)	R (1/1)	R (1/1)	R (1/1)
Enterobacter cloacae	S (1/1)	S (1/1)	R (1/1)	S (1/1)	S (1/1)	R (1/1)	S (1/1)	R (1/1)
Klebsiella oxytoca	S (2/2)	S (2/2)	R (2/2)	S (2/2)	S (2/2)	R (2/2)	R (2/2)	R (1/2)
Leclercia adecarboxylata	S (1/1)	S (1/1)	R (1/1)	S (1/1)	S (1/1)	R (1/1)	R (1/1)	S (1/1)
Raoultella ornithinolytica	R (1/1)	S (1/1)	R (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)
Vibrio metschnikovii	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	R (1/1)	R (1/1)	S (1/1)
Myroides odoratus	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	S (1/1)	R (1/1)	S (1/1)

S=Sensitive, R=Resistant, CRO= Ceftriaxone, TE= Tetracycline, AML= Amoxycilin, CIP= Ciprofloxacin, CN= Gentamycin, CD= Clindamycin, VA= Vancomycin, E= Erthromycin.

Table 2, shows antibiotic susceptibility patterns of gram positive bacterial isolates. The current studies reveal many multidrug resistant bacteria like *Staphylococcus aureus, Staphylococcus intermedius and Micrococcus sp. to* Amoxycilin, Clindamycin and Vancomycin. This current study agrees with a study done by Feglo and Nkansah [1] who found multidrug resistant bacteria prevalent in the currency that included methicillin resistant Staphylococcus aureus, methicillin resistant coagulase negative staphylococci, multi drug resistant *Escherichia coli* and *Klebsiella sp*. Srinu *et al*. [42] also reported that *S. aureus* was sensitive to Streptomycin, cotrimoxazole and Ciprofloxacin which concur with the current study that *S. aureus* is sensitive *to* Ciprofloxacin.

The study found that 96.0%, 98.0% and 98.0% of gram positive isolates were susceptible to ceftriaxone, tetracycline and gentamycin respectively. Table 2 shows resistance rates of all bacterial isolates; overall isolates exhibited resistance to vancomycin, amoxycilin and clindamycin with percentages 40%, 31% and 37% respectively. On another hand, isolates of all bacterial species showed absent or little resistance rates against antibiotics like ceftriaxone, tetracycline, gentamycin, ciprofloxacin and Erthromycin that were 2%, 2%, 2%, 7% and 26% respectively. It is known that infection by multidrug-resistant bacteria limit therapeutic options and subsequently facilitate the dissemination of these strains

According to table 3, the study found that all (100.0%) of the gram negative bacteria isolates were susceptible to Gentamycin, Ciprofloxacin and Tetracycline which concurs with a study by Vriesekoop *et al.* [43] who also found gram negative bacteria like *Klebsiella sp, Entrobacter sp* and *Proteus sp to be* sensitive to Amoxoftine, Gentamicin, Nalidixic acid and Ofloxacin. The development of antimicrobial resistance in bacteria renders some infections untreatable today and antimicrobial resistance is now a major health concern [32].

This study revealed that many multidrug resistant strains of different isolates were prevalent in the Kenyan bank note currencies that further emphasize the public health significance of the notes and clearly indicates a marked resistance to the commonly used antibiotics. For example; isolates of various gram negative bacterial species recorded high rates of resistance collectively as 64%, 50% and 34% against vancomycin, clandamycin and amoxycilin respectively. This result agree with [44,45,46] presence of multidrug-resistant strains poses a big challenge to human survival and continued existence in relation to bacterial infection and diseases that is highly consequential when contracted by the debilitated individuals. The observed high antibiotic resistances could be attributed to the abuse of antibiotics which showed that majority of the populace sampled purchases antibiotics in the open market without any medical prescription and use them for the wrong diseases and infections [46]. Antibiotics like ciprofloxacin, gentamicin, ceftriaxone and tetracycline; collectively expressed absent and little resistance rates. This latter observation goes with [45, 46]. It is therefore suggested that individuals should improve upon their personal health consciousness by washing hands after handling of currency notes [11]). Babies must be prevented from handling currency notes and adults should avoid using saliva during counting of paper.

4. CONCLUSION

This study revealed that Kenyan banknote currencies circulating in Nyeri County were contaminated with different pathogenic and potential pathogenic bacteria including multi drug resistant strains. Hence, great care must be taken while handling money during the preparation and handling of food to avoid cross contamination. So, awareness related to the improvement of personal hygiene and good money handling practice such as washing hands properly with soap and water after handling currency before eating and avoiding using saliva during counting money are strongly recommended as the main pillar to reduce the risk of infection.

COMPETING INTERESTS

The authors have no competing interests to declare

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DEFINITIONS, ACRONYMS, ABBREVIATIONS

OTRH	Outspan Teaching and Referral Hospital
Shs	shillings
S	Sensitive
R	Resistant
CRO	Ceftriaxone
TE	Tetracycline
AML	Amoxycilin
CIP	Ciprofloxacin
CN	Gentamycin
CD	Clindamycin
VA	Vancomycin
E	Erthromycin.