Research Article

Microbial Load and Antibiotic Resistance of *Escherichia coli* and *Staphylococcus aureus* Isolated from Ready-to-Eat (RTE) Khebab Sold on a University Campus and Its Environs in Ghana

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The demand for ready-to-eat (RTE) foods is handy to busy urban dwellers. Handling, processing, and selling are known to contaminate these foods and cause foodborne outbreaks. This study assessed a load of *S. aureus* and *E. coli* in khebabs (beef, chevon, and gizzard) sold on the KNUST campus and its environs and how resistant they are to clinically relevant antimicrobial agents. Thirty-six (36) khebab samples were purchased from vendors at Kotei, Ayeduase, Kentinkrono, Boadi, KNUST campus, and Ayigya. They were analyzed for *S. aureus* and *E. coli* and their resistance to clinically relevant antimicrobial agents checked using standard methods. *S. aureus* and *E. coli* load ranged from 4.09 to 5.96 CFU/g and 1.79 to 6.12 MPN/g in beef, 4.02 to 6.01 CFU/g and 1.99 to 4.44 MPN/g in chevon, and 5.37 to 6.18 CFU/g and 1.79 to 6.10 MPN/g in gizzard khebabs in the different locations. *E. coli* ($n=27$) were multiresistant to ampicillin, tetracycline, gentamicin, cefuroxime, ceftriaxone, cefotaxime, and cotrimoxazole (51.85%) and susceptible to chloramphenicol (100%). *S. aureus* ($n=36$) isolates were multiresistant to penicillin, tetracycline, flucloxacillin, cefuroxime, ampicillin (97.22%), erythromycin (75%), cotrimoxazole (86.11%), and gentamicin (69.44%). It can therefore be concluded that the majority of khebabs from the KNUST campus and its environs were contaminated with *S. aureus* and *E. coli* above the acceptable standard limits ($\leq 4 \log_{10}$ CFU/g and $\leq 2 \log_{10}$ MPN/g, respectively). Also, the *S. aureus* and *E. coli* isolated were multiresistant to the antibiotics tested and could be a medium for the transmission of antibiotic-resistant bacteria and therefore expose consumers to a high risk of contracting foodborne infections with drug-resistant strains.

1. Introduction

Ready-to-eat (RTE) foods have been defined as foods that do not require further preparation with exception of reheating [1]. These RTE foods are usually consumed raw or cooked, or hot or cold without further heat treatment [2, 3]. Khebab is a popular ready-to-eat street-vended meat in Ghana, which is easily accessible to most Ghanaians. The khebab is usually prepared using meat from cow, goat, sheep, chicken, etc. The khebab may contain high protein or carbohydrate, high moisture content, or low acidity, which provides a suitable medium for the rapid growth of microorganism, therefore

making it potentially hazardous food. Because it provides a medium for rapid microorganism's growth, microbial pathogens or toxins can affect consumer's health and may even lead to death when they are contaminated [4].

S. aureus and *E. coli* have been found to contaminate ready-to-eat foods [5–9]. They have the ability to survive on hands and other surfaces and are therefore transferred to foods [10]. Feglo and Sakyi [11] recorded different levels of *S. aureus*, *E. coli*, and other bacteria in different ready-to-eat foods in the Kumasi metropolis of Ghana. *S. aureus* is a major foodborne pathogen in ready-to-eat foods responsible for foodborne infections across the globe [12, 13]. It grows rapidly under

room temperature and produces toxins that cause the infections. Every year, about 241,000 foodborne diseases of *S. aureus* are reported in the United States [14, 15]. Also, China recorded 12.5% foodborne diseases associated with *S. aureus* in 2013 [14]. *E. coli* on the other hand is one of the most dangerous foodborne pathogens [16, 17]. It produces one or more types of cytotoxins such as shiga toxin (Stx) or vero-cytotoxin (VT). Those producing Stx and VT are referred to as shiga toxin-producing *E. coli* (STEC) and vero-cytotoxic *E. coli* (VTEC), respectively [18]. According to Monaghan et al. [19], STEC is one of the most important foodborne pathogens to emerge within the past two decades. It is a frequent cause of foodborne diarrhea outbreak [20–22]. In North America, Europe, Asia, and Africa, *E. coli*, particularly serotype O157:H7, is an important food-borne pathogen responsible for gastroenteritis epidemics [23, 24]. In 2011, the CDC reported that shiga toxin-producing *Escherichia coli* (STEC) O157 infections cause more than 63,000 illnesses, 2,100 hospitalizations, and 20 deaths in the United States [15]. In the world, STEC O157 is the most common serotype associated with human gastrointestinal illness and ranks third in the cause of bacterial foodborne-related hospitalizations in the United States [15, 25]. Individuals infected with STEC usually develop hemolytic uremic syndrome, hemolytic anemia, and thrombocytopenia that can be fatal [26].

The increased contaminations of RTE foods in the society could be linked to the increased mobility of people due to urbanization, larger number of itinerant workers, and less home activities have resulted in large percentage of the population depending on RTE foods for employment and food. This situation, however, resulted that food sanitary measures and proper handling have been transferred from individual and families to the food vendors who rarely enforce such practices [27, 28]. Majority of these vendors are unaware of improper handling of food and their role in the transmission of infections [29, 30]. Most RTE foods are also sold under insanitary conditions that make them prone to contamination [4, 31–33]. Additionally, most RTE foods are sold openly, with little or no covering, and are therefore easily contaminated by flies and dust in the environment [34].

Besides foodborne contamination, the emergence of antimicrobial-resistant bacteria is a great challenge to public health. The indiscriminate uses of antimicrobials in animals and humans have led to the development of antimicrobial-resistant microorganisms [35]. In recent times, more and more multidrug-resistant (MDR) *S. aureus* food poisoning outbreaks have been reported [36–39]. There are limited data on antimicrobial resistance of *S. aureus* and *E. coli* foods in Ghana. It is with this background that this study was conducted to assess the *S. aureus* and *E. coli* loads in khebab samples sold on the KNUST campus and its environs and how resistant they are to clinically relevant antimicrobial agents.

2. Materials and Methods

2.1. Study Design. A cross-sectional study was conducted in 2018 to assess the *S. aureus* and *E. coli* loads in khebab samples sold on the KNUST campus and its environs, and how resistant they are to clinically relevant antimicrobial agents [40].

2.2. Study Location. The study was conducted in the KNUST campus and its environs in the Oforikrom Municipal Assembly, Kumasi, Ghana (Figure 1). According to Ababio and Adi [41], the KNUST campus and its environs are one of the communities in Kumasi with high population of food vendors because of the socioeconomic activities that take place in this area. Majority of students, staff, and indigenous people residing on the KNUST campus and its environs patronize these ready-to-eat foods.

2.3. Collection of Samples. Samples of khebab made from beef, chevon, and gizzard were purchased from two vendors in each location. A purposive sampling technique was employed in the selection of the vendors. About one hundred grams of the khebab samples were purchased from each vendor into a sterile Ziploc bag. The purchased khebab samples were kept in an ice chest with ice packs and transported immediately to the laboratory and stored at 4°C and analyzed the following day [40].

3. Microbiological Analysis

3.1. Sample Analysis. Serial dilutions of 10^{-1} to 10^{-5} of the sample were carried out by placing ten grams of each khebab sample into ninety milliliters of sterilized buffered peptone water (Oxoid CM 0009; Oxoid Ltd Basingstoke, Hampshire, England) and pulsed for 15 seconds [40].

3.2. Total Viable Count (TVC). Pour plate technique was employed to estimate the TVC of *S. aureus* using mannitol salt agar. Aliquot of 1 ml from each of the dilutions for the khebab samples was placed into labeled petri dishes, and about 10 ml of molten (45°C) mannitol salt agar (Oxoid CM 0085; Oxoid Ltd Basingstoke, Hampshire, England) was poured into the labeled petri dishes. The plates were swirled slowly for uniform mixing, allowed to solidify, sealed with parafilm, and then incubated at 35°C for 24 hours. Colonies with yellow and pink zones observed indicated the presence of *S. aureus*, which were counted using colony counter (Stuart colony counter, UK). Colonies between 30 and 300 were used in their estimation by using the following formula:

$$\text{CFU} = \text{average colonies} \times \frac{\text{dilution factor}}{\text{aliquot plated}} \text{ and expressed as CFU/g.} \quad (1)$$

3.3. Isolation of *S. aureus*. Yellow and pink zone colonies on the mannitol salt agar were isolated onto nutrient agar as presumptive *S. aureus* [42].

3.4. Enumeration, Isolation, and Characterization of *Escherichia coli*. The most probable number (MPN) method was employed to enumerate the total *E. coli* in the khebab samples. One milliliter aliquot from each of the dilutions was inoculated into a 5 ml sterile MacConkey Broth (Oxoid CM 0085; Oxoid Ltd Basingstoke,

FIGURE 1: Map showing sampling locations.

Hampshire, England) and incubated at 44°C for 24 hours. Tubes showing colour change from purple to yellow after incubation were identified as presumptive positive for thermotolerant coliforms. From each of the positive tubes, 1 ml was transferred into a test tube containing 5 ml of sterile tryptophan broth (Scharlau 02-418; Scharlau chemie S.A, Barcelona, Spain) and incubated at 44°C for 24 hours. A drop of Kovacs' reagent was added to the overnight (ON) culture tubes of tryptophan broth. All tubes showing a red ring development after gentle agitation denoted the presence of indole and were recorded as presumptive positive for thermotolerant coliforms (*E. coli*). Counts per gram were calculated from the most probable number (MPN) tables.

The tubes that showed ring colour development were further streaked on eosin methylene blue (EMB) agar media (Oxoid CM 0069; Oxoid Ltd Basingstoke, Hampshire, England) and incubated at 37°C for 24 hours and colonies with green metallic sheen indicated *E. coli*. The colonies were then subcultured into nutrient agar to obtain pure isolates.

Bacteria were characterized using an API 20E Biochemical Test Strip following manufacturer's manual (bio-Mérieux, France). All codes obtained were referenced to the API database for organism identification.

3.5. Antimicrobial Susceptibility of *E. coli* and *S. aureus*. Antimicrobial susceptibility of *E. coli* and *S. aureus* was determined by the Kirby Bauer agar disk diffusion method on Mueller–Hinton agar according to the protocol and guidelines of the European Committee on Antibiotic Susceptibility Testing [43].

Broth cultures of the isolates and Muller–Hinton agar (Oxoid CM 0337; Oxoid Ltd Basingstoke, Hants, United Kingdom) plates were prepared. The Muller–Hinton agar plates were streaked with the broth cultures with the help of a sterile swap and allowed to dry for 2–5 minutes. Sterile forceps were used to aseptically pick each of the antibiotic disks (Abtek Biologicals Ltd) and placed on each plate. The plates were labeled and incubated at 37°C for 24 hrs. The zone of inhibition (ZOI) was measured using a ruler, and data were recorded and interpreted according to the EUCAST breakpoints [44].

3.6. Statistical Analysis. The data collected were subjected to the analysis of variance (ANOVA) using Genstat statistical software version 12. Significant differences were assessed at 5% level of significance ($p=0.05$). Where there was a significant difference, means were separated using the Fishers protected least significant difference (LSD)

TABLE 1: Mean loads of *E. coli* and *S. aureus* in beef kebab sold on the KNUST campus and its environs.

Location	Range of <i>E. coli</i> load (MPN/g)	Mean load of <i>E. coli</i> ($\log_{10}$ MPN/g)	Range of <i>S. aureus</i> load (CFU/g)	Mean load of <i>S. aureus</i> ($\log_{10}$ CFU/g)
Kotei	$0.00-9.30 \times 10^5$	3.77 ± 2.94^{ab}	$3.10 \times 10^2-1.44 \times 10^6$	4.09 ± 1.47
Ayeduse	$9.00 \times 10^4-2.10 \times 10^6$	5.61 ± 0.57^b	$6.40 \times 10^3-2.96 \times 10^7$	5.12 ± 1.81
Kentinkrono	$0.00-9.30 \times 10^5$	1.99 ± 3.08^a	$8.80 \times 10^2-9.60 \times 10^6$	5.46 ± 1.52
Boadi	$0.00-2.30 \times 10^5$	1.79 ± 2.77^a	$3.70 \times 10^3-2.94 \times 10^6$	5.43 ± 1.40
KNUST campus	$0.00-2.40 \times 10^6$	3.91 ± 3.06^{ab}	$6.40 \times 10^2-4.40 \times 10^6$	4.80 ± 1.56
Ayigya	$2.30 \times 10^5-9.30 \times 10^6$	6.12 ± 0.60^b	$4.40 \times 10^5-1.94 \times 10^6$	5.96 ± 0.24
CV (%)		63.2		27.8
<i>p</i> value		0.019		0.323

MPN = most probable number; CFU = colony-forming unit. Mean loads with the same letters are not significantly different ($p > 0.05$).

TABLE 2: Mean loads of *E. coli* and *S. aureus* in chevon kebab sold on the KNUST campus and its environs.

Location	Range of <i>E. coli</i> load (MPN/g)	Mean load of <i>E. coli</i> ($\log_{10}$ MPN/g)	Range of <i>S. aureus</i> load (CFU/g)	Mean load of <i>S. aureus</i> ($\log_{10}$ CFU/g)
Kotei	$0.00-2.40 \times 10^6$	3.91 ± 3.06	$3.60 \times 10^3-3.70 \times 10^4$	4.02 ± 0.39^a
Ayeduse	$0.00-9.30 \times 10^6$	4.44 ± 3.45	$2.40 \times 10^4-2.88 \times 10^7$	6.01 ± 1.31^{bc}
Kentinkrono	$0.00-9.30 \times 10^6$	4.43 ± 3.44	$1.80 \times 10^5-1.64 \times 10^7$	6.53 ± 0.71^c
Boadi	$0.00-9.30 \times 10^5$	1.99 ± 3.08	$3.60 \times 10^3-1.40 \times 10^6$	4.82 ± 1.13^{ab}
KNUST campus	$0.00-4.30 \times 10^6$	3.99 ± 3.14	$4.50 \times 10^3-1.28 \times 10^7$	5.71 ± 1.62^{bc}
Ayigya	$0.00-2.40 \times 10^6$	4.25 ± 3.29	$4.60 \times 10^3-1.52 \times 10^7$	5.81 ± 1.49^{bc}
CV (%)		84.7		21.7
<i>p</i> value		0.779		0.013

MPN = most probable number; CFU = colony-forming unit. Mean loads with same letters are not significantly different ($p > 0.05$).

procedure. The data were logarithmically ($\log_{10}$) transformed to minimize the variations associated with the enumeration techniques.

4. Results

4.1. Mean Load of *E. coli* and *S. aureus* in Beef Kebab. The beef kebab from the different locations recorded varying mean loads of *E. coli* ranging from 0.00 to 9.30×10^6 MPN/g with those from Ayigya recording the highest load ($6.12 \log_{10}$ MPN/g) and Boadi the lowest ($1.79 \log_{10}$ MPN/g) (Table 1). *E. coli* load was significantly different ($p = 0.019$) and was above the Food Standards of Australia New Zealand (FSANZ) guidelines of <100 MPN/g ($<2 \log_{10}$ MPN/g). Nonetheless, the *E. coli* load in beef at Kentinkrono and Boadi was within the acceptable limit.

The mean load of *S. aureus* ranged from 3.10×10^2 to 2.96×10^7 CFU/g with no significant difference among them. Samples from Ayigya recorded the highest load of $5.96 \log_{10}$ CFU/g, whereas those from Kotei recorded the least load of $4.09 \log_{10}$ CFU/g (Table 1). *S. aureus* load was, however, above the FSANZ acceptable limit of $\leq 10^4$ CFU/g ($\leq 4 \log$ CFU/g) for safe foods.

4.2. Mean Load of *E. coli* and *S. aureus* in Chevon Kebab. *E. coli* load in chevon kebab ranged from 0.00 to 9.30×10^6 MPN/g with Ayeduse recording the highest

mean *E. coli* load of $4.44 \log_{10}$ MPN/g and Boadi the least ($1.99 \log$ MPN/g) (Table 2). The differences were not significant ($p = 0.779$) but were above the FSANZ guidelines of <100 MPN/g ($<2 \log_{10}$ MPN/g) with the exception of Boadi, which was within the guidelines limit. *Staphylococcus aureus* ranged from 3.60×10^3 to 2.88×10^7 CFU/g in chevon kebab irrespective of the location. Samples from Kentinkrono recorded the highest mean load of $6.53 \log_{10}$ CFU/g, whereas those from Kotei the least ($4.02 \log_{10}$ CFU/g) (Table 2). The mean loads of *S. aureus* were significantly different ($p = 0.013$) and above the FSANZ acceptable limit of $\leq 10^4$ CFU/g ($\leq 4 \log$ CFU/g).

4.3. Mean Load of *E. coli* and *S. aureus* in Gizzard Kebab. For the gizzard kebab, the mean load of *E. coli* for the locations ranged from 0.00 to 2.90×10^7 MPN/g with Kotei recording the highest mean load ($6.10 \log_{10}$ MPN/g) and the least observed in Boadi ($1.79 \log_{10}$ MPN/g). Although the mean load of *E. coli* in the gizzard kebab from the various locations was not significantly different ($p = 0.207$), it was above the FSANZ guidelines of <100 MPN/g ($<2 \log_{10}$ MPN/g), with the exception of Boadi, which had a mean *E. coli* load within the acceptable limit. *S. aureus* load ranged from 4.20×10^3 to 1.64×10^7 CFU/g. Samples from Kentinkrono recorded the highest mean load ($6.18 \log$ CFU/g), whereas those from Kotei recorded

TABLE 3: Mean load of *E. coli* and *S. aureus* in gizzard kebab sold on the KNUST campus and its environs.

Location	Range of <i>E. coli</i> load (MPN/g)	Mean load of <i>E. coli</i> (log ₁₀ MPN/g)	Range (CFU/g) of <i>S. aureus</i> load	Mean load of <i>S. aureus</i> (log ₁₀ CFU/g)
Kotei	2.30×10 ⁵ -4.30×10 ⁶	6.10 ± 0.52	1.52×10 ⁴ -3.50×10 ⁶	5.37 ± 0.98
Ayeduse	0.00-2.40×10 ⁶	3.85 ± 3.03	4.20×10 ³ -2.96×10 ⁶	5.43 ± 1.36
Kentinkrono	0.00-2.90×10 ⁷	2.94 ± 3.85	3.00×10 ⁵ -1.64×10 ⁷	6.18 ± 0.81
Boadi	0.00-2.40×10 ⁵	1.79 ± 2.78	1.24×10 ⁵ -1.76×10 ⁶	5.80 ± 0.54
KNUST campus	0.00-1.50×10 ⁶	4.05 ± 3.14	1.48×10 ⁵ -9.60×10 ⁶	5.82 ± 0.65
Ayigya	0.00-9.30×10 ⁶	4.38 ± 3.41	7.40×10 ³ -1.64×10 ⁷	5.69 ± 1.50
CV (%)		79.1		18.1
<i>p</i> value		0.207		0.788

MPN = most probable number; CFU = colony-forming unit.

FIGURE 2: A graph showing percentage resistance and susceptibility of *E. coli*.

the least (5.37 log₁₀ CFU/g) (Table 3). The mean load differences of *S. aureus* were statistically not significant (*p* = 0.788); however, they were above the FSANZ acceptable standard limit of ≤ 10⁴ CFU/g (≤ 4 log₁₀ CFU/g).

4.4. Antimicrobial Susceptibility of *E. coli* and *S. aureus* from Kebab on KNUST Campus and Its Environs

4.4.1. *E. coli*. Based on the British Society for Antimicrobial Chemotherapy (BSAC) Methods for Antimicrobial Susceptibility Testing, version 14, May 2015, *E. coli* (*n* = 27) were all resistant to the antibiotics tested with the exception of chloramphenicol, which was susceptible (Figure 2).

4.4.2. *S. aureus*. *S. aureus* (*n* = 36) was resistant to the antibiotics tested (ampicillin, tetracycline, gentamicin, cefuroxime, ceftriaxone and cefotaxime = 100%, cotrimoxazole = 52%) with the exception of few which were susceptible (chloramphenicol = 100% and cotrimoxazole = 48%).

5. Discussion

5.1. Microbiological Quality. The mean *E. coli* count in the beef, chevon, and gizzard kebab samples from the various locations ranged from 1.79 to 6.12 log₁₀ MPN/g, 1.99 to 4.44 log₁₀ MPN/g, and 1.79 to 6.10 log₁₀ MPN/g, respectively. The mean *E. coli* count for the kebab samples (beef, chevon, and gizzard) in the locations was above the standard acceptable limit, except Boadi, which was within the acceptable limit. The high count of *E. coli* in the kebab samples suggests a possible faecal contamination. This may be due to poor hygienic practices of the vendors. Hygienic practices such as protection of food from flies and dust, cleaning of fingernails, use of aprons, and head cups by street food vendors are one of the key measures that helps to prevent foodborne contamination [40]. But majority of street food vendors are uneducated and therefore lack the knowledge in safe food preparation and handling. As a result, they rarely adhere to hygienic practices and this might have accounted the high level of *E. coli* count in the kebab samples. Additionally, meat generally contains the necessary nutrients for microbial growth as well as their metabolism, making it prone to microbial contaminations. Thus, if the vendor does not practice proper hygiene, it facilitates the growth of the organism resulting in their high numbers [45]. According to Oladipo-Adekeye and Tabit [46], Carrasco et al. [47], and Wei et al. [48], poor sanitary practices by street food vendors results in food contaminations. The use of nonportable water by vendors during preparation or processing of the kebab could also contaminate the kebab with *E. coli*. *E. coli* is destroyed at a temperature above 70°C, so their presence in the kebab samples could be that the kebabs were insufficiently heated (roasted) or grilled [49]. Bryan et al. [50] have reported similar high *E. coli* count of 6 log₁₀ CFU/g in street-vended foods. Djoulde et al. [51] also reported *E. coli* counts of 3.3 log₁₀ CFU/g and 2.8 log₁₀ CFU/g in mobile and stationary food sellers, respectively, which are lower than the current findings but were above the permissible limit. Ologhobo et al. [52] also reported unsatisfactory levels of *E. coli* counts in RTE beef (3.3×10⁴ CFU/g) and chicken (3.4×10⁵ CFU/g) “suya,” which is lower than the current findings but above the permissible limit. Similar results of high *E. coli* count above the permissible limit have also

FIGURE 3: A graph showing percentage resistance and susceptibility of *S. aureus*.

been reported by Salihu et al. [53] in traditionally prepared ground beef.

The mean total viable count (TVC) of *S. aureus* in the beef, chevon, and gizzard khebabs in the locations was all above the standard acceptable limit of $\leq 10^4$ CFU/g ($\leq 4 \log_{10}$ CFU/g). According to Bishop and Onyowoicho [54] and Gilbert and Harrison [55], *S. aureus* is a normal flora of the human skin. Therefore, the high levels of *S. aureus* in the khebab samples might be a cross-contamination from the vendor. Gay [56] also indicated that the presence of *S. aureus* in food is mainly a result of human contamination, which is normally from the human respiratory passages and the skin, as well as the superficial wounds on the human skin surfaces. But according to Levine [57], the TVC of microbes present in any food is not indicative of their safety for consumption, but it is a supreme importance of judging the hygienic conditions under which the foods had been prepared, handled, and stored. The current results are consistent with the findings of Hassan et al. [58], who reported microbial load of *S. aureus* ranging from 0.125 to 2.6×10^6 CFU/g in barbecue meat (suya). Bagumire and Karamuna [1] and Selvan et al. [59] also reported higher *S. aureus* count of 4.37 and 4.88 $\log_{10}$ CFU/g in ready-to-eat beef and chicken samples, respectively. However, the current results are in contrast to the findings of Uzeh et al. [60] and Djoulde et al. [51] who reported relatively lower *S. aureus* count of 1.0×10^2 – 12.0×10^2 CFU/g and 1.10 $\log_{10}$ CFU/g in tsire-suya and roasted chicken, respectively.

5.2. Antimicrobial Susceptibility of *S. aureus* and *E. coli* Isolated from Khebab Samples. The antibiotic resistance pattern observed in the *E. coli* ($n = 27$) and *S. aureus* ($n = 36$) revealed a multiresistance to the antibiotics tested, although some of them were susceptible to few of the

antibiotics tested (Figures 2 and 3). *E. coli* ($n = 27$) were 100% resistant to ampicillin, tetracycline, gentamicin, cefuroxime, ceftriaxone, and cefotaxime, and 100% susceptible to chloramphenicol. The current findings are in line with work carried out by Ahmadi et al. [61] who reported that *E. coli* isolates from meat and meat product were resistant to ampicillin, tetracycline, and other antibiotics. Barua [62] also reported a higher percentage of VTEC isolates resistant to ampicillin. Additionally, Somda et al. [63] reported *E. coli* isolates from fumed, grilled, and flamed chicken resistant to cefotaxime (7.14%), ceftriaxone (10.71%), ampicillin (42.86%), tetracycline (64.3%), and other antibiotics that support the current results. The current findings also agree with work carried out by Apun et al. [64] who reported *E. coli* isolates from Malaysian broiler chickens resistant to ampicillin, tetracycline, and gentamicin ranging from 11 to 95%. Tricia et al. [65] reported 43% of *E. coli* isolates resistant to ampicillin but were not resistant to gentamicin, and this partly agrees with the current findings.

In the case of the *S. aureus* ($n = 36$), majority of them were multiresistant to all the antibiotics tested and only few were susceptible to four of the antibiotics namely ampicillin (2.78%), erythromycin (25%), cotrimoxazole (13.89%), and gentamicin (30.56%). Since the *S. aureus* been multiresistant to the antibiotics tested, the khebabs could pose a health risk to the consumer. The current findings agree with work carried out by Temesgen et al. [66], who reported *S. aureus* isolates from ready-to-eat foods resistant to ampicillin, ceftriaxone, cloxacillin, and other antimicrobial drugs. This therefore makes treatment of *S. aureus* infection difficult.

The *E. coli* and *S. aureus* exhibited a similar antibiotic resistance pattern even though the khebab samples were taken from different locations. This agrees with work carried out by Achi and Madubuike [67], who reported similar antibiotic resistance patterns of *S. aureus* isolates from different vendors (hawkers and retail outlets) in food samples. These antibiotic-resistant bacterial isolates from the khebab samples give an indication that street foods might pose serious health problems to the public who patronize them. According to Umoh et al. [68] and Chigbu and Ezeronye [69], the level of antimicrobial resistance is because of the result of indiscriminate use and abuse of antibiotics in the environment. Additionally, the practice of administering antimicrobials agents to domestic livestock as a way of preventing and treating diseases as well as serving as promoting growth could result in the emergence of antimicrobial-resistant bacteria.

In recent years, antimicrobial resistance in foodborne pathogens has been on the rise. According to Allison and Gilbert [70], the increase could be attributed to the selection pressure created by using antimicrobials in food-producing animals and unregulated use of antibiotics by humans in developing countries. De Briyne et al. [71] also indicated the prevalence of resistance to these antibiotics is expected as the result of extensive use of these substances in veterinary medicine.

6. Conclusion

The prevalence of foodborne illness in Ghana is rising each day, which is a major threat to public health. The current research sought to determine the quality of khebabs on the KNUST campus and its environs as well as the antibiotic resistance of *E. coli* and *S. aureus* isolated from the khebabs. The findings of the study generally suggest that street-vended khebabs on the KNUST campus and its environs were contaminated. Isolated *E. coli* and *S. aureus* were multiresistant to the antibiotics tested and therefore expose consumers to risk of contracting multiresistant *E. coli* and *S. aureus* illness.

Data Availability

The data used to support the findings of this study are included within the supplementary information file.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Supplementary Materials

The supplementary material contains the raw dataset on MPN count for *E. coli*, TVC for *S. aureus*, and antimicrobial susceptibility test on *E. coli* and *S. aureus* isolates obtained from the beef, chevon, and gizzard khebabs analyzed in the laboratory. The laboratory analysis on each method was replicated three times. (*Supplementary Materials*)

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