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Research Article

Detection and Antibiogram of *E. coli* O157:H7 from Food Contact Surfaces in Selected Restaurants in FCT, Abuja, Nigeria

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Abstract
Escherichia coli is a well-known pathogen that has been associated with numerous foodborne illness worldwide. The bacterium can contaminate food products through various sources, such as contaminated water, improper food handling, cross-contamination, and unsanitary food processing environments. The study was aimed at assessing microbial quality on food contact surfaces and to detect *E. coli* on food contact surfaces in selected restaurants in Abuja municipal area council, Kuje, and Gwagwalada area council of the FCT. Two hundred and fifty nine swab samples were collected from food contact surfaces and analyzed for total aerobic plate count and total coliform count using standard microbial method. Counts for APC 6.05±0.2 log CFU/ml and TCC 4.78±0.1 log CFU/ml from Abuja municipal area council, 5.92±0.1 log CFU/ml and 5.91±0.1 log CFU/ml from Gwagwalada and Kuje 5.62±0.2 log CFU/ml and 5.77±0.2 log CFU/ml respectively. *E. coli* was detected isolated on selective agar such as MacConkey and Eosin-methylene blue and *E. coli* O157:H7 on Cefixime-Tellurite Sorbitol MacConkey agar (CT-SMAC agar), while antibiotic susceptibility testing was carried out using the disc diffusion method. The overall percentage rate of 11(3.10%) was obtained. The highest isolation rate 5(5.00%) was obtained from Gwagwalada, 4(3.70%) from Kuje and 2(1.33%) from Abuja municipal area respectively. The antibiotic susceptibility of the isolates showed 100% susceptibility to gentamicin, 9(81.8%) to augmentin, 8(72.7%) to sulfamethoxazole and amoxicillin respectively while a 100% resistance was recorded for linezolid and cefazolin. Therefore, there is need for educative awareness among food handlers on good hygienic practices and sanitation as well as environmental hygiene and also self-medication and use of over the counter usage of antibiotic should be discouraged.
Keywords: Foodborne Illness, Pathogen, Sanitation, Awareness.

Introduction

A food contact surface is any surface of equipment or a utensil with which food normally comes into contact (Baghapour *et al*., 2015). It is also a surface of equipment or a utensil from which food may drain, drip, or splash into a food or onto a surface normally in contact with food. These can be things that are quite obvious like a glass, soft drinks cans, machinery in a food factory, conveyor belts, table tops, saw blades, abattoir surfaces, hands of food handlers, spoons, dishes, pots, augers, stuffers, knives, stockpots, and cutting boards (Omoruyi *et al*., 2011; Oranusi *et al*., 2013; Orogu *et al*., 2017). Foodborne illnesses are a significant public health concern worldwide, with bacterial contamination being a leading cause of these infections. Foodborne diseases due to contaminated foods are of global concern with hazards leading to approximately 1.5 billion cases of diarrhea in children worldwide and greater than 3 million deaths annually (Gholammostafaei *et al*., 2014; Biranjia-Hurdoyal and Latouche, 2016). Therefore the preparations should be performed in a clean environment and also on clean food contact surfaces as the final product will not be subjected to the heating process, for poor hygienic practices can act as a source of contamination which may result in food spoilage and the spread of diseases and infections such as food poisoning to humans (Saad *et al*., 2013; Adekolurejo *et al*., 2016).

E. coli is a non-spore-forming, Gram-negative rod, usually motile by peritrichous flagella that is a member of the family *Enterobacteriaceae* (Algammal *et al*., 2020). The bacterium can contaminate food products through various sources, such as contaminated water, improper food handling, cross-contamination, and

unsanitary food processing environments. The majority of *E. coli* strains are non-pathogenic, but a few are very pathogenic, which when consumed in food contaminated with pathogenic *E. coli* strains can lead to causing watery and bloody diarrhea, *E. coli* 0157:H7 has been linked to life-threatening diseases such as hemorrhagic colitis, hemolytic uremic syndrome (HUS), and thrombotic thrombocytopenic purpura (Rahman *et al*., 2017). *E. coli* have been found to contaminate ready to eat foods (Abebe *et al*., 2020). This species can survive on hands and other surfaces and is readily transferred to foods (Ayamah *et al*., 2021).

Antibiotics have been used in human and veterinary medicine for many years to minimize morbidity and mortality and the economic effect of bacterial infections. However, *E. coli* has developed resistance to one or more antibiotics, which has raised public health concerns. Regular monitoring and effective detection methods for *E. coli* on food contact surfaces can help identify potential sources of contamination, assess the efficacy of cleaning and sanitation practices, and implement corrective actions to prevent further contamination. This can significantly reduce the risk of foodborne illnesses and protect public health (WHO, 2018; Liu and Mustapha, 2019). The rapid urbanization and population growth in FCT, Abuja have led to increased demand for food services and products. As a result, the frequency and diversity of food handling practices have expanded, creating new challenges in maintaining food safety standards. Inadequate awareness, limited access to proper training, and resource constraints further exacerbate the situation, making these areas particularly vulnerable to foodborne illnesses related to *E. coli* contamination (Tearfund, 2007). This necessitated the present study to evaluate bacteriological quality of food contact surfaces, to isolate and identify *Escherichia coli* and to determine the antibiogram of the *E. coli* isolated from food contact surfaces in restaurants in Federal Capital Territory.

Materials and Methods

Collection of Samples

The study was conducted in Federal Capital Territory Abuja restaurants. A total of three hundred and fifty-nine (359) samples were collected from three (3) area councils in FCT. One hundred and fifty (150) samples were collected from Abuja municipal area council, one hundred and nine (109) samples were collected from Kuje while one hundred (100) samples were collected from Gwagwalada. The restaurants were visited during operation time and the food contact surfaces namely; tables, pots, spoons, plates, chopping boards were identified. The swab samples were collected using sterile swab stick by swabbing a delimited area (100 cm^2) (Christison *et al*., 2008; Baghapour *et al*., 2015). Swab head was rubbed slowly and thoroughly over a total area of 100 cm^2 of sampled area. A 4 × 5 cm^2 dimension of cart was used to measure the area. Swabbing was performed five times to cover an area of 100 cm^2. Thereafter the swab was broken and the tube covered. Then, the swabs were then placed into 5ml of maximum recovery diluents (Cheesbrough, 2010). All swab samples were placed in an ice-cooled box and transported to Laboratory of Institute of Human Virology, Abuja for analysis.

Analyses

Serial Dilution

Each tube containing the swab was vortexed for 10 seconds to ensure mixture of the sample. A 100 fold dilution method was used by serially diluting 0.1 ml of each sample in 9.9 ml of physiological saline to achieve a dilution factor of 10^2, 10^4 and 10^6 respectively. Tenfold serial dilution up to 10 were used for both total aerobic plate and coliform counts. A volume of 0.1ml from the final dilution was spread on nutrient agar for total aerobic plate counts and on MacConkey agar for coliform counts and incubated at 37^0C for 24hr. Discrete colonies between 30 to 300 colonies were counted using a colony counter and expressed as CFU/cm^2 (ISO, 2013; APHA, 2015).

Isolation of *E. coli*

Escherichia coli was isolated on Eosin Methylene Blue (EMB) agar, colonies with a metallic green sheen on eosin methylene blue (characteristic of *E. coli*) was later characterized microscopically using Gram's stain according to the method described by (Cheesbrough, 2010) and subsequently stored at 4^oC in the refrigerator for further identification by standard methods.

Isolation and Identification of *E. coli* O157:H7

The selective plating of *E. coli* O157:H7 was carried out using a loopful of the overnight culture purified on eosin methylene-blue and streaked onto Cefixime-Tellurite Sorbitol MacConkey agar (CT-SMAC agar) plate and incubated at 37^oC for 24 hours. A typical *E. coli* O157:H7 appeared as slightly transparent, almost colourless with a weak pale brownish appearance (ISO, 2003). Then, the isolates were subjected to different biochemical tests according to (Quinn *et al*., 2002) such as sugar fermentation test and indole production

test, methyl-red, Voges-Proskauer, and citrate utilization (IMViC) test (Cheesbrough, 2010; Purkayastha *et al*., 2010).

Antibiotic Susceptibility Test

The Kirby–Bauer disk diffusion method described by Bauer *et al*., (1966) was used to perform an antimicrobial susceptibility test on Mueller–Hinton agar (MHA) (HiMedia) using the following antibiotic disks: Amoxicillin (10µg), Gentamicin (10µg), Chloramphenicol (10µg), Streptomycin (10µg), Augmentin (30µg), Cefpodoxime (10µg), Linezolid (30µg), Sulfamethoxazole (10µg), Levofloxacin (10µg) and Cefazolin (10µg). The zone of inhibition was compared with standards for resistance and sensitivity stated by the Clinical and Laboratory Standards Institute (CLSI, 2020).

Results

Table 1 shows the total aerobic plate count and total coli form from the food contact surface in AMAC, Gwagwalada and Kuje area council of the Federal Capital Territory with the range of APC 6.05±0.2 log CFU/ml and TCC 4.78±0.1 log CFU/ml from AMAC, 5.92±0.1 log CFU/ml and 5.91±0.1 log CFU/ml from Gwagwalada and Kuje 5.62±0.2 log CFU/ml and 5.77±0.2 log CFU/ml respectively.

Table 1. The mean total aerobic and total coliform counts from three area councils, AMAC, Gwagwalada and Kuje, FCT, Abuja-Nigeria.

Locations	Aerobic plate count (Log CFU/ml)	Total coliform count (Log CFU/ml)
AMAC	6.05±0.2	4.79±0.1
Gwagwalada	5.92±0.1	5.91±0.1
Kuje	5.62±0.2	5.77±0.2

Table 2 shows the frequency of isolation of *E. coli* O157:H7 isolates. Out of three hundred and fifty-nine (359) samples collected from food contact surfaces eleven (11) were positive on the basis of biochemical and enzymatic tests.

Table 2. Frequency of isolates of potential pathogenic *E. coli* O157:H7 from food contact surfaces in FCT, Abuja.

	Number of samples						
Locations	**Plates**	**Spoon**	**Pot**	**Table**	**Chopping board**	**Number positive**	**Percentage positive (%)**
AMAC	30	25	30	35	30	2/150	1.33
Kuje	20	20	20	19	30	4/109	3.70
Gwagwalada	20	20	10	30	20	5/100	5.00
Total	**70**	**65**	**60**	**84**	**80**	**11/359**	**3.10**

Antibiotics Susceptibility of Isolates

Antibiogram of *E. coli* O157:H7 isolated from food contact surfaces in FCT, revealed that all the isolates showed 100% susceptibility to gentamicin and intermediate pattern was observed for cefpodoxime 10(90.9%) while all isolates showed 100% resistance to cefazolin and linezolid respectively as showed in Table 3.

Table 3. Antibiotic susceptibility of *E. coli* O157:H7 isolated from food contact surfaces from restaurants in FCT, Abuja.

Antibiotics	Disk potency	Susceptibility	Intermediate	Resistance
Amoxicillin	10µg	8(72.7%)	3(27.3%)	0(0.0%)
Chloramphenicol	10µg	7(63.6%)	4(36.4%)	0(0.0%)
Gentamicin	10µg	11(100%)	0(0.0%)	0(0.0%)
Streptomycin	10µg	5(45.5%)	6(54.5%)	0(0.0%)
Augmentin	30µg	9(81.8%)	2(18.2%)	0(0.0%)
Cefpodoxime	10µg	0(0.0%)	10(90.9%)	1(9.1%)
Linezolid	30µg	0(0.0%)	0(0.0%)	11(100.0%)
Sulfamethoxazole	10µg	8(72.7%)	3(27.3%)	0(0.0%)
Levofloxacin	10µg	0(0.0%)	9(81.8%)	2(18.2%)
Cefazolin	10µg	0(0.0%)	0(0.0%)	11(100%)

Table 4 show the antibiotics resistance profile of *E. coli* O157:H7 from food contact surfaces in three area councils in FCT (Abuja municipal area council, Kuje and Gwagwalada). Isolates with code G2, G4 and K3 were more resistant with multiple resistant indices of 0.3 compared to the other isolates which recorded lower multiple resistance index of 0.2.

Table 4. Antibiotics resistance profile of *E. coli* O157:H7 from food contact surfaces in FCT, Abuja.

Isolates	Resistance pattern	MARI
G2	Cef, Lin, Cefp	0.3
G4	Cef, Lev, Lin	0.3
K3	Lin, Lev, Cef	0.3
G1	Lin, Cef	0.2
G3	Lin, Cef	0.2
G5	Lin, Cef	0.2
K1	Lin, Cef	0.2
K2	Lin, Cef	0.2
K4	Lin, Cef	0.2
A1	Lin, Cef	0.2
A2	Lin, Cef	0.2

Discussion

Good hygienic practices are essential for ensuring food safety. They are required by law under National and International Food Hygiene Regulations and are frequently considered as pre-requisites to food safety systems based on Hazard Analysis and Critical Control Point (HACCP) (Sudheesh *et al.,* 2013). The compromise of good hygiene will almost always leads to the establishment and growth of pathogens as well as spoilage microorganisms on the storage of food contact surfaces. This could result in the contamination of food products with hazardous microorganisms making them unsafe for human consumption. Good hygienic practices are primary preventative measures and the monitoring of their effectiveness not only provides an early warning of potential problems but also evidence of due diligence (Orogu *et al*., 2017). This present study revealed aerobic plate counts and total coli form counts in the range of APC 6.05±0.2 log CFU/ml and TCC 4.78±0.1 log CFU/ml from AMAC, 5.92±0.1 log CFU/ml and 5.91±0.1 log CFU/ml from Gwagwalada and Kuje 5.62±0.2 log CFU/ml and 5.77±0.2 log CFU/ml respectively which agrees with the reports of Orogu *et al*., (2017) who determined the bacteriological quality of food contact surface on cutleries. Similarly, Nhlapo *et al*., (2014) reported microbial counts on food contact surfaces above permissible level. Contamination of food contact surfaces might be attributed to lack of adequate cleaning and sanitization of these surfaces as well as improper personal hygiene of the food processors and environmental hygiene which can lead to contamination of the surfaces and can serve as a vehicle for *Escherichia coli* and other foodborne pathogens.

Escherichia coli contamination on food contact surfaces poses a significant concern due to its potential transmission to food products, leading to foodborne illnesses. The findings of this study revealed the overall percentage rate of 11(3.10%), results obtained revealed the highest isolation rate 5(5.00%) from Gwagwalada, 4(3.70%) for Kuje and 2(1.33%) from Abuja municipal area council respectively. The detection of *E. coli* O157:H7 on food contact surface indicates improper food handling practices, cross-contamination, or inadequate sanitation (CDC, 2020). This might also be due to the type of water used in the cleaning of surfaces which may be feacally contaminated as well as lack of environmental hygiene around the premises and lack of personnel hygiene by the food processors.

The detection of *E. coli* O157:H7 from this present study agrees with the reports of Sudheesh *et al*., (2013) who recorded 13(26 %) and Mohammed *et al*., (2018) who also reported the presences of *E. coli* on food contact surfaces in Kaduna State Nigeria. Similarly, Zailani *et al*., (2013) reported the isolation of 3 isolates of *E. coli* from meat contact surfaces from abattoirs in Bauchi State, Nigeria. Nhlapo *et al*., (2014) from South Africa observed 50% and 90% of *E. coli* from food contact surfaces. Dahiru *et al*., (2016) also observed the prevalence of 20.3% *E. coli* from food contact surface in Kano State, Nigeria. The variation from the various studies could be attributed to locations, different level of personnel hygiene among food processors and water quality. The presences of *E. coli* on food contact surfaces may lead to food borne intoxicosis. The antimicrobial susceptibility of the eleven isolates showed a 100% susceptibility to gentamicin, 9(81.8%) to augmentin, 8(72.7%) to sulfamethoxazole and amoxicillin respectively, which agrees with Gugsa *et al*., (2022) who reported 19(79.2%) to sulfamethoxazole, 22(91.7%), gentamycin 1(4.2%), amoxicillin respectively. Similarly, Kibret and Abera (2011), reported 16(22.9) to augmentin, 46(65.7) to streptomycin and amoxicillin to 15(21.4) from clinical source.

The *E. coli* isolates identified in this study were characterized as possessing multiple drug resistance, manifesting two distinct resistance patterns involving linezolid and cefazolin. The assessment of health risk factors and antibiotic resistance was facilitated by the application of the multiple antibiotic resistance index. All the isolates exhibited a multiple antibiotic resistance index greater than or equal to 0.2, with only three isolates notably exhibiting a multiple antibiotic resistance index of 0.3, indicative of the high-risk origin of contamination for the *E. coli* isolates identified in this study. The degree of antimicrobial resistance observed in the identified *E. coli* aligns with the findings of Okoli *et al.*, (2016), who demonstrated the prevalence of multiple resistances in *E. coli* originating from food contact surfaces. The resistance patterns exhibited by the *E. coli* isolates in this investigation against commonly used antibiotics corroborate existing research indicating the multidrug-resistant nature of *E. coli* from food contact surfaces (Kahan *et al.,* 2015). The emergence of resistance genes in these bacterial species, as observed in the sampled restaurant areas, is often linked to the indiscriminate use of antimicrobials, enabling organisms to develop resistance under selective antibiotic pressure.

Conclusion and Recommendation

This study highlights the contamination of food contact surfaces by *Escherichia coli* O157:H7 in selected area councils of FCT, Abuja. The presence of *E. coli* O157:H7 on food contact surface indicates a significant risk of foodborne illness transmission, necessitating enhanced sanitation practices and regulatory oversight. While the antimicrobial susceptibility profiles indicate varying degrees of susceptibility and resistance, the presence of multiple antibiotic resistance strains underscores the urgency of addressing antimicrobial resistance in foodborne pathogens. The findings from this study underscore the critical importance of effective hygiene practices to food processors and as well as antimicrobial stewardship.

Declarations

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