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Article

Isolation, characterization and antibiogram studies of bacteria isolated from ready-to-eat foods sold at different places of Dinajpur district, Bangladesh

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Abstract: Ready-to-eat (RTE) foods are widely used at home, restaurants, and during festivals in Bangladesh. Foodborne illness is very common and mainly caused by the consumption of contaminated street foods. It is very important to investigate possible microbial contamination in RTE foods. The present study was conducted to isolate and characterize bacterial pathogens from RTE foods and to know the antimicrobial susceptibility patterns of the isolated bacteria. A total of 60 RTE food samples for instance, burger, fuchka, fried rice, and chicken grill (fifteen samples each) were collected aseptically from street food vendors of different locations at Dinajpur. Bacteria were isolated and identified based on cultural, staining, and biochemical properties following standard microbiological methods. Among four types of tested RTE foods, 100% comprised of bacterial contamination. The total viable count (TVC) in burger ranged from 4.2×10^3 to 1.6×10^4; in fuchka ranged from 4.5×10^3 to 2.5×10^4; in fried rice ranged from 4.7×10^3 to 1.5×10^4; and in chicken grill ranged from 4.9×10^3 to 1.6×10^4. Among the tested RTE food samples, *Escherichia coli* 6 (10%), *Salmonella* spp. 7 (11.66%), and *Klebsiella* spp. 2 (3.33%) were isolated. Antibiogram studies revealed that Streptomycin, Gentamicin, Tetracycline, and Neomycin were found sensitive for both of the isolated *E. coli* and *Klebsiella* spp. On the other hand, Streptomycin, Azithromycin, Gentamicin, Tetracycline, and Neomycin were found sensitive for *Salmonella* spp. Vancomycin, Penicillin, Erythromycin, Amoxicillin, and Ampicillin were found resistant for *E. coli* and *Salmonella* spp. isolates, whereas Vancomycin, Azithromycin, Penicillin, Erythromycin, Amoxicillin, and Ampicillin were found resistant for *Klebsiella* spp. The results of this study suggested that RTE foods should be manufactured under good hygienic practices.

Keywords: antibiotic; street foods; sensitivity; resistance; total viable count; food safety

1. Introduction

Food-borne illnesses are becoming a global public health concern. These microorganisms are responsible for an estimated 48 million illnesses and 3000 fatalities in the United States each year (Rahman *et al.*, 2017). In contrast, RTE foods do not require any additional preparation, with the exception of warming, and these RTE foods are often eaten raw or cold without any additional heat treatment (Bagumire and Karumuna, 2017; Oje *et al*., 2018). RTE foods are foods and beverages consumed at the point of sale or at a later time, without any further processing or treatment in such a way that may significantly reduce the microbial load and could be raw or cooked, hot or chilled (Tsang, 2002; Clarence *et al*., 2009). RTE foods can be fruits and fruit products (Oranusi and Olorunfemi, 2011), meat and its products, eggs and the like (Oranusi *et al.*, 2011; Adesetan *et al.*,

2013; Bello *et al.,* 2014). RTE foods provide an important source of readily available and nutritious meals for consumers. Today, the increasing demand for RTE foods has led to an increase in the amount of food and different types of food that consumers can easily obtain (Almualla, 2010). RTE foods are convenient meals for today's lifestyle because they do not require cooking or further preparation (Hassan *et al*., 2017; Khalif *et al*., 2018; Paul *et al*., 2018). In addition to its benefits, the incidence of foodborne diseases is increasing globally, involving a wide range of diseases caused by pathogenic organisms, and becoming a public health problem that requires urgent response (De Vogli *et al*., 2014). Due to the negligence of regulatory agencies and weak law enforcement, which has affected food quality and led to the provision of unsafe food to consumers, the hygiene and safety practices of most food suppliers have not been supervised or monitored (Alimi *et al*., 2016). Even in developed countries, it is estimated that one-third of the population is affected by microbial foodborne diseases every year (Andargie *et al*., 2008). According to Scallan *et al.* (2011), from 2000 to 2010, there were approximately 47.8 million foodborne illnesses in the United States each year, of which 9.4 million were caused by 31 known and identified pathogens. In developing countries, food-borne or water-borne microbial pathogens are the main cause of disease (Andargie *et al*., 2008). Feglo and Sakyi (2014) identified various types of microorganisms in RTE foods, such as *Staphylococcus aureus*, *Bacillus*, *Klebsiella pneumoniae,* and *E.coli* in different types of RTE foods. Furthermore, Gizaw, also identified various bacterial species that cause food poisoning and foodborne diseases such as *Salmonella, Shigella, E. coli, Clostridium, Staphylococcus, Campylobacter*, and *Vibrio* from RTE foods, some of which are common bacteria that cause food-related illness (Gizaw, 2019). Similarly, according to the study conducted in China using national food-borne disease outbreak surveillance system data (2003-2017), 19517 foodborne outbreaks were reported, which resulted in 235754 illnesses, 107470 hospitalizations, and 1457 deaths. Of 13307 outbreaks with known etiology, about 6.8%, 4.2%, and 3.0% of outbreaks were caused by *Salmonella, Staphylococcus aureus*, and *Bacillus cereus*, respectively (Li W *et al.,* 2020). In general, illness and death from diseases caused by contaminated food are a threat to public health and a significant impediment to socio-economic development. Foodborne disease outbreaks are common and cause considerable morbidity and mortality (Havelaar *et al*., 2015). This indicates the need to determine the microbial load or status of RTE foods to prevent foodborne diseases and promote health and well-being. In Bangladesh, some previous microbiological studies conducted to know respiratory bacterial agents from buffalo (Akter *et al*., 2018), bacterial load in dental caries (Borty *et al*., 2015), bacterial load of poultry meat (Hossain *et al*., 2015), bacteria from mobile phones of student (Hussein *et al*., 2020), bacteria isolated from table eggs (Islam *et al*., 2018), bacterial species isolated from milk (Munsi *et al*., 2016), bacterial pathogens from egg shell, egg yolk, feed and air samples (Parveen *et al*., 2017), bacterial loads in butter and cheese (Parvin *et al*., 2016), bacterial population of raw milk (Rana *et al*., 2021) and antibiotic sensitivity of bacteria in raw milk (Talukder and Ahmed 2016). A very few studies are conducted to assess the bacterial load and their antibiogram in RTE foods, however, this study is the first study from the current study location for assessing the bacterial load and their antibiogram in RTE foods. Therefore, this study sought to determine the microbiological quality and public health risks of RTE foods in developing countries. Fuchka, fried rice, chicken grill and burger are the most popular RTE foods in Bangladesh (Khalif *et al*., 2018; Paul *et al*., 2018). All aged people and all class of people like as children, students, rickshaw puller, and laborers eat fuchka, fried rice, chicken-grill and burger. Although there is a growing demand for RTE food products, no recent information is available regarding the microbiological quality of this product in Dinajpur, Bangladesh. Therefore, this study aimed to isolate, identify and characterize the bacteria in RTE foods sold in Dinajpur, Bangladesh.

2. Materials and Methods

2.1. Collection of RTE food samples

The present research work was conducted during the period from July 2021 to June 2022, in the Bacteriology Laboratory of the Department of Microbiology, Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. For this study, a total number of sixty RTE food samples were collected from different street food vendors located at Sadar Upazila at Dinajpur district of Bangladesh. The RTE food samples (fuchka, fried rice, chicken grill, and burger) were collected from Basherhat, Boro Math, Suihari, Lilimor, and Maldhapotti of Dinajpur Sadar Upazila (Table 1). Approximately 300 g of each food sample was collected using the vendors serving utensils, take parcel and placed into sterile plastic bags. All the collected samples were kept on an ice-box during transportation to the laboratory and stored at 4°C until testing. They were analyzed within 24 hours of sampling.

Table 1. Summary of RTE food samples collected from different places of Dinajpur Sadar.

Sl. No.	Sample name	Source of sample	Number of collected samples	Total no. of tested samples
01	Burger	Boro Math, Madhopatti, Basherhat, Suihari, Dinajpur	15	60
02	Fried rice	Nimtala, Madhopatti, Suihari, Dinajpur.	15	
03	Chicken grill	Boro Math, Basherhat, Suihari, Dinajpur.	15	
04	Fuchka	Boro Math, Lilimor, Basherhat, Dinajpur.	15	

2.2. Preparation of samples

An adequate amount of each street food (fuchka, fried rice, chicken grill, and burger) samples were uniformly homogenized in mortar and pastel using a sterile diluent as per recommendation of International Organization for Standardization (ISO), 1995. A homogenized suspension was made with the help of mortar and pastel. A quantity of 10 g homogenate sample of each food was taken aseptically with a sterile spoon and transferred carefully into a sterile pastel containing 90 ml of phosphate buffered saline (PBS) solutions. Thus 1:10 dilution of the food samples was obtained.

2.3. Laboratory preparations

All the items of glassware including test tubes, micropipettes, cylinder, conical flasks, flasks, glass plates, slides, vials and test tubes were soaked in a household dishwashing detergent solution for overnight. The glassware were then cleaned by brushing, washed thoroughly and finally sterilized either by dry heat at 160°C for 2 hours or by autoclaving for 15 minutes at 121°C under 15 lbs. pressure per square inch. Autoclaved items were dried in a hot air oven at 50°C. Disposable plastic ware (micropipette tips) was sterilized by autoclaving.

2.4. Enumeration of total viable count (TVC)

From each ten-fold dilution, 50 µl of diluted food samples were transferred into a Plate Count Agar (PCA) using a micropipette for each dilution and immediately spread on the surface of the plate using a sterile glass spreader for the determination of total bacterial count. The plates were kept in an incubator at 37°C for 24 hrs. After incubation, plates exhibiting 30-300 colonies were counted. The average number of colonies in particular dilution was multiplied by the dilution factor to obtain the TVC. The TVC was calculated according to ISO (1995). The results of the TVC were expressed as the number of colony forming units (CFU) per gram of food samples.

2.5. Isolation of associated bacteria

Bacteriological examinations were performed using standard method for aerobic bacteria (Brown, 2005). Each sample of burger, fried rice, chicken grill, and fuchka were inoculated separately in nutrient broth (NB) to promote bacterial growth. Each group of these culture media was incubated at 37°C for overnight. The colonies on primary cultures were repeatedly sub-cultured by streak plate method (Cheesbrough, 1985) until the pure culture with homogenous colonies were obtained. Different bacteriological culture media such as Nutrient agar, MacConkey agar, Eosin Methylene Blue agar, Salmonella Shigella (SS) agar, and Mannitol Salt Agar (MSA) were used for sub-culturing and incubated at 37°C for 24 hours for growth.

2.6. Identification of associated bacteria

The cultural examinations of collected RTE food (burger, fried rice, chicken grill, and fuchka) samples for bacteriological study were performed according to the standard method of International Commission on Microbiological Specifications for Foods (ICMSF, 1985). Identification of bacteria was performed on the bases of colony morphology, Gram's staining reaction and biochemical tests. Biochemical tests, such as Oxidase, Catalase, Methyl Red (MR), Voges-Proskauer (VP), Urease test, Triple Sugar Iron (TSI), Iodole test, and Citrate utilization tests were performed as per the standard methods (Cheesbrough, 1985).

2.7. Antibiogram study

To determine the drug sensitivity and resistance patterns of isolated organisms, different types of commercially available antibiotic discs (Mast diagnostics Mersey side, UK) were used. The antibiotic resistance was determined by Kirby-Bauer agar disc-diffusion technique using Mueller-Hinton agar (Difco), according to the guidelines of Clinical and Laboratory Standards Institute (CLSI, 2007). After overnight incubation at 37 °C, the

diameter (millimeters) of the zones of bacterial growth inhibition around each of the antimicrobial discs was recorded and categorized as resistant, intermediate and sensitive in accordance with company recommendations (Cappuccino and Carpenter, 2005).

3. Results and Discussion

3.1. Determination of microbial load of tested RTE food samples by total viable count (TVC)

TVC in burger ranged from 4.7×10^3 to 1.6×10^4, in fuchka ranged from 4.7×10^3 to 2.5×10^4, in fried rice ranged from 4.7×10^3 to 1.5×10^4 and in chicken grill ranged from 4.9×10^3 to 1.6×10^4. The highest numbers of bacterial colonies were observed in chicken grill sample (4.9×10^3 CFU/g) followed by fried rice sample (4.7×10^3 CFU/g), fuchka sample (4.5×10^3CFU/g), and burger sample (4.2×10^3 CFU/g) (Table 2). The study of Khalif *et al*. (2018) found 6.3×10^7 CFU/g to 9.7×10^5 CFU/g of TVC in fuchka from Dinajpur district, which is found relevant with this current finding. While another study found TVC in chotpoti ranged between 6.4×10^7 CFU/g to 9.6×10^5 CFU/g from Khulna city (Paul *et al*., 2018).

Table 2. Microbial load by total viable count (TVC).

Sl. No.	Burger (CFU/g)		Fuckha (CFU/g)		Fried rice (CFU/g)		Chicken grill (CFU/g)	
1	2.1×10^3	1.9×10^4	3.4×10^3	2.9×10^4	TFTC	TFTC	TFTC	TFTC
2	TFTC	TFTC	TFTC	TFTC	4.7×10^3	3.7×10^4	2.9×10^3	1.6×10^4
3	TFTC	TFTC	4.2×10^3	3.8×10^4	TFTC	TFTC	TFTC	TFTC
4	2.8×10^3	1.7×10^4	TFTC	TFTC	TFTC	TFTC	4.9×10^3	3.1×10^4
5	TFTC	TFTC	TFTC	TFTC	3.2×10^3	2.2×10^4	TFTC	TFTC
6	3.5×10^3	2.9×10^4	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC
7	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC
8	TFTC	TFTC	3.1×10^3	2.6×10^4	TFTC	TFTC	4.5×10^3	3.9×10^4
9	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC
10	2.7×10^3	1.6×10^4	TFTC	TFTC	TFTC	TFTC	TFTC	TFTC
11	TFTC	TFTC	TFTC	TFTC	2.5×10^3	1.6×10^4	TFTC	TFTC
12	TFTC	TFTC	TFTC	TFTC	3.9×10^3	2.4×10^4	3.2×10^3	2.1×10^4
13	TFTC	TFTC	4.4×10^3	3.2×10^4	TFTC	TFTC	TFTC	TFTC
14	4.2×10^3	2.5×10^4	TFTC	TFTC	2.1×10^3	1.5×10^4	TFTC	TFTC
15	TFTC	TFTC	4.5×10^3	2.5×10^4	TFTC	TFTC	3.6×10^3	2.5×10^4

Notes: RTE = Ready to eat, TFTC =Too few to count, CFU=Colony forming unit

3.2. Bacteriological investigation

A total of 60 different RTE food (burger, fried rice, chicken grill, and fuchka) samples were collected from different places under Sadar Upazila, Dinajpur for this study. Among 60 RTE foods samples, *E. coli, Salmonella* spp. and *Klebsiella* spp. of bacteria were isolated and identified. While the study of Hassan *et al*. (2016) found *Acinetobacter*, *Klebsiella* spp., *E. coli* and *Proteus* spp. in the food samples collected from Dhaka metropolitan area.

3.3. Prevalence of different bacteria isolated from RTE food samples

Three different genera of bacteria such as *Salmonella* spp., *Klebsiella* spp., and *Escherichia coli* were isolated from different RTE street food (fuchka, fried rice, chicken grill, and burger) samples. During the study period, a total 60 samples were collected from different RTE street foods. In case of burger, three (20%) positive for *Escherichia coli*, and two (13.33%) positive for *Klebsiella* spp. In case of fuchka, two (13.33%) positive for *Salmonella* spp., in case of fried rice, two (20%) positive for *Salmonella* spp. In case of chicken grill, two (13.33 %) positive for *Salmonella* spp., and 3 (20%) were positive for *Escherichia coli*. In 60 RTE food samples, *Salmonella* spp. was found to be the highest 3 (20%) in fried rice and lowest 2 (13.33 %) in chicken grill and fuchka samples, then another organism *E. coli* was found to be the same prevalence 3 (20%) in burger and chicken grill samples. *Klebsiella* spp. was found prevalent 2 (13.33%) only in burger samples (Table 3). The overall prevalence of bacteria was found 25 % out of 60 collected RTE food samples. A study from Dhaka

metropolitan area isolated bacteria and 78% of food samples were contaminated with microbes while 66% were contaminated with *Acinetobacter*, 54% were contaminated by *Klebsiella* spp. and 2.8% of foods were contaminated with *E. coli* (Hassan *et al*., 2016).

Table 3. Summary of isolation of bacteria from ready to eat foods.

Name of RTE foods	Number of RTE foods	Bacterial isolates	Number of culture positive samples	Positive percentage (%)	Overall prevalence of isolated bacteria (%)
Burger	15	*E. coli*	3	20	
		Klebsiella spp.	2	13.33	
Fuchka	15	*Salmonella* spp.	2	13.33	
Fried rice	15	*Salmonella* spp.	3	20	25
Chicken grill	15	*Salmonella* spp.	2	13.33	
		E. coli	3	20	
Total Sample = 60			15	100	

3.4. Cultural characteristics of the isolated bacteria

Cultural characteristics of each type of bacteria isolated from different RTE food samples were studied for the determination of size, shape and colony morphology on different bacteriological culture media. The pure cultures of the organism from each mixed culture were obtained by repeated streak plate method using different simple and selective solid media for study (Table 4). Similar observations were reported by Khalif *et al.* (2018) from Dinajpur and Paul *et al*. (2018) from Khulna city.

Table 4. Cultural characteristics of the bacterial isolates from different ready to eat foods.

Name of the culture media	Cultural properties	Remarks
NA	1. Large mucoid, white colony.	*E. coli*
MAC	2. Produced large mucoid rose pink color colonies.	
EMB	3. Mucoid, no metallic sheen with transmitted light, grey brown and pink color with clear edge.	
NA	1. Large mucoid, white colony.	*Klebsiella* spp.
MAC	2. Produced large mucoid, rose pink colony.	
EMB	3. Mucoid no metallic sheen with transmitted light, grey brown and pink color with clear edge.	
NA	1. Large mucoid white colonies.	*Salmonella* spp.
MAC	2. Colorless, smooth, transparent, raised colonies.	
EMB	3. Pale pink color colonies.	
SS	4. Translucent, smooth small round black centered colonies.	
BGA	5. Pale pink color colonies against a red background.	
MSA	6. No growth.	
XLD	7. Pink color colony with black center.	

Note: NA= Nutrient agar media, MAC= MacConkey agar media, EMB= Eosin methylene blue, BGA= Brilliant green agar, SS = Salmonella Shigella, MSA = Mannitol salt agar, XLD= Xylose lysine deoxycholate agar.

3.5. Staining characteristics of the isolated bacteria

Isolated *E. coli* revealed gram negative, pink colored, short rod shaped organisms arranged singly, paired or in short chain form; *Salmonella* spp. isolates revealed gram negative, small rod shaped organisms arranged singly or paired in arrangement; and *Klebsiella* spp. isolates revealed gram negative, small rod shaped organisms arranged singly, paired or in short chain form (Table 5). Similar observations were reported by Khalif *et al.* (2018) from Dinajpur and Paul *et al*. (2018) from Khulna city.

Table 5. Morphological and staining characteristics of the bacterial isolates from RTE food samples.

Staining	Morphology characteristics	Result	Remarks
Gram staining and viewed under Microscope	Single, paired or in short chain	(-) ve	*E. coli*
Gram staining and viewed under Microscope	Pink color short rod shaped singly or paired arranged or short chain	(-) ve	*Salmonella* spp.
Gram staining and viewed under Microscope	Pink colored, small rod shaped organisms arranged in single, pairs or short chain.	(-) ve	*Klebsiella* spp.

3.6. Biochemical characteristics of the isolated bacteria

Isolated *E. coli* and *Salmonella* spp. were positive and *Klebsiella* spp. was negative for methyl red test. All isolates were positive for catalase test with gas bubble formation. All isolates were negative for oxidase test with no color change. *E. coli* and *Salmonella* spp. were negative and *Klebsiella* spp. was found positive for voges-proskauer test. Indole test were also positive (presence of a cherry red colored ring on the surface of the media) for *E. coli* whereas negative (absence of a cherry red colored ring on the surface of the media) for *Salmonella* and *Klebsiella* spp. Simmons citrate agar test was negative (no color change of the medium) for *E. coli* and positive (formation of Prussian blue color on the slant) for *Salmonella* spp. *and Klebsiella* spp. MIU test were positive (Diffuse, hazy growth, slightly opaque media) for *E. coli, Salmonella* spp. and negative (no color change) for *Klebsiella* spp. TSI agar slant reactions showed yellow color slant and butt for *E. coli*, red color slant and yellow butt for *Salmonella* spp., and yellow color slant and butt for the isolated *Klebsiella* spp. The H_2S formation presented by *Salmonella* spp. and absence of H_2S in case of *E. coli* and *Klebseilla* spp. (Table 6). Similar observations were reported by Khalif *et al.* (2018) from Dinajpur city.

Table 6. Biochemical characteristics of the isolated *E. coli, Salmonella* spp., and *Klebsiella* spp.

SL. No.	Cata	Oxi	Ind	Cit	MR	VP	MIU	TSI	Identification
1	+	–	+	–	+	–	+	Yellow slant, Yellow butt, Gas= (+) ve H_2S= (-) ve	*E. coli*
2	+	–	–	+	+	–	+	Red slant, Yellow butt, Gas= (-) ve H_2S= (+) ve	*Salmonella* spp.
3	+	–	–	+	–	+	-	Yellow slant, Yellow butt, Gas= (+) ve H_2S= (-) ve	*Klebsiella* spp.

Notes: SL No. = Serial Number, Cata= Catalase test, Oxi= Oxidase test, Ind= Indole test, Cit= Citrate Utilization test, MR= Methyl red, VP = Voges-proskauer, TSI = Triple Sugar Iron, MIU=Motility, Indole and Urease test, (+) = Positive, (-) = Negative.

3.7. Antibiogram profiles of the bacterial isolates

A total of three isolates such an *E. coli, Salmonella* spp. and *Klebsiella* spp. were subjected to antibiotic sensitivity assay (Tables 7, 8 and 9). Antibiotic sensitivity test showed that the isolated *Klebsiella* spp., *Salmonella* spp. and *E. coli* were found sensitive to Streptomycin, Gentamicin, Tetracycline, and Neomycin. All of the isolates were found resistant to Vancomycin, Penicillin, Erythromycin, Amoxicillin, and Ampicillin. *E. coli* isolates were found to be intermediate sensitive to Azithromycin whereas *Salmonella* spp. and *Klebsiella* spp. isolates were found sensitive and resistant to Azithromycin respectively. The study of Khalif *et al.* (2018) from Dinajpur city showed the antimicrobial profile of *Klebsiella* spp., *Staphylococcus* spp., *Shigella* spp., *Salmonella* spp. and *E. coli*; while some of the bacteria showed resistance to most of the antibiotics and some were sensitive.

Table 7. Antimicrobial profile of *E. coli.*

Organisms	Name of the antibiotics	Zone of inhibition (mm)	Interpretation
E. coli	Vancomycin (VA)	1 mm	R
	Streptomycin (S)	18 mm	S
	Azithromycin (AZM)	17 mm	I
	Penicillin (P)	0 mm	R
	Gentamicin (GEN)	21 mm	S
	Tetracycline (TE)	23 mm	S
	Erythromycin (E)	0 mm	R
	Neomycin (N)	21 mm	S
	Amoxicillin (AMX)	0 mm	R
	Ampicillin (AMP)	0 mm	R

Note: R= Resistance, S= Sensitive, I = Intermediate

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Table 8. Antimicrobial profile of *Salmonella* spp.

Organism	Name of the antibiotics	Zone of inhibition (mm)	Interpretation
Salmonella spp.	Vancomycin (VA)	1 mm	R
	Streptomycin (S)	22 mm	S
	Azithromycin (AZM)	25 mm	S
	Penicillin (P)	0 mm	R
	Gentamicin (GEN)	29 mm	S
	Tetracycline (TE)	19 mm	S
	Erythromycin (E)	1 mm	R
	Neomycin (N)	24 mm	S
	Amoxicillin (AMX)	1 mm	R
	Ampicillin (AMP)	1 mm	R

Note: R= Resistance, S= Sensitive, I = Intermediate

Table 9. Antimicrobial profile of *Klebsiella* spp.

Organism	Name of the antibiotics	Zone of inhibition (mm)	Interpretation
Klebsiella spp.	Vancomycin (VA)	0 mm	R
	Streptomycin (S)	18 mm	S
	Azithromycin (AZM)	15 mm	R
	Penicillin (P)	0 mm	R
	Gentamicin (GEN)	22 mm	S
	Tetracycline (TE)	17 mm	S
	Erythromycin (E)	2 mm	R
	Neomycin (N)	20 mm	S
	Amoxicillin (AMX)	1 mm	R
	Ampicillin (AMP)	0 mm	R

Note: R= Resistance, S= Sensitive, I = Intermediate

5. Conclusions

The findings of this study indicated that contaminated RTE foods with multidrug-resistant bacteria collected from street food serving cafeterias and local small-scale food vendors present health risks to the consumers. Also, there is a high chance that the multidrug-resistant genes from one bacterium could horizontally transfer to another among the Enterobacteriaceae family with the help of plasmids and thereby, transferring antimicrobial resistance leading to difficulties in selecting and using appropriate therapeutic treatments. Hence, appropriate

measures should be taken for controlling the dissemination of these resistant genes by planning and following proper antibiotic stewardship regimes in the community. This study's insights and future extensions also call for harmonizing food safety practices and training for street food establishments on a continuous basis with oversight from local municipalities regulating these food service enterprises. Future studies with a more significant number of samples from a wide selected geographical area will provide more comprehensive information on contamination of RTE street foods by multidrug-resistant bacteria.

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Data availability
The data presented in this study are contained in this manuscript.

Conflict of interest
None to declare.

Authors' contribution
Conceptualization: Md. Fakhruzzaman; methodology: Tania Aktar; writing: original draft preparation: Tania Aktar; writing—review and editing: Md. Fakhruzzaman, Md. Tazul Islam Sarker. All authors have read and approved the final manuscript.

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