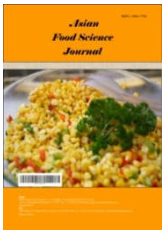

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Identification of Coliform in Common Street Food and Associated Factors of Contamination in Noakhali, Bangladesh: A Cross-sectional Study

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Authors' contributions

This work was carried out in collaboration among all authors. Author SG has designed the study and contributed to analysis of result and the writing of the manuscript. Authors NN, MFH, MMR and FA contributed in data collection and the laboratory work. They also contributed on writing of the manuscript as well. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of this study was to find out the quality of street food as means of total coliform count and identify the relationship with the personal hygiene of the food vendors during cooking, processing, and serving of these foods as well.
Study Design: It is a cross-sectional study of nature.
Place and Duration of Study: The study was conducted in the Department of Food Technology and Nutrition Science, Noakhali Science and Technology University, from October 2019 to February 2020.
Methodology: A cross-sectional study was conducted with a pretested structured questionnaire by convenient sampling method. Apart from data collection from 40 street vendors, nine types of street food were selected for analysis from those vendors, and a total of 40 samples were collected for a laboratory test. Most Probable Number (MPN) method was used for the determination of total coliform count.

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Findings: From the study, it was found that about 70% of food samples had a satisfactory level of coliform count (total coliform < 100 per gm). The study also identified that people aged 25 to 35 years had a greater satisfactory bacterial level (84.6%) in the foods, they sold due to incognizance about hygiene, significant relation between the timing of business and the bacterial count (p=0.049) was also reported in the present study.
Conclusion: The present study was conducted to identify the quality of street food and the hygiene behaviors of the food vendors and the paper find out the need of proper education and training might be a compatible way to enhance the quality of street foods as well as to ensure a healthy lifestyle for the consumers.

Keywords: Street foods; vendors; Bangladesh; MPN method; personal hygiene.

1. INTRODUCTION

Street food are foods and beverages prepared and/or sold by vendors in street and other public places for immediate consumption or consumption at the later time without further processing or preparation [1]. It may be consumed where it was purchased or can be taken away and eaten elsewhere. Street-vended foods include foods as diverse as meat, fish, fruits, vegetables, grains, and cereals based ready to eat foods, frozen produce and beverages [2].

In developing countries, various kinds of street food are available and sold by the street vendors which are widely consumed by millions of people. These are available in metropolitan and other cities of Bangladesh [3] Street vended foods are becoming popular among urban people as they are inexpensive, convenient and attractive among all ages of people [4]. Poor hygienic conditions during food preparation and the lack of awareness about food safety are possibly the most common causes of foodborne illness. A high number of foods sold in our communities are contaminated to a large extent with pathogenic microorganisms such as coliforms. Foods sold near polluted environments are prone to contamination by pathogenic microorganisms [5] and water is a good source of contamination.

The microbiological quality of street vended food is an important concern for current situation as many people with all ages consume these street foods. The microbiological contamination this food is a significant contributor to food borne disease [4]. The incidence of foodborne illness is increasing worldwide, and bacterial contamination of the food and beverages vended by street vendors around the school and roadside might be a common occurrence in Bangladesh, although the exact level of contamination is not properly known [4]. High counts of Escherichia coli and total coliform (TC) in foods usually indicates lack of hygiene in handling and production operations, inadequate storage and post process contamination [6]. Therefore, E. coli and TC enumeration are used as a food-quality parameter. Mostly mesophilic bacteria are common in the food and several studies have demonstrated high count of coliforms and aerobic mesophilic in foods collected from street vendors [7].

School going children, regular consumers of these certain street vended foods are at particular risk in relation to most foodborne disease [4]. Street foods contribute significantly to the diet of many people in a developing country. The global incidence of food borne disease is difficult to estimate, but it has been reported that in 2005 alone 1.8 million people died from diarrheal disease [2]. Studying the quality of street foods, hygiene practice of the street food vendors has paramount importance to understand the public health importance of street vended foods. Thus, the study is conducted to identify the quality of street foods by coliform count and also the association with the personal hygiene of the food vendors during cooking, processing, and serving of these foods as well.

In developing countries like Bangladesh, there are serious concerns about the sanitation of street foods, particularly as potable water is available at food preparation and most food handlers lack basic knowledge of proper personal and environmental hygiene [8]. Regarding this issue, the study's aim was to find out the coliform count and identify the association between the quality and the personal hygiene of the vendors in Noakhali, Bangladesh.

2. MATERIALS AND METHODS

2.1 Study Location and Sampling

For the present study, we defined 'street food vendors' as the persons who vended a variety of

local food items among the children, adolescent, adult during school hours at the school entry, or at the side of outer school-wall, or on the streets around the school, or at the side of market, or before/after shopping within approximately 50 m of distance from the school entry or outer school-wall of any primary or high school or market within Maijdee, Noakhali. Several zones of Maijdee, Noakhali and its outskirts were selected for the study ensuring representation of street vendors. A total of 40 food samples from forty street food vendors (i.e. one food sample from each selected food vendor) were collected for laboratory analysis. We selected those food vendors who were available within surrounding areas or streets of the pre-selected schools, or market during the study period, gave informed consent for interviewing them, and agreed to provide food samples for laboratory analysis. Due to logistic constraints, a non-probability convenience sampling technique was applied for the selection of area and area-based street food vendors, and for the collection of food samples from these vendors.

2.2 Questionnaire for Face to Face Interviews

We conducted face to face interviews with the area-based street food vendors employing a pre-tested questionnaire [9]. The duration of each interview was approximately 20 min. We performed pretested questionnaire with 40 street food vendors. A two-page structured questionnaire consisting of 36 closed and open-ended questions were finalized after a required modification. The variables included in the questionnaire were general characteristics of street food vending such as the location of food vending, type of food item vended, number of customer per day and duration of food vending around the school, and the socio-demographic profile of the street food vendors such as sex, age, educational status, income, and health status.

2.3 Sample Collection

There are several varieties of street foods (such as-chotpoti, fuchka, beguni, vapa pitha, peyaju, jhal-muri, pickles, fried peas, chanachur, and halim). At least 3 samples of each type and total 40 samples were collected for laboratory tests. The samples were collected in sterile containers from the different vendors of different places of Noakhali.

2.4 Sample Processing

The samples were in semi-solid, or semi-liquid, or dry form, so further processing was required. 10 g of sample was taken and transferred into sterilized cotton plugged test tubes containing 90 ml of distilled water. Then they were mixed thoroughly by shaking.

2.5 Bacteriological Analysis

Most Probable Number (MPN) method was used for the determination of total viable count [10].

2.6 Biochemical Analysis

Three types of biochemical test were used to identify the types of bacteria. Morphological characteristics and Gram-negative bacteria were selected by Gram staining test [11]. KIA (Kligler's Iron Agar) [12] and MIU (Motility Indole Urea) Base media [13] were used apart from Gram staining.

2.7 Statistical Analysis

Data were analyses by using SPSS 23 and normal frequency distribution were performed for the demographic and socioeconomic factors and relationship with two variables were identified by performing chi-square test.

3. RESULTS AND DISCUSSION

3.1 Total Coliform Count

Foods that were carried to the laboratory were processed according to standard guidelines and then most probable number method (MPN) was applied to find out the total coliform count. About 70% of the samples were found to have lower coliform count (<100 per gram) that's satisfactory level and 30% have shown unsatisfactory level (total coliform > 100 per gm). List of MPN table for several food samples are given in Table 1 by following American Health Association, 1980 standard [14].

3.2 Morphological and Biochemical Test for Identification of Bacteria

After MPN method, we conducted Gram staining test. So that we can identify Gram positive bacteria and Gram-negative bacteria. The Gram-negative bacteria were found by using EMB (Eosin Methylene Blue) Agar for culture bacteria. Then we tested the KI agar and MIU base test.

Four types of bacteria were mainly found in the study. They are *Providencia, Salmonella paratyphi-A, Pseudomonas spp., Parahaemolyticus*.

In this study, we divided the street vendors into 4 age groups and the age range of the vendor was 10 years to 44 years. In educational qualification, we found that 62.5% had only formal and most of the vendors (72.5%) had a good health status during this study.

All vendors were classified into 3 types according to their vending technique, they were sheltered, temporarily sheltered, not sheltered vendors in this present study, it was found that the number of temporary sheltered vendors was highest (47.5%) and most of (77.5%) their time of business was between 8:0 am to 9:0 pm. In our study, we also found that about half of the time they have used the reused oil 1 to 3 times for frying. In terms of treating leftover food, we divided it into 3 types and the findings reported that half of the vendors stored the leftover food for next day use, 35% have consumed by themselves, and the rest of them throw away the leftover food.

Table 1. **Description of local food items vended to school children by school and market-based street food vendors, Noakhali, Bangladesh, 2019

Food name	Brief description	Key ingredients	Method of cooking	Method of serving	Sources of contamination
Chotpoti	This is quick street food and one of the main populars hot and sour snacks among the urban people in Bangladesh	Water, white pea, chickpea, local chotpoti mix spices, salt, onion, green chili, potato, egg, coriander bay leaf, cucumber, tomato.	Soaking overnight and boiling	Served with a spoon in a reusable plate	Utensils, water, cut pieces of onion, green chili, and coriander bay leaves
Fuchka	This is another quick street food and one of the main popular hot and sour snacks among the urban people in Bangladesh	Flour, semolina, star thorn, oil for fuchka portion and Water, white pea, chickpea, local chotpoti mix spices, salt, onion, green chili, potato, egg, coriander bay leaf, cucumber, tomato for filling portion of fuchka.	Soaking overnight and Boiling for filling and frying	Served with a spoon in a reusable plate	Utensils, water, cut pieces of onion, green chili, and coriander bay leaves
Vajavuji (Piaju/ Beguni)	Piaju (onion lentil fritter) and beguni (fried eggplant/brinjalslice) are snacks of great demand in Bangladesh and liked by people of all ages.	Several types of pulse, onion, green chili, oil/Pea-flour, water, several species, salt, onion, green chili, eggplant	Mashing followed by deep frying in soybean oil	Served with a reusable plate or sometimes in unusable paper or old newspaper	Spoon, hand, pieces of newspaper, old book paper
Fried peas	Another street food consumed by all age group of people	Fried peas with some salt	Frying with sand	Served in a paper bag called thonga	Spoon, hand, pieces of newspaper, old book paper
Chanachur	This is a popular	Pea flour, water,	No cooking,	Served	Spoon, hand,

Food name	Brief description	Key ingredients	Method of cooking	Method of serving	Sources of contamination
	street food item in Bangladesh, basically a mixture of chanachur, raw onion, green chili, cucumber and tomatoes.	salt, and species	mixing Chanachur with mustard oil and all other ingredients	with reusable plate or sometimes in unusable paper or old newspaper	pieces of newspaper, old book paper, cut pieces of onion and green chili
Vapa-pitha (Rice cake with sweet like molasses)	This is a traditional food in Bangladesh and now also found in street, mainly made with rice powder, molasses, and sometimes flesh of the coconut was used to improve its taste.	Rice flour, water, coconut, and jaggery/molasses.	Mixing all ingredients step by step by making a mould and then cook with steam.	Served with a reusable plate or sometimes in unusable paper or old newspaper	Spoon, hand, pieces of newspaper, old book paper
Halim	One of the popular street foods in Bangladesh	Several pulses, local halim mix spices, water, onion, green chili, meat (beef/mutton/chicken)	Cooking of the pulse with all ingredients and then mix with raw coriander leaf, sliced onion, and green chili and meat	Served with a spoon in a reusable plate	Spoon, hand, pieces of newspaper, old book paper, cut pieces of onion and green chili
Achar (Pickle)	These are sweet, sour, and spicy pickled vegetables and green fruits; very popular food item among the school children in Bangladesh.	Raw (seasoned fruits and spices), uncooked (fruit heated then mix with species, oil, and vinegar)	Boiling followed by drying, preserved in mustard oil	Served with spoon/hand on pieces of newspaper or old book paper	Spoon, hand, pieces of newspaper, old book paper

***Adapted with permission. Source: (4)*

3.3 Personal and Food Hygiene Maintenance

The study found that none of the street vendors have wear an apron during their business or cooking of the food. Also, we have found 87.5% street food vendors did not have clean fingernails. Regarding quality and hygiene maintenance of the food, it was found that 85% of the food exposed to flies. When serving food, 35% of the time, they have used cup or plate. Most of the time about 85% of the time they have been using tube well water and only 2% of the time used tap water for cooking and washing of the utensils. About 37.5% of the time they wash the serving utensils with soap water and 32.5% time they dried it only with a cloth. Most of the vendors (60%) have used a hand towel to wash their hands. 40% of the respondents did not cover their food while covered by plastic, and lid was accordingly 27.5% and 32.5%. 70% of the time insect droppings and dirt from equipment's were found. Finally, the study reported that most of the time (67.5%) of foodstuffs was washed before cooking.

Table 2. MPN table for coliform count

Serial No	Sample name	MPN (g/ml)	Serial No	Sample name	MPN (g/ml)
01	FU1	14	21	VPGS3	20
02	ChU1	17	22	ChHP3	12
03	PU1	54	23	JMHP3	17
04	JMU1	12	24	FM3	110
05	PeBM1	17	25	HSup3	58
06	ChaBM1	6.1	26	PiHR3	150
07	PiHR1	280	27	PiP4	120
08	BeHR1	26	28	PPB3	84
09	HDH1	280	29	BeBM3	220
10	HPB2	14	30	PHP4	69
11	PiS2	6.8	31	HM3	170
12	BeS2	14	32	ChPB4	81
13	FM2	39	33	HSup4	26
14	JMSup2	20	34	FBM4	130
15	VPU1	31	35	JMHR4	110
16	ChaM2	14	36	ChaHR4	120
17	VPM2	45	37	JMHR4	14
18	PM2	45	38	ChaSup5	140
19	ChGS2	28	39	PeU2	130
20	ChaGS3	37	40	VPU4	20

***Food: F=fuchka, Ch=Chotpoti, JM=Jhalmuri, Cha=Chanachur, Be=Beguni, H=Halim, VP=Vapapitha, P=Pickles, Pe=Peas, Pi=Piaju*

Location: U=University, BM=Boro-masjid, HR=Hospital road, DH=Dotter haat, PB=Pouro bajar, S=Sonapur, M=Maizdee, Sup=Supermarket, GS=Noakhali Girls school, HP=Horinarayanpur high school

Table 3. Categorization of bacterial count

Category	Frequency	Percentage
Satisfactory (total coliform < 100 per gm)	28	70
Unsatisfactory (total coliform > 100 per gm)	12	30

A correlation was found between the timing of business and coliform count (p =0.049). In this study, we found that the maximum (77.4%) food vendor's timing of business was between 8:00 am to 9:00 pm. In terms of cooking, we have found that about 77.3% of the time the food was cooked before the sale.

The present study was conducted to identify the microbial quality of school and market-based street foods regarding coliform count in Noakhali, Bangladesh.

The study found that only 30% of the tested street food sample had unsatisfactory level (total coliform > 100 per gm), while the remaining 70% samples were in satisfactory level (total coliform < 100 per gm), which is comparable to the study conducted in Dhaka, Bangladesh [4]. In our analysis, we found that 17.5% of vendor's age was 10-25 years which is comparable to the findings of a study done in Owerri, Nigeria where it is mentioned that 14.29% vendor's age was 10-25 years [15]. It was reported that people aged 25 to 35 years was greater satisfactory bacterial level in their foods (84.6%) and unsatisfactory bacterial level was greater in 10 to 25 years aged people (42.9%) because of their incognizance in hygiene. In this study, we also found that 37.5 % had no formal education and 62.5% had formal education which was also like the study done in Owerri, Nigeria where the education qualifications for non-formal and formal educational percentages were14.29 and 85.71percent respectively [15].

Hygiene practices were better among formally educated vendors even the satisfactory bacterial count percentage was good in formally educated vendors (76%) than non-formally educated vendors (60%). We also found that 87.5% of vendors did not clean their nails but in a study

done in Nigeria, there only 9.52% of vendors had longer nails which were very high in the present study [15]. We found that 85% of foods were exposed to flies which is comparable to the study of Benin City where authors found only 27.7% foods were exposed to flies [16], for that reason we found bacteria *Providencia spp*. in most of our samples after biochemical identification. In our study, we also found that no street vendors used any apron during sale and cooking but in the study of Gauteng, 60.5% vendors used full apron [17] that was very good for maintain the personal hygiene as well as the food hygiene. We found, 72.5% of vendors were in good health status even no one had any sore in their hand which is comparable to the study of Gauteng where they found 98.5% hands of vendors free of sores [17]. We also found that below half of the vendors (37.5%) were used soap as a method of cleaning utensils and only 10% of vendors were used hot water in it that can be one of the vital sources of microbiological contamination as well as good coliform count [18]. Our laboratory analysis showed the presence of unsatisfactory coliform count mostly in cooked food items than uncooked foods. Only 12% of vendors washed their hands by soap and 60% of vendors washed their hand by hand towel. Cleaning hand after work or touching any equipment is a very much necessary because of the organisms such as Salmonella typhi, non-typhi *Salomnella, Compylobacter spp. and E. coli* can survive on fingers tips and other surfaces for varying periods of time and some cases after handwashing [19].

Table 4. Frequency distribution of the demographic characteristics of the street vendor

Characteristics	Frequency (N)	Percentage (%)
Age		
10-25 years	7	17.5
25-34 years	13	32.5
35-44 years	12	30.0
>44 years	8	20.0
Educational Qualification		
No formal education	15	37.5
Formal education	25	62.5
Health Status		
Good	29	72.5
Moderate	7	17.5
Poor	4	10.0
Type of Vendor		
Sheltered	8	20
Temporary sheltered	19	47.5
Not sheltered	13	32.5
Timing of Business		
8am-1pm	2	5.0
1pm-4pm	1	2.5
4pm-9pm	6	15.0
8am-9pm	31	77.5
Reused oil for frying		
1-3 times	20	50.0
3-5 times	2	5.0
More than 5 times	7	17.5
Handling of leftover food		
Consumed	14	35.0
Stored for use next day	20	50.0
Throw away	6	15.0

Table 5. Personal hygiene information of street vendors and correlation of personal hygiene with laboratory bacterial count

Characteristics	Frequency (%)	Satisfactory (%) (>100 coliform per 100 ml)	Unsatisfactory (%) (<100 coliform per 100 ml)	P-value
Does he/she use apron?				
Yes	0(0.0)	0(0.0)	0(0.0)	NA
No	40(100.0)	28(70.0)	12(30.0)	
Does he/she use gloves?				
Yes	0(0.0)	0(0.0)	0(0.0)	NA
No	40(100.0)	28(70.0)	12(30.0)	
Does he/she cover hair?				
Yes	1(2.5)	1(100)	0(0.0)	0.507
No	39(97.5)	27(69.2)	12(30.8)	
Neat/clean fingernails?				
Yes	5(12.5)	4(80)	1(20)	0.602
No	35(87.5)	24(68.6)	11(31.4)	
Do you chewing/talking while serving?				
Yes	34(85)	23(67.6)	11(32.4)	0.440
No	6(15)	5(83.3)	1(16.7)	
Is food exposed to flies?				
Yes	34(85)	23(67.6)	11(32.4)	0.440
No	6(15)	5(83.3)	1(16.7)	
Food served with				
Spoon/fork	7(17.5)	7(100)	0(0.0)	0.137
Cup/Plate	14(35)	10(71.4)	4(28.6)	
Bare hands	12(30)	8(66.7)	4(33.3)	
Both cup and plate	7(17.5)	3(42.9)	4(57.1)	
From where water is collected?				
Tap	1(2.5)	1(100)	0(0.0)	0.799
Tube-well	24(60)	19(79.2)	5(20.8)	
Municipal	9(22.5)	6(66.7)	3(33.3)	
Pond	3(7.5)	2(66.7)	1(33.3)	
Which method is used in cleaning utensils?				
Washing with soap	15(37.5)	10(66.7)	5(33.3)	0.904
Washing with hot water	4(10)	3(75)	1(25)	
Drying with cloths	13(32.5)	9(69.2)	4(30.8)	
Washing with water	2(5)	2(100)	0(0.0)	
Both washing with water and drying with cloths	4(10)	3(75)	1(25)	
Hand washing requirements?				
Soap	5(12.5)	3(60)	2(40)	0.781
Water	9(22.5)	7(77.8)	2(22.2)	
Hand towel	24(60)	17(70.8)	7(29.2)	
How does he/she cover the food?				
Plastics	11(27.5)	8(72.7)	3(27.3)	0.973
Lid	13(32.5)	9(69.2)	4(30.8)	

Characteristics	Frequency (%)	Satisfactory (%) (>100 coliform per 100 ml)	Unsatisfactory (%) (<100 coliform per 100 ml)	P-value
No cover	16(40)	11(68.8)	5(31.2)	
Are there any insect droppings and dirt from equipment?				
Yes	28(70)	20(71.4)	8(28.6)	0.635
No	11(27.5)	7(63.6)	4(36.4)	
Do you wash foodstuffs before cooking?				
Yes	27(67.5)	20(74.1)	7(25.9)	0.326
No	12(30)	7(58.3)	6(41.7)	

**p=0.05*
***NA: Not Applicable*

Table 6. Correlation of educational qualifications of vendors, cooking time and type of food with laboratory coliform count

	Satisfactory (total coliform < 100 per gm)	Unsatisfactory (total coliform > 100 per gm)	P value
Educational Qualification	9(60%)	6(40%)	0.311
No formal education	19(76%)	6(24%)	
Formal education			
When food is cooked?			
During sale	11(61.1%)	7(38.9%)	0.315
Before sale	17(77.3%)	5(22.3%)	
Type of food			
Cooked	25(67.6%)	12(32.4%)	0.541
Uncooked	3(100%)	0(0%)	
Timing of business			
8am-1pm	0(0.0%)	2(100%)	
1pm-4pm	0(0.0%)	1(100%)	0.049*
4pm-9pm	4(66.7%)	2(33.3%)	
8am-9pm	24(77.4%)	7(22.6%)	
Type of vendors			
Sheltered	7(87.5%)	1(12.5%)	0.442
Temporary sheltered	13(68.4%)	6(31.6%)	
Not sheltered	8(61.5%)	5(38.5%)	
Age			
10-25 years	4(57.1%)	3(42.9%)	0.542
25-34 years	11(84.6%)	2(15.4%)	
35-44 years	8(66.7%)	4(33.3%)	
>44 years	5(62.5%)	3(37.5%)	

**p=0.05*

About 35% left-over foods were consumed by the vendors themselves, in whereas 50% left-over foods were stored for next day and 15% left-over foods were thrown away that is comparable with the study of Atbara city, Sudan where they found that 30% left-over foods were thrown away, 22% left-over foods were consumed and only 2% left-over foods were stored in the refrigerator [20].

In our study, we also found that 30% of vendors served the foods bare hand which was higher in the study conducted in Atbara city, where they found this percentage was about 60% that was almost double from our study [20]. We also found that only 2.5% of vendors used tap water as the source of washing and cooking but in Atbara city, 60% vendors used tap water as the source of washing and cooking [20].

4. CONCLUSION

The most effective finding of this study was the socio-economic results regarding the hygiene practices of street vendors supported the findings of the microbiological analysis. Coliforms are being used traditionally as indicator organism to assess the overall quality of foods and the hygiene conditions present during food processing. The criteria and standard for a suitable number of coliforms in food depend on

food products, educations of vendors, age of vendors and proper hygiene practices. Relevant national, and international authorities should be concerned about this matter and formulate effective rules, laws, and guidelines for training street food vendors in our country and to bring all street food vendors under coverage of these regulations as early as possible. The authority of Noakhali region should also be concerned about the street food vendors and take the necessary step to train them in the proper way to ensure the well-being of mass people.

CONSENT

All authors declare that 'written informed consent was obtained from the vendor for publication of this case report and accompanying images.

ETHICAL APPROVAL

Ethical permission was taken from the ethical board of Noakhali Science and Technology University.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO. Regional consultation on safe street foods. WHO Regional Office for South-East Asia; 2012.
2. Adimasu A, Mekonnen B, Guadu T, Gizaw Z, Adane T. Bacteriological quality assessment of selected street foods and their public health importance in Gondar town, North West Ethiopia. Global Veterinaria. 2016;17(3):255-64.
3. Khan MM, Islam MT, Chowdhury MMH, Alim SR. Assessment of microbiological quality of some drinks sold in the streets of Dhaka University Campus in Bangladesh. International Journal of Food Contamination. 2015;2(1):4.
4. Al Mamun M, Rahman SMM, Turin TC. Microbiological quality of selected street food items vended by school-based street food vendors in Dhaka, Bangladesh. International Journal of Food Microbiology. 2013;166(3):413-8.
5. Bukar A, Uba A, Oyeyi T. Occurrence of some enteropathogenic bacteria in some minimally and fully processed ready-to-eat foods in Kano metropolis, Nigeria. African Journal of Food Science. 2010; 4(2):32-6.
6. González R, Tamagnini L, Olmos P, De Sousa G. Evaluation of a chromogenic medium for total coliforms and *Escherichia coli* determination in ready-to-eat foods. Food Microbiology. 2003;20(5):601-4.
7. HBNY. Eating to live or eating to damage one's health: Microbiological risks associated with street-vended foods in a subtropical urban setting (Yaoundé-Cameroon); 2018.
8. Rane S. Street vended food in developing world: hazard analyses. Indian Journal of Microbiology. 2011;51(1): 100-6.
9. Mensah JO. Constraints to growth of street food enterprises in Ghana and effects of targeted business interventions on performance; 2016.
10. Feng P, Weagant SD, Grant MA, Burkhardt W, Shellfish M, Water B. BAM: Enumeration of *Escherichia coli* and the Coliform Bacteria. Bacteriological Analytical Manual. 2002;13.
11. Coico R. Gram staining. Current protocols in microbiology. 2006;1:A. 3C.1-A.3C.2.
12. Koneman EW, Allen SD, Janda W, Schreckenberger P, Winn W. Diagnostic microbiology. The nonfermentative gram-negative *Bacilli* Philedelphia: Lippincott-Raven Publishers. 1997;253-320.
13. Rahman MI, Hossain MK, Mst DB, Rumi NA, Fakhruzzaman M, Islam MR. Food Safety and Health; 2012.
14. Association APH. APHA standard methods for the examination of water and wastewater. Washington, DC: APHA; 1980.
15. Chukuezi CO. Food safety and hyienic practices of street food vendors in Owerri, Nigeria. Studies in Sociology of Science. 2010;1(1):50-7.
16. Okojie P, Isah E. Sanitary conditions of food vending sites and food handling practices of street food vendors in Benin City, Nigeria: Implication for food hygiene and safety. Journal of environmental and Public Health; 2014.
17. Martins J. Socio-economic and hygiene features of street food vending in Gauteng.

South African Journal of Clinical Nutrition. 2006;19(1):18-25.

18. Barro N, Bello AR, Savadogo A, Ouattara C, Iiboudo A, Traoré A. Hygienic status assessment of dish washing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso). African Journal of Biotechnology. 2006;5(11).

19. Pether J, Gilbert R. The survival of salmonellas on finger-tips and transfer of the organisms to foods. Epidemiology & Infection. 1971;69(4):673-81.

20. Abdalla M, Suliman S, Bakhiet A. Food safety knowledge and practices of street food vendors in Atbara City (Naher Elneel State Sudan). African Journal of Biotechnology. 2009;8(24).

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