



Bacterial Contaminants Associated with the Hands of Food Handlers at Ahmadu Bello University, Zaria

*¹Jimoh, O., ²Abdulkadir, M.I., ²Yusuf, T. I., ²Mohammed, B. I., ³Ige, O.T., ¹Ibrahim, M., ¹Oriya, A., ¹Yusuf S., ¹Idris M.S. and ⁴Ahmed S.A

¹Department of Medical Microbiology, Ahmadu Bello University, Zaria- Nigeria

² University Medical Centre, Ahmadu Bello University, Zaria - Nigeria

³Department of Medical Microbiology and Parasitology, Kaduna State, University, Kaduna - Nigeria

⁴ Department of Pathology, Ahmadu Bello University, Zaria-Nigeria/Federal Medical Centre, Abuja

Corresponding Author: drwritelanrej@yahoo.com; +2347038505938

Abstract

Food and water borne diseases are leading cause of morbidity and mortality in developing countries. This study identified bacterial agents contaminating the hands of food handlers at Ahmadu Bello University Zaria. A total of 205 food handlers were recruited, their hands were swabbed, processed to isolate and identify bacteria using standard microbiological techniques. Of the two hundred and five (205) participants, fifty-five (55) were positive for bacterial contamination (26.8%). Fifty-nine (59) different bacteria strains were isolated; *Staphylococcus aureus* was the commonest with the frequency of 29(49%). Other foodborne pathogens isolated were *Escherichia coli* 4(6.8%) and *Salmonella* subspecies IIIb 1(1.7%). It has been shown from this study that a significant proportion of food handlers' hands were contaminated with bacterial agents. Therefore, optimizing hand hygiene programme among food handlers will help to minimize food contamination.

Keywords: Hygiene, Food, contamination, Bacteria

INTRODUCTION

Food is the basic necessity of human life. For a healthy life, it is not only important to eat food but to eat quality and hygienic food. A food handler is a person who is directly involved in, cooking, serving food, touching food equipment and utensils or food environment or contact surfaces (Ifeadike *et al.*, 2014; Mohtaram *et al.*, 2017). For safe food consumption devoid of any form of contamination, a food handler must adhere strictly to proper hand and other food hygiene practices (Mushtaq, 2018).

The World Health Organization (WHO) estimated that up to 70% of the populations suffer from diarrheal diseases in developing countries, with an estimated 2 million deaths per year. These diseases are caused mostly by food-borne pathogens such as *Staphylococcus aureus*, *Salmonella* spp, *Escherichia coli*, *Shigella*, and other related intestinal parasites (Bafa *et al.*, 2019). Food and waterborne diarrheal diseases are leading causes of morbidity and mortality in developing countries accounting for an estimated 2.2

million death of adults and 3million children annually (Oladoyinbo *et al.*, 2015; WHO, 2015). Food-borne diseases do not only affect people's health and well-being but have economic consequences for individuals, families, communities, businesses, and countries (Omoleke, 2015; Umar *et al.*, 2018). Food may be contaminated by some pathogenic organisms such as *Salmonella* species, *Escherichia coli*, *Campylobacter* species, helminths and protozoa through contaminated hands (Lambrechts, 2014). Chronic asymptomatic carriers of *Salmonella* species perpetuate typhoid fever in the human-environment by intermittently shedding the organism into the environment and spread do occur faeco-orally (Gunn, 2014). Food vendors and processors may be important vehicles of infection transmission. Staphylococcal food poisoning is a global challenge due to food-borne pathogens, affected individuals that developed diarrhea which may be severe if early treatment is not instituted (Humodi *et al.*, 2010; Kadariya *et al.*, 2014).

Unhygienic food handlers remain the source of most reported food-borne outbreaks (Fiore, 2004; Asgharet al., 2006).

Microbial transmission occurs through food, water, nails, and fingers that are contaminated with faeces (Havelaar et al., 2015). Food handlers that are chronic carriers and excrete bacteria may contaminate foods. Beneath the fingernail is a habitat for spreading pathogenic bacteria because it is an area where people hardly concentrate when performing hand hygiene (Mengist et al., 2018).

Although, in Ahmadu Bello University food handlers are screened yearly for some food-borne pathogens, published research on the risk factors and bacterial contamination associated with the food handler's hand are scarce. This research aimed to contribute to the existing scarce information on bacterial contaminants associated with the hands of food handlers at Ahmadu Bello University, Zaria with the hope of promoting adequate and effective hand hygiene practices among food handlers in tertiary educational institutions.

MATERIALS AND METHODS

Study area

The study was conducted at Ahmadu Bello University Zaria, a tertiary educational institution in Northwestern Nigeria. The University is cosmopolitan that accommodates students from within and outside Nigeria. Its environment comprises different food vendors from different ethnic groups in Nigeria.

Data collection

A structured interviewer-administered questionnaire was used to obtain demographic details (age, sex, marital status, educational status, and duration of food handling time).

Specimens collection and processing

Palms and fingers of participants were swabbed with sterile swab stick that was moistened with sterile saline into the sterile container as inoculation was done within 1 hour of collection.

Bacteria Isolation and identification

The collected swabs were separately streaked on the prepared blood and McConkey agar plates and incubated at 37°C for 24 hours. Bacteria isolates were characterized using the colonies morphology, biochemical tests and gram staining technique. Gram-negative rods were identified by performing a series of biochemical tests such as Triple sugar iron agar (TSI), Urea, Citrate, Oxidase, and motility. Gram-positive cocci were also identified based on their Gram reaction, catalase, and coagulase

test results. Commercially available API Microbactkit (Oxoid) were used to further specify gram-negative bacilli.

Data analysis and Patient Confidentiality

Personal identifiers were removed from the study files that are accessible to non-study personnel. Data analysis was done using Statistical Package for Social Science version 20. Univariate and bivariate analyses were conducted. The chi-square, Fisher's exact test were used to assess the unadjusted significance of associations between categorical variables. A p-value of 0.05 or less was considered statistically significant.

RESULTS

Total of 205 food handlers with the mean age of 35.8 ± 13.9 years, and an age range of 17-72 years participated in the study. The majority of the participants, 166 (81%) were female, while 104 (50.7%) were within age group 26-50 years. Larger proportion of 106 (51.7%) were married with 26% among them without any formal education. Of these participants, a significant proportion of 99 (48.3%) were Hausa ethnic groups followed by a combination of other minority ethnic groups (Table 1).

The majority of the participants 162 (79%) were working as permanent staff/owners of the food outlet. Total of 69 (33.7%) participants were working for a period of 1-5 years while only 29 (14.1%) have been working for 10 years and above. Majority of the participants (189 "92.2%") used pipe-borne water for cooking while 136 (66.3%) of them use water closet as their toilet facility. Commonest vegetable consumed/handled by 68 (33.2%) participants was carrot. Majority 199 (97.1%) washes the carrot before being handled/consumed and also 184 (89.8%) wash their hands before serving the food. About 153 (74.6%) knew that typhoid and cholera 171 (83.4%) can be transmitted through food while 105 (51.2%) knew hepatitis A and E as food-borne infection. The majority of the participants 152 (74.1%) had previous training on food hygiene and 175 (85.4%) of them are still interested in having retraining (Table 2).

Of the 205 total participants, 55 were positive for bacterial contamination representing 26.8%. A total of 59 bacteria strains were isolated from those 55 participants. *Staphylococcus aureus* a gram-positive bacterium was the commonest organism isolated 29 (49%). Other important bacteria isolates were *Escherichia coli* 4 (6.8%) and *Salmonella* subspecies 1 "1.7%" (Table 3).

Of all the factors examined, statistically significant association was observed between, age of the participants, types of vegetable, washing vegetable before consumption, facemask usage during food preparation and bacterial contamination (p<0.05).

Table1: Socio-demographic characteristics of food handlers at Ahmadu Bello University Zaria

Variable	Frequency n= (205)	Percentage (%)
Sex		
Male	39	19.0
Female	166	81.0
Age		
<25	67	32.7
26-50	104	50.7
51-75	34	16.6
Marital status		
Single	69	33.7
Married	106	51.7
Divorced	30	14.6
Educational status		
Primary	44	21.5
Secondary	79	38.5
Tertiary	28	13.7
Others/none	54	26.3
Ethnicity		
Hausa	99	48.3
Fulani	22	10.7
Yoruba	13	6.3
Igbo	6	2.9
Others	65	31.7

Table 2: Associated risk factors for food handlers at Ahmadu Bello University Zaria

Risk factors	Frequency	Percentage (%)
Occupation/Staffing		
Permanent	162	79.0
Casual	43	21.0
Working experience(year)		
<1	65	31.7
1-5	69	33.7
6-10	42	20.5
>10	29	14.1
Water sources		
Tap water	189	92.2
River/stream water	2	1.0
Well water	6	2.9
Others	8	3.9
Type of toilet		
Water closet	136	66.3
Pit latrine	61	29.8
Bush	2	1.0
Others	6	2.9
Washing of vegetable before consumption		
Yes	199	97.1
No	6	2.9
Types of vegetables		
Carrot	68	
Cabbage	65	
Lettuce	42	
Tomatoes	27	
Others	3	
Washing of hands before serving food		
Yes	184	89.8
No	21	10.2
Wearing a face mask when serving		
Yes	63	30.7
No	142	69.3

Table 3: Bacteria isolated from food handlers at Ahmadu Bello University Zaria

Bacteria isolates	Frequency	Percentage
<i>Acinetobacter baumannii</i>	3	5.1
<i>Acinetobacter iwoffii</i>	7	11.9
<i>Acinetobacter haemolyticus</i>	1	1.7
<i>Citrobacter sakazakii</i>	1	1.7
<i>E. agglomerans</i>	1	1.7
<i>Enterobacter cloacae</i>	2	3.4
<i>Escherichia coli</i>	4	6.8
<i>E. gergoviae</i>	1	1.7
<i>K. pneumonia</i>	5	8.5
<i>Klebsiellae ozoanae</i>	1	1.7
<i>Morganella morganii</i>	2	3.4
<i>Pseudomonas aeruginosa</i>	1	1.7
<i>S. aureus</i>	29	49.0
<i>Salmonella</i> subspecies IIIb	1	1.7
Total	59	100

TABLE 4: Hand Contamination and Associated risk factors among the food handlers at Ahmadu Bello University Zaria

Risk Factors	Hands Contamination		P-value
	Presence	Absence	
Age(years)			
≤25	11(16.4)	56(83.66)	0.011*
26-50	29(27.9)	75(72.1)	
51-75	15(44.1)	19(55.9)	
Working Experience			
<1 Year	21(32.3)	44(67.7)	0.17
1-5 Years	12(17.4)	57(82.6)	
6-10 Years	12(28.6)	30(71.4)	
>10 Years	55(26.8)	150(73.2)	
Educational Level			
Primary	15(34.1)	29(65.9)	0.09
Secondary	17(21.5)	62(78.5)	
Tertiary	4(14.3)	24(85.7)	
Others	19(35.2)	35(64.8)	
Types of Vegetable			
Carrot	22(32.4)	46(67.6)	0.03*
Cabbage	13(20.0)	52(80.0)	
Lettuce	11(26.2)	31(73.8)	
Tomatoes	6(22.2)	21(77.8)	
Others	3(100.0)	0(0.0)	
Washing Vegetable Before Consumption			
Yes	51(25.6)	148(74.4)	0.02*
No	4(80.0)	1(20.0)	
Others	0(0.0)	1(100)	
Washing Hands Before Serving Food			
Yes	48(26.1)	136(73.9)	0.48
No	7(33.3)	14(66.7)	
Face Mask Usage During Preparation of Food			
Yes	10(16.1)	52(83.9)	0.02*
No	45(31.5)	98(68.5)	
Face Mask usage when Serving Food			
Yes	9(14.3)	54(85.7)	0.01*
No	46(32.4)	96(67.6)	
Typhoid being feco-orally transmitted			
Yes	32(22.9)	118(77.1)	0.03*

DISCUSSION

Food borne pathogens remained the leading cause of food borne diseases due to poor and faulty food handling and preparation processes (Clayton *et al.*, 2002; Ifeadike *et al.*, 2014). Food handlers are potential risk to the public health through microbial transmission (Fawziet *al.*, 2009). In this present research, the overall rate of palm of food handler's bacterial contamination was high 55(26.8%). However, it was lower than the findings of Jibrin *et al.* (2016) and Sylvia *et al.* (2015) who found 89% and 48% respectively. The work of Jibrin was done among food handlers in Kano city while that of Sylvia was done in managed food service in Uganda. In another similar research done among university cafeteria food handlers in Egypt by Assefa *et al.* (2015) a higher contamination rate of 49.6% in contrast to ours was also observed. The reason for this was because hand of the participants were rinse into a sterile polythene bag from where a loopful was inoculated into the culture media in comparison to this current research where sterile cotton wool swab was used for sample collection. Furthermore a significant proportion (74.7%) of food handlers that participate in this work have some form of formal education which might have accounted for the lower level of contamination which is agreement findings reported by Abeba *et al.*, 2018 in Ethiopia. Prabhu and Shah, (2014) reported that food handlers could pose a potential risk to food safety due to low level of education and hence may have little or no knowledge of the risk of microbial or chemical contamination of food or how to get rid of them. Overall findings have demonstrated poor hygiene practice by most of the food handlers working at Ahmadu Bello University Zaria.

Staphylococcus aureus was observed to be the most prevalent bacteria isolated from the swabbed hand of food handler's, this is not as surprising as it is an important widely reported cause of food poisoning globally (Argudin *et al.*, 2010; Lima *et al.*, 2013; Kadariya *et al.*, 2014). This our finding is in agreement with previous 65.4% *Staphylococcus aureus* reported by Mohtaram *et al.*, 2017 and with the finding of 71.8% by Humodi and Hatim, (2010) from Iran and Sudan respectively both reported *S. aureus* as the most common pathogen isolated from food handlers. High contamination rate observed here could be due to the fact that *S. aureus* as a pathogenic organism is also known as an important commensal of skin and mucous membrane of human. Nearly 50% healthy human may harbor it as a normal flora in their nasal cavity (Mohtaram *et al.*, 2017)

therefore, healthy food handler may contaminate their hand or food environment when sneeze or cough directly on their hand or palm without adhering to proper hand hygiene. Food handler can easily contaminate food with *S. aureus* during food processing and serving causing food poisoning and attendant consequences on the sufferer.

Moreover, enteric pathogens such as *Escherichia coli*, *Klebsiella* species, *Enterobacter* species and other environmentally colonized Gram negative bacteria *Acinetobacter* species were also isolated from the food handlers that participated in this research. *Escherichia coli* is a normal commensal in the gastrointestinal tract of human though some strains such as Enteropathogenic, Enterohaemorrhagic, Enterotoxigenic *Escherichia coli* may cause acute diarrhea disease under certain condition in man (Lambrechts *et al.*, 2014). However, it is not normally found in the hands, and the presence of *Escherichia coli* gives an indication of recent fecal contamination with enteric bacteria. *Escherichia coli* is considered one of the enteric pathogens capable of being transmitted by food handlers if hand hygiene is inadequate (Mengist *et al.*, 2018).

Salmonella sub-specie 3b isolated from one of the food handlers' hand showed that hand hygiene practice was grossly inadequate, as it is known that *Salmonellae* specie, is always pathogenic anytime it is isolated from human body. The organism could have colonized the participant's hand following inappropriate hand hygiene after visiting toilet and this has ability to cause outbreak of salmonellosis among students, lecturers and university community.

Age was found to have a direct statistically significant association ($p=0.01$) with rate of bacterial contamination of food handlers' hand. This may be because as people are getting older they tend to have some ailments which may affect their urine and fecal continence and due to low energy they may not ensure adequate hand hygiene. Nevertheless, the result showed no statistically significant relationship between the duration of service and microbial contamination ($p=0.2$).

The result shows that only 63(30.7%) of the participants wear face mask during food preparation whereas vast majority do not wear. Microbial contamination was found to be higher among the food handlers who do not wear mask during food preparation. Furthermore, our result showed statistically significant association between wearing of face mask and microbial contamination ($p= 0.01$). This might be due to the fact that nasal cavity may be

colonized with bacteria such *Staphylococcus aureus* that can be contaminate hands, plates and serving utensils during coughing or sneezing. Hence, wearing face mask has ability to minimized contamination with nasal secretion and saliva. Consumption and washing of vegetables among the study participant was found to be statistically significant ($p = 0.02$). This might be as a result of their education level and food safety and hygiene practices among the study participants.

CONCLUSION

The finding revealed that 26.8% of food handlers' hands were colonized with bacterial pathogens such as *Staphylococcus aureus*, *Escherichia coli* and *Salmonella* subspecies IIIb which are capable of causing food and water

borne disease. Our findings emphasized the role of food handlers' hand as a vehicle of food-borne bacterial pathogens transmission that could be a major source of food-borne disease outbreak in the institution. We hereby advocate for proper education and promotion of effective hand hygiene among food handlers in our educational institutions canteens and restaurants.

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Conflict of Interest:

There are no conflicts of interest

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