

Article

Bacteriological Evaluation of Food Handlers' Thumb in Ajayi Crowther University, Oyo, Oyo State

*Theresa Abimbola Awotundun , Bunmi Victoria Oluwatusin, Oluwabunmi Florence Bamigboye and Afolake Atinuke Olanbiwoninu

Department of Microbiology and Biotechnology, Faculty of Natural Sciences, Ajayi Crowther University, P. O. Box 1066, Oyo, Oyo State, Nigeria; ta.awotundun@acu.edu.ng (T.A.A.); bunmivictoriaoluwatusin@gmail.com (B.V.O.); bunmikebamigboye@gmail.com (O.F.B.); aa.olanbiwoninu@acu.edu.ng (A.A.O.)

* Correspondence: T.A. Awotundun (ta.awotundun@acu.edu.ng; +234-8106075890)

Article history: received, Nov. 15, 2023; revised, Jan. 13, 2024; accepted, Feb. 2, 2024; published, July 30, 2024

Abstract

Food handlers, in most cases, act as vehicles for the spread of foodborne illness and this is a pointer to a public health problem that is of major global concern. Food handlers contribute to foodborne illness due to their inadequate, inefficient hygiene leading to subsequent passage of pathogens to food. Hence, this study was carried out to determine the level of bacterial contamination of food handlers who work in canteens at Ajayi Crowther University (ACU), Oyo campus. Microbiological analysis was conducted on the thumbs of both cooks (24) and servers (24) from 12 distinct canteens situated within ACU, Oyo campus. With strict aseptic precautions, the left and right thumbs of each food handler were firmly placed onto Nutrient agar plates. After incubation, bacterial isolates were conventionally identified through the utilization of biochemical assays. A total number of 42 bacteria were isolated and identified, they include *Staphylococcus aureus* (26.2 %), *Staphylococcus saprophyticus* (2.4 %), *Staphylococcus epidermidis* (4.8 %), *Micrococcus luteus* (7.1 %), *Micrococcus varians* (4.8 %), *Corynebacterium kutscheri* (7.1 %), and *Bacillus* spp. (47.6 %). Particularly notable is the prevalence of potentially pathogenic bacterial strains colonizing the hands of the food handlers. This highlights the existing vulnerabilities in food safety practices, subsequently heightening the risk of propagating foodborne illnesses within the campus environment and beyond. Given the propensity of these bacterial strains to elicit foodborne poisoning or illnesses, often leading to severe health implications, the imperative for enhanced training becomes evident. Addressing proper hygienic practices and meticulous hand-washing protocols among food handlers emerges as a paramount necessity to promote a safer food service environment.

Keywords: Food handlers, thumb, Ajayi Crowther University, food safety, hygiene.

1. Introduction

The hands are the primary tools for physically influencing the environment. As a paired organ, it can execute a variety of activities and is managed by the opposing hemisphere of the brain. Microorganisms can spread from person to person and from one location to another through the hands. The hand is rarely completely devoid of microorganisms, the presence of pathogenic bacteria can cause acute or chronic sickness. Human hands typically include both transient microbes picked up from the environment and bacteria that are a normal component of the body's flora. The natural habitat of microorganisms like *Staphylococcus* is the human skin and can therefore be passed from one person to another. Many foodborne diseases and pathogenic microorganisms are spread by contaminated hands [1].

Food handlers are directly involved in the chain of preparation, cooking, packaging and delivery of food. Hence, their hands can be a major source of food contamination [2]. They could transmit microorganisms directly or indirectly to the food from their skin, nasal secretions, and bowel, as well as from the contaminated utensils and food prepared or served by them through hand contact [2]. Cross-contamination in the home and food service establishments are major factors in sporadic and epidemic food-borne illness [3]. Employees of ready-to-eat food service have been demonstrated to be vectors for the spread of foodborne illnesses, primarily due to inadequate hand cleanliness [4]. About 97 % of foodborne ailments have been reported to occur as a result of incorrect practices of food handlers in food industries [4-5]. The most frequent locations of foodborne outbreaks include restaurants, staff canteens, school canteens, and other catering service facilities [6-9]. Some of the pathogens that have been reported to colonize the hands of food handlers are *Escherichia coli* and *Staphylococcus aureus* [10].

One of the most crucial aspects of food service operations is food safety [5]. To protect consumer health and safety, food handlers must have the necessary knowledge and training in personal and general hygiene [11]. Also, food handlers must comply with food safety requirements to ensure food hygiene to guarantee that the food is safe and uncontaminated. This study was done to assess the hand contamination of food handlers by bacteria in Ajayi Crowther University, Oyo, Oyo State.

2. Materials and Methods

This study was conducted at the shopping complex, Ajayi Crowther University, Oyo campus, Oyo State, Nigeria in 2020. It involved 48 food handlers (chefs and servers) randomly selected from 12 different canteens in the study area. The food handlers had no prior knowledge of the sampling activity, and the sampling was done during working hours

2.1 Microbiological Sampling of Food Handlers' Thumbprint

The microbiological profile of the food handlers was determined using the direct fingerprint method [11]. The left and right thumbs of the food handlers (chefs and servers), while working, were printed onto the surface of nutrient agar with gentle pressure for about 5 seconds aseptically. The plates were aseptically transported to the Microbiology laboratory and incubated aerobically at 37 °C for 18 – 24 hours. The number of colonies on each plate was counted and recorded. Colonies were sub-cultured on fresh plates until pure cultures were obtained. The obtained pure cultures were maintained on agar slants and stored in the refrigerator for further analysis.

2.2 Identification of Isolates

The conventional isolation method was adopted. All the bacterial isolates were identified using Gram staining, morphology and biochemical tests following Bergey's manual of determinative bacteriology [12].

3. Results

3.1 Total Viable Count of Bacteria from Food Handlers' Thumbs

The total viable count of bacterial isolates from the food handlers' thumbs in Ajayi Crowther University, Oyo campus is shown in Table 1. The count ranged from 1 – 102. Half (50 %) of food handlers have a higher microbial load on their right thumb than their left thumb, 36% have a higher microbial load on their left thumb than their right thumb and 14% have the same number of colonies on both thumbs.

3.2 Biochemical Characteristics and Identification of Bacteria Isolated from Food Handlers' Thumbs

In this study, a total of 42 bacteria isolates were cultured and identified. All were Gram-positive, out of which 19 (45.2 %) were Gram-positive cocci while 23 (54.8 %) were Gram-positive rods from which 14 (60.9 %) were endospore positive. Bacteria isolated include *Staphylococcus aureus*, *Staphylococcus*

saprophyticus, *Staphylococcus epidermidis*, *Micrococcus luteus*, *Micrococcus varians*, *Corynebacterium kutscheri*, and *Bacillus* spp. having the highest occurrence (45.2 %) while *Staphylococcus saprophyticus* had the lowest occurrence (2.4 %) as presented in Figure 1.

Table 1: Number of Colonies of Bacteria from Food Handler’s Thumbs

Code for cooks and servers	Number of colonies	
	Left thumb	Right thumb
SCS 1	67	57
SCC 1	1	1
YCS 2	13	14
YCC 2	2	2
GCS 3	45	82
GCC 3	3	3
AS 4	21	27
IDS 5	33	70
IDC 5	98	57
GS 6	45	32
GDC 6	82	102
PDS 7	25	60
PDC 7	52	50
MS 8	46	37
MC 8	34	36
FS 9	27	22
PSS 10	25	45
PSC 10	25	30
ICS 11	5	6
ICC 11	28	14
FNSS 12	75	82
FNCS 12	59	33

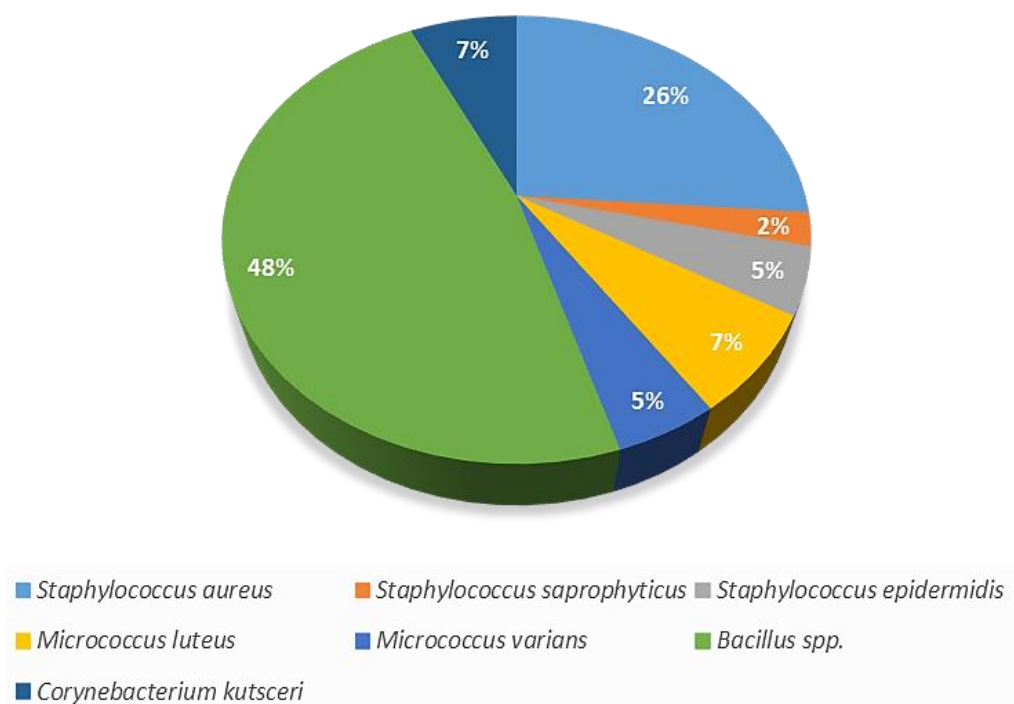


Figure 1: Percentage Frequency of Bacterial Occurrence in Food Handlers’ Thumbs in Ajayi Crowther University, Oyo Campus

Table 3: Biochemical Characteristics of Bacteria Isolated from Food Handlers' Thumb

Isolate codes	Gram Reaction	Morphology	Catalase	Mannitol	Yellow Pigment	Glucose	Coagulase	Endospore	Strict Anaerobe	Starch Hydrolysis	Probable Organism
SCS 1.1	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
SCS 1.2	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
SCC 1.1	+	Rod	+	+	-	+	-	-	-	+	<i>Corynebacterium kutscheri</i>
YCS 2.1	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
YCC 2.2	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
GCS 3.2	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
GCS 3.3	+	Cocci	+	-	-	+	-	-	-	+	<i>Staphylococcus epidermidis</i>
AS 4.1	+	Cocci	+	-	+	+	-	-	-	-	<i>Micrococcus varians</i>
AS 4.2	+	Cocci	+	-	+	-	-	-	-	-	<i>Micrococcus luteus</i>
IDS 5.1	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
IDS 5.2	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
IDC 5.1	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
IDC 5.2	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
GGs 6	+	Cocci	+	-	-	+	-	-	-	+	<i>Staphylococcus epidermidis</i>
GGs 6.1	+	Cocci	+	-	+	-	-	-	-	-	<i>Micrococcus luteus</i>
GGC 6.1	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
GGC 6.2	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
PDS 7.1	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
PDS 7.2	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
PDS 7.3	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
PDS 7.4	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
PDC 7.2	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
PDC 7.3	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
MS 8.2	+	Rod	+	+	-	+	-	-	-	+	<i>Corynebacterium kutscheri</i>
MS 8.3	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
MS 8.4	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
MC 8.1	+	Cocci	+	+	-	+	+	-	-	+	<i>Staphylococcus aureus</i>
MC 8.2	+	Rod	+	+	-	+	-	-	-	+	<i>Corynebacterium kutscheri</i>
MC 8.3	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.
FS 9.3	+	Rod	+	+	-	+	-	+	-	+	<i>Bacillus</i> sp.

4. Discussion

Food handlers play a key role in the spread of microbes, and poor handling techniques can result in food contamination and foodborne infections, which pose a potential risk to public health [11]. To identify preventive measures and corrective actions regarding biological hazards in HACCP systems, it is crucial to have accurate data on contamination sources. Given that food handlers' hands can get contaminated by cross-contamination, it is important to conduct an objective assessment of hand hygiene. In this current study, 42 bacteria were revealed from 48 food handlers' thumbs, with the most common bacterium being *Bacillus* spp. (48 %). This could be attributed to the fact that *Bacillus* species are known to bear-resistant spores which possess the ability to adhere to several surfaces. They are also common environmental contaminants and transient microflora of the hand due to their spore-forming ability. They are difficult to control in the food environment because of their relatively high resistance to physical and chemical treatments [13]. This result corresponds with that of Dorotíková *et al.* [14] who detected *Bacillus* spp. from food handlers' hands at a frequency of 30.2 %, *Bacillus* spp. were also the most frequently isolated bacteria in their study. Some species of this endospore-forming bacterium possess the capability of causing foodborne illness with distinct symptoms and origins. They are namely the emetic and diarrheal syndromes [15-17]. Hand washing with soap and water can reduce the number of *Bacillus* spores as proven by Sasahara *et al.* [18]. Additionally, applying more mechanical energy and prolonging the washing period can improve the effectiveness of hand washing in food handlers [14].

Another pathogen isolated from food handlers' thumbs in this study was *Staphylococcus aureus* representing 26 % of the isolates. This figure is comparable to 29.2% mentioned by Allam *et al.* [19], who also detected *S. aureus* in food handlers' hands. *S. aureus* is a toxin-producing bacterium and an important cause of food poisoning [11]. It is also the leading cause of gastroenteritis following the handling of food by persons who carry this bacterium in their noses and skin [20]. The presence of *S.*

aureus on food handlers' thumbs reflects improper hygiene practices such as poking fingers into the nose [21]. This is alarming and poses a threat to food safety especially since finished meals are handled by these highly contaminated hands. Hence, it can be concluded from this study that food handlers' hands can be considered a potential hazard for staphylococcal food contamination.

Staphylococcus epidermidis was also detected on food handlers' thumbs in this study. It is a known commensal inhabitant of human skin that rarely causes disease in healthy persons. However, in recent years, it has emerged as a major nosocomial pathogen with infection rates as high as those of *S. aureus* [19,22]. The presence of species of *Micrococcus* and *Corynebacterium* in food handlers' thumbs from this study could be attributed to the fact that they are resident flora of the human skin. Micrococci are known to be potential/opportunistic human pathogens. They could serve as an easy route for human infections. Effective hand washing will help prevent possible deleterious effects from these organisms [1].

5. Conclusions

This study revealed that the hand hygiene of ACU food handlers is unsatisfactory due to the presence of some human pathogens, and may lead to serious health problems as a result of contamination of food from food handlers' hands. These findings emphasized the importance of food handler's hands as potential vectors of foodborne bacterial pathogens that could constitute a potential risk of foodborne disease outbreaks. Therefore, this indicates the importance of further training to improve food handlers' knowledge of proper hygienic and good hand-washing practices. They should also be informed of the importance of adhering to food safety hygiene at all times.

References

- Oranusi, S., Dahunsi, S.O., Owoso, O.O. and Olatile, T. (2013) Microbial profiles of Hands, Foods, Easy contact surfaces and Food contact surfaces: A case study of a University Campus. *Novus International Journal of Biotechnology and Bioscience* 2(1):30-38.
- Alum, A. E., Urom, S. M., Otu, C. B., and Ahudie, C.M. (2016). Microbiological Contamination Of Food: The Mechanisms, Impacts And Prevention. *International Journal of Scientific & Technology Research* 5: 65-78..
- Chen, Y., Jackson K.M., Chea, F.P. and Schaffner, D.W. (2000) Quantification and variability of analysis of bacteria cross-contamination rates in common food service tasks. *Journal of Food Protection* 64: 72-80.
- Lambreches, A.A., Human, I.S., Doughari, J.H. and Lues, J.F.R. (2014) Bacterial contamination of the hands of food handlers as indicator of hand washing efficacy in some convenient food industries in South Africa. *Pak j med sci.* 30(4)755-758.
- Khan, M. A. (2018). Detection of colonized pathogenic bacteria from food handlers in Saudi Arabia. *Journal of Pure and Applied Microbiology* 12(3): 1301-1306. <http://dx.doi.org/10.22207/JPaM.12.3.32>
- European Food Safety Authority, EFSA (2021). The European union one health 2019 zoonoses report *EFSA Journal* 19 (2): e06406, [10.2903/j.efsa.2021.6406](https://doi.org/10.2903/j.efsa.2021.6406)
- Osimani, A., Milanović, V., Aquilanti, L., Polverigiani, S., Garofalo, C., and Clementi, F. (2018). Hygiene auditing in mass catering: A 4-year study in a university canteen. *Public Health* 159: 17-20, [10.1016/j.puhe.2018.03.015](https://doi.org/10.1016/j.puhe.2018.03.015)
- Garayoa, R., Yanez, N., Díez-Leturia, M., Bes-Rastrollo, M., and Vitas, A.I. (2016). Evaluation of prerequisite programs implementation and hygiene practices at social food services through audits and microbiological surveillance *Journal of Food Science* 81 (4): Article M921eM927.
- Gould, L.H., Rosenblum, I., Nicholas, D., Phan, Q., and Jones, T.F. (2013). Contributing factors in restaurant-associated foodborne disease outbreaks, FoodNet sites, 2006 and 2007. *Journal of Food Protection* 76 (11): 1824-1828. [10.4315/0362-028X.JFP-13-037](https://doi.org/10.4315/0362-028X.JFP-13-037)
- Luesa, J.F.R. and Tonder, I.V. (2007) The occurrence of indicator bacteria on hands and aprons of food handlers in the delicate essential sections of a retail group. *Food Control* 18(4):326-332.
- Abd-Elaleem, R., Bakr, W. M. K., Hazzah, W. A., and Nasreldin, O. (2014). Assessment of personal hygiene and bacteriological quality of butchers' hands in some abattoirs in Alexandria, Egypt. *Food Control* 41: 147-150. <https://doi.org/10.1016/j.foodcont.2014.01.016>
- Bergey, D. H. and Holt, J. G. (1994). *Bergey's Manual of Determinative Bacteriology*. 9th Edition, Williams & Wilkins, Baltimore, Maryland.
- Cho, W.I. and Chung, M.S. (2020). *Bacillus* spores: A review of their properties and inactivation processing technologies. *Food science and biotechnology* 29 (11): 1-15. [10.1007/s10068-020-00809-4](https://doi.org/10.1007/s10068-020-00809-4)
- Dorotíková, K., Kameník, J., Bogdanovičová, K., Křepelová, S., Strejček, J., and Haruštiaková, D. (2022). Microbial contamination and occurrence of *Bacillus cereus sensu lato*, *Staphylococcus aureus*, and *Escherichia coli* on food handlers' hands in mass catering: Comparison of the glove juice and swab methods. *Food Control* 133:108567. <https://doi.org/10.1016/j.foodcont.2021.108567>
- Choi, W., and Kim, S. S. (2020). Outbreaks, Germination, and Inactivation of *Bacillus cereus* in Food Products: A Review. *Journal of food protection* 83(9), 1480–1487. <https://doi.org/10.4315/0362-028X.JFP-19-429>
- Ramarao, N., Tran, S.L., Marin, M., and Vidic, J. (2020). Advanced methods for detection of *Bacillus cereus* and its pathogenic factors. *Sensors* 20 (9): 2667. [10.3390/s20092667](https://doi.org/10.3390/s20092667)

17. Messelhäuser, U. and Ehling-Schulz, M. (2018). *Bacillus cereus*—a multifaceted opportunistic pathogen *Current Clinical Microbiology Reports* 5: 120-125. [10.1007/s40588-018-0095-9](https://doi.org/10.1007/s40588-018-0095-9)
18. Sasahara, T., Ae, R., Watanabe, M., Kimura, Y., Yonehawa, C., Hayashi, S., and Morisawa, Y. (2016). Contamination of healthcare workers' hands with bacterial spores *Journal of Infection and Chemotherapy* 22: 521-525. [10.1016/j.jiac.2016.04.007](https://doi.org/10.1016/j.jiac.2016.04.007)
19. Allam, H.K., Al-Batanony, M.A., Seif, A.S. and Awad, E.T. (2016) Hand Contamination among Food Handlers. *British Microbiology Research Journal* 13(5):1-8.
20. Do Carmo, L.S., Cummings, C. Linardi, V.R., Dias, R.S. and De Souza, J.M. (2004) A case study of a massive staphylococcal food poisoning incident. *Foodborne Pathog Dis* 1:241-246.
21. Assefa, T., Tasew, H., Wondafrash, B. and Beker, J. (2015) Contamination of Bacteria and Associated Factors among Food Handlers Working in the Student Cafeterias of Jimma University Main Campus, Jimma, South West, Ethiopia. *Altern Intern Med.* 4:185.
22. Lee, E., and Anjum, F. (2022). *Staphylococcus Epidermidis*. In *StatPearls*. StatPearls Publishing.

Funding

Not applicable.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Acknowledgements

Not applicable

Conflict of Interest

The author declared no conflict of interest in the manuscript.

Authors' Declaration

The author(s) hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

Author Contributions

Concept – A.A.O., Design – A.A.O, Supervision – A.A.O, Resources – T.A.A, B.V.O, O.F.B, Materials - T.A.A, B.V.O, O.F.B, Data collection and/or processing - T.A.A, B.V.O, O.F.B, Analysis and/or interpretation - T.A.A, B.V.O, O.F.B, Literature search – T.A.A, Writing – T.A.A, Critical reviews – A.A.O.

Cite article as:

Awotundun, T.A., Oluwatusin, B.V., Bamigboye, O.F., Olanbiwoninu, A.A. Bacteriological Evaluation of Food Handlers' Thumb in Ajayi Crowther University, Oyo, Oyo State. *Ajayi Crowther J. Pure Appl. Sci.* 2024, 3(3), pp. 14-19. | doi: <https://doi.org/10.56534/acjpas.2024.03.03.14>