Hygiene Assessment of Paper Currency and Fomites Handled by Food Vendors in Covenant University

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Nwinyi Obinna C.*, Chukwukadibia Somachi Q. and Kayode-Afolayan Olushola D.

Biotechnology Research Cluster, Department of Biological Sciences, College of Science and Technology, Covenant University, KM 10 Idiroko Road, Canaan Land, PMB 1023 Ota, Ogun State, Nigeria.

*Corresponding Author's email: nwinyiobinna@gmail.com;
obinna.nwinyi@covenantuniversity.edu.ng

Abstract. Fomites have been known to harbor significant amount of microbial load and its handling by food vendors poses a significant risk to consumers. In this study, swab samples were collected from vendors handling paper currency; their food contaminated hands, and selected foods-Akara, Suya and Bole. These fomites were evaluated for organisms that may pose a risk of food infection/contamination. The organisms isolated were identified based on their macroscopic, mi-croscopic and biochemical characteristics and comparison with standard reference organisms. From the results obtained, the paper currency had the highest numbers of bacterial and fungal load (too numerous to count – TNTC), food contaminated hands ranged between 12 x 10^5- 15 x10^5 cfu/g and the selected foods- Akara, Suya and Bole had 7x10^5- 12 x10^5 cfu/g. The bacteria members' species recorded include *Pseudomonas, Streptococcus pyogenes, Shigella, Proteus vulgaris, Escherichia coli, klebsiella pneumonia, Salmonella typhi, Enterobacter* sp*, Aeromonas hydrophila, Micrococcus luteus*. Others include *Clostridium* sp, *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Bacillus cereus*. The fungal species reported include *Aspergillus*, Yeast, *Penicillium* sp. and *Saccharomyces* spp. *Mucor* sp. and Rhizopus sp. Members of *Staphylococcus aureus* and *Escherichia coli* were noted to occur on all the samples surveyed. From this study, it can be deduced that handling of paper currencies by food vendors could serve as a direct and indirect pathway for man-microbe interface.

Keywords: Paper currency, food vendors, Hygiene assessment, Bacteria, Fungi

1. Introduction

For several decades, there has been a concerted effort to minimize the incidence of food-borne outbreaks and its fatalities [1]. Life on earth depends on the activities of microorganisms. Many are harmless, some are useful, some cause spoilage, and others cause diseases or produce toxins that cause poisoning. Humans have practiced the act of trade since the early centuries and the use of money has been an essential part of it [2, 3]. Some of the uses of money during transactions include debt payment, and promissory notes. In Nigeria, Naira is the legal tender [4]. The naira banknote is made up of 75% cotton and 25% linen; and are in different denominations. These include N5, N10, N20, N50, N100, N200, N500 and N1000 notes. The commonly used denominations for daily transactions include N5, N10, N20, N50, N100 and N200 naira notes [5, 6]. The N500 and N1000 notes are used mainly among the wealthy and in the corporate transactions [7].

In Nigeria, the naira bank notes could be abused by squeezing, stapling, cellotaping and writings on them [8]. When the bank notes are used as medium of exchange especially unhygienically, it could be contaminated with microorganisms thus making it a repository for proliferation

of several microorganisms. There are a number of ways the currency notes can be contaminated. These include when counting with saliva to dampen the currency to enable easy counting, coughing and sneezing on hands and subsequent touching of the currency, placement on dirty surfaces and poor hand washing attitude after using the toilets [3].

Some organisms such as *Citrobacter* sp., *Mycobacterium leprae*, *Salmonella* sp., *Shigella* sp., *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* have been isolated from different naira bank notes [9]. The significant proportion of these organisms are normal flora of the human skin; although some such as *S. aureus* and *P. aeruginosa* could be opportunistic pathogens. The contaminated currency notes act as a vehicle for bacteria transmission to the end users [10, 11]. The handling of foods with contaminated currency could result in food-borne infection [2]. Many people do not care about the level of cleanliness of their fingers when handling money and as such pick paper currencies with contaminated hands. For instance, meat sellers in market places and abattoirs usually collect money during the sales of the meat product with the same hands that has been contaminated by animal blood and wastes. Such money handling practice can be a potential source of contamination of the naira notes [6]. Certain money handling habits such as; hiding money inside socks, bras, under wrappers and rugs and squeezing in the hand can also introduce microbes to the paper currency. For instance, when the old Nigerian currency notes were withdrawn from exchange it was discovered that it was contaminated that it posed health hazard to treasury workers.

In Nigeria, most food outlets rely on the naira banknotes as their sole means of exchange for sales with high frequency of contacts between currencies and foods thus endangering the safety of consumers [6]. In this study, we evaluated the microbial load of some banknotes (paper currency) used by food vendors, their food contaminated hands, and some selected foods-Akara, Suya and Bole sold in Covenant University. We noted that organisms isolated have been implicated in food-borne infections and contamination.

2. Materials and Methods

2.1. Chemical and Reagents

All the chemical and reagents used in this study were of analytical grade. The media used include Nutrient Agar, MacConkey Agar, Potato Dextrose Agar, Sabouraud Dextrose Agar, Citrate Agar, Urea Agar. Reagents used include the following Hydrogen peroxide, Phenol red, Saffra-nin, Crystal violet, Iodine, Ethanol and α-naphtol.

2.2. Sample collection

Samples were collected from food vendors around the Covenant University Cafeteria 1 and 2. Three (3) different food vendors were selected at random from cafeteria 1 and 2 of Covenant University. The food sold by them include: Roasted plantain also known as Bole, roasted meat also known as suya and fried bean ball also known as akara. The hand of these vendors alongside the money handled by them was swabbed with a sterile cotton swab soaked with sterile distilled water. The samples were labeled accordingly. For the akara samples, they were labeled as AF, AH and AM. For the suya samples, they were labeled as SF, SH and SM. For the bole samples, they were labeled as BF, BH and BM respectively.

2.3. Analyses of the food samples

For each food samples- Bole, Akara and Suya (25 g) were weighed and homogenized using a waring blender. These were serially diluted using phosphate buffer as diluents to prevent osmotic shock of the organisms. About 1ml of 10-3 sample was plated using pour plate method on Nutrient agar (NA), MacConkey agar (MA), Salmonella-Shigella agar (SSA), Eosine methyleneblue agar (EMB) and Sabouraud dextrose agar (SDA). The hand and money swabs were also streaked on the prepared agar. The plates were incubated at 37°C for 24 hours and the fungi plates were kept at

room temperature for 5-7 days to grow. The colonies that grew on the nutrient agar plates were counted using a colony counter and was used to determine the total bacterial count. The represented colonies on the plates were sub-cultured on fresh nutrient agar plates to obtain pure cultures of the isolates after successive transfers. The fungi that grew were also sub-cultured on fresh potato dextrose agar plates. The pure cultures were placed into nutrient agar and Sabouraud dextrose agar slants for morphological and biochemical characterization [12].

2.4. Characterization of the Organisms

2.4.1. Identification of bacterial and fungal species
Nutrient agar and potato dextrose agar were prepared, poured into plates and allowed to solidify respectively. The discrete colonies of the samples obtained were sub-cultured by streaking on the sterile plates. The plates were incubated at 37°C for 24 hours for the bacteria culture and 27°C for 5 days for the fungi culture.

Standard microbiological methods were used to identify the different bacteria isolated. The bacteria isolates were identified by making use of 24 hours old culture that were gram stained for cell morphological differentiation. The tests carried out include, voges-proskeur test, indole test, citrate utilization test; catalase test, motility test, methyl red test, coagulase test and carbohydrate fermentation test for sugars such as glucose, fructose lactose and galactose according to modified methods of Cowan and Steel [13]. For the fungi characterization, two drops of lactophenol cotton blue was placed on a sterile glass slide. Using a sterile a sterile inoculating needle, a portion of the fungal colony to be identified was placed on the lactophenol cotton blue. The hyphae were teased in the lactophenol cotton blue with an inoculating needle. The glass slide was placed on the stage of the bright field microscope and viewed using an objective lens of x10 and x 40. The focal length was adjusted until a clear view of the hypha was seen. The fungal colony was characterized based on microscopic and macroscopic morphology.

3. Results
The total viable count recorded is as shown in Table 1.0. From the result obtained, the range of viable count was 7 x 10^5 cfu/g to too numerous to count (TNTC). All the cafeterias showed incidence of high microbial load on the monies

Table 1.0 The total viable count from the selected Cafeteria

Sample Source	Sample	Viable plate count = cfu/g
Cafeteria 1 (n=1)	Akara	$7x10^5$
Cafeteria 1 (n=1)	Akara hand	$12x10^5$
Cafeteria 1 (n=1)	Akara money	TNTC
Cafeteria 2 (n=1)	Bole	$7x10^5$
Cafeteria 2 (n=1)	Bole hand	$10x10^5$
Cafeteria 2 (n=1)	Bole money	TNTC

Cafeteria 1 (n=1)	Suya	$12x10^5$
Cafeteria 1 (n=1)	Suya hand	15x105
Cafeteria 1(n=1)	Suya money	TNTC

Table 2.0 showed the bacterial burden from the samples, it was evident that organisms of normal flora to common gastrointestinal organisms dominated the count.

Table 2.0 Common bacteria isolates enumerated from selected foods –Akara, Bole and Suya

SAMPLE	BACTERIAL ISOLATES
Akara	*Staphylococcus aureus*
Akara hand	*Staphylococcus aureus, Staphylococcus epidermidis*
Akara money	*Micrococcus luteus, Pseudomonas spp. ,Shigella spp, Clostridium spp, Proteus vulgaris, Aeromonas hydrophila, Escherichia coli*
Bole	*Escherichia coli*
Bole hand	*Escherichia coli, Streptococcus pyogenes*
Bole money	*Escherichia coli, Staphylococcus aureus, Enterococcus feacalis, Staphylococcus epidermidis, klebsiella pneumonia*
Suya	*Staphylococcus aureus,*
Suya hand	*Salmonella typhi, Staphylococcus aureus*
Suya money	*Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Pseudomonas aeruginosa, Enterobacter spp., Escherichia coli*

Table 3.0a showed the cultural, morphological characterization of the bacteria species. These include: *Pseudomonas; Streptococcus pyogenes, Shigella, Proteus vulgaris, Escherichia coli, klebsiella pneumonia, Salmonella typhi, Enterobacter spp.; Aeromonas hydrophila, Micrococcus luteus* species. Based on morphological characterization, most of the organisms occurred as rods and cocci. Most of the organisms showed different reactions when tested on some of the sugar glucose, lactose, fructose and galactose. Some were able to produce different colors with no gas change, while other showed both color changes and gas production. From the results obtained and on comparison with standard organisms the probable organisms were recorded.

In Table 3.0b, morphological identification of the fungal species were noted. The organisms include: *Aspergillus*, Yeast, P*enicillium* spp. and *Saccharomyces* spp. *Mucor* spp. and *Rhizopus* spp. Some of the micrographs of the organisms have been shown in Plate 1.0. In addition, the distribution of the fungal species based on the foods from which they were isolated is as shown in Table 3.1

Table3.0a: Cultural and biochemical characteristics of bacteria species isolated from the selected samples

	Gram stain	Colony morphology	Catalase	Starch hydrolysis	Indole	Motility	Oxidase	Citrate	Methyl red	Indole	Voges proskeur	Glucose	Lactose	Fructose	Galactose	Most probable orgs.
1	+	cocci	+	+	-	-	-	+	-	-	+	+	+	+	+	*Clostridium*
2	-	rods	+	-	-	+	+	+	-	-	-	+	-	+	+	*Pseudomonas*
3	-	rods	+	+	-	+	-	+	-	-	-	+	-	+	-	*Pseudomonas*
4	-	rods	-	-	+	+	-	-	+	+	-	++	++	++	++	*Enterobacter*
5	+	cocci	+	-	-	-	-	-	-	-	+	++	++	++	++	*Stapylococcus epidermidis*
6	-	rods	+	-	-	-	-	-	+	-	-	++	-	+	-	*Salmonella*
7	+	cocci	+	-	-	-	-	-	+	-	+	+	+	+	+	*Staphylococcus aureus*
8	+	rods	+	+	-	+	-	-	+	-	-	++	-	++	++	*Bacillus cereus*
9	+	cocci	-	+	-	-	+	-	-	-	-	+	-	+	+	*Micrococcus luteus*
10	-	rods	+	-	-	-	-	-	+	-	-	+	-	+	-	*Shigella*
11	-	rods	+	-	+	+	+	+	+	+	-	++	-	++	++	*Proteus*
12	-	rods	+	+	-	-	-	+	-	-	+	++	++	++	++	*Klebsiella pnuemonia*
13	-	rods	+	-	+	+	-	-	+	+	+	++	++	++	++	*Escherichia coli*
14	-	rods	+	+	-	+	+	+	-	-	-	+	-	+	+	*Aeromonas hydrohilia*
15	+	cocci	+	+	-	-	-	-	-	-	-	+	+	+	+	*Streptococcus pyogenes*
16	+	cocci	+	-	-	+	-	+	-	-	-	+	+	+	+	*Enterococcus feaclis*

Negative -; Positive+ positive with Gas production++

Table 3.0b Morphological characterization of fungal isolates

Code	Macroscopic culture	Microscopic appearance	Most probable isolate
SM SDA AM SDA S SDA	Black spores with white condiospores. It grows in colonies or clusters	Septate hyphae conidia occur on large radiating heads. condiospores arises from a segment of mycelium	*Aspergillus Niger*
BM on SDA AM SDA	whitish colonies with short-hair like spite around the periphery with an irregular shape	Large oval budding yeast cells with short strands of pseudomycellium	*Yeast*
BM on SDA	Olive green spores with white periphery	Septate hyphae conidiophores with smooth stripe and branched	*Penicillium spp.*
BH SDA	White filamentous hyphae bearing black spores	Sporangia are globose with slightly rough walled stolen opposite the branched rhizoids.	*Rhizopus spp.*
SM SDA BM SDA	Greyish cotton hyphae raised from plates.	Non septate hyphae, sporangiospores symbolically branched with long and short criminate branches	*Mucor spp.*
AH SDA SH SDA	Cream coloured with smooth edged surface and raised on the plate	Presence of ascospore and pseudomycellum	*Saccharomyces spp.*
SH SDA	Greenish spores with white conidiophores. It grows in colonies.	Septate hyphea with long	*Aspergillus flavus*

Table 3.1 Common fungi isolates enumerated from selected foods –Akara, Bole and Suya

SAMPLE	**FUNGI ISOLATES**
Akara	Nil
Akara hand	*Saccharomyces spp.*
Akara money	*Aspergillus niger, Penicillium spp., Mucor spp*
Bole	Yeast
bole hand	*Aspergillus niger*
bole money	*Saccharomyces spp, Aspergillus niger, Rhizopus spp.*
Suya	*Aspergillus niger*
Suya hand	*Aspergillus flavus*
Suya money	*Aspergillus niger, Aspergillus flavus, Yeast*

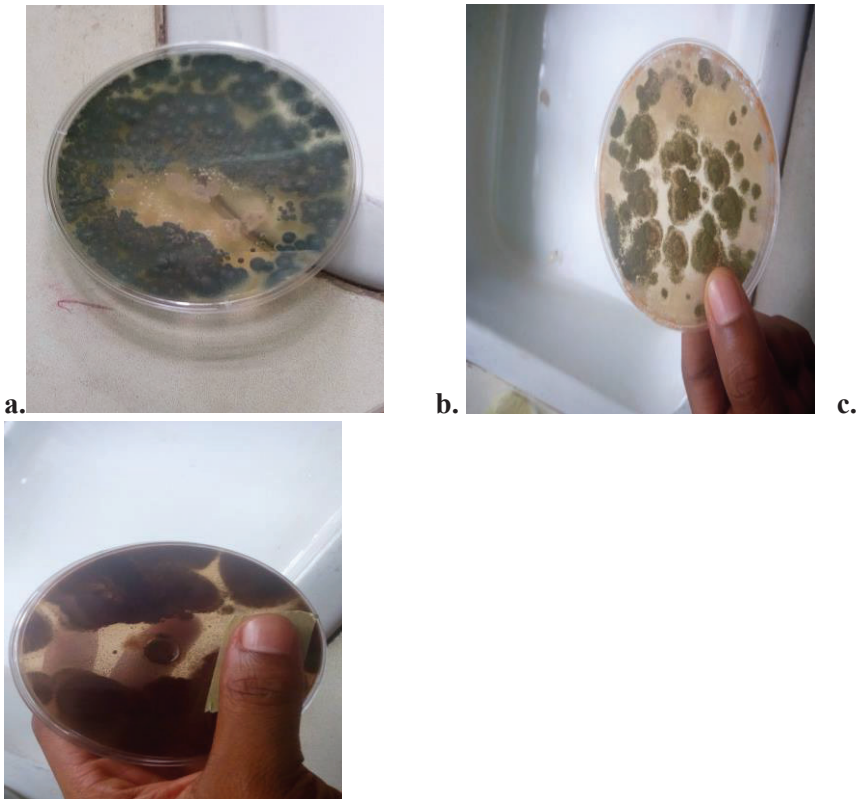

Plate 1.0 shows typical morphological views of some of the fungal species isolated **a**. *Penicillium* **b**. *Aspergillus flavus* **c**. *Aspergillus niger* species

4. Discussion

The result of the microbiological assessment of paper money, food contaminated hands and foods- Akara, Bole and Suya obtained from three (3) different food vendors showed signifi-cant amount of bacterial isolates. The paper currencies were shown to have the highest amount of microbial contaminant followed by the contaminated hands of the food vendors thereafter the food sold- Akara, Bole and Suya (See Table 1.0). The high number of microbial contamination from the paper currencies is not surprising because paper money is used as a standard measure for exchange of goods and services which entails it to be passed from one person to another thus exposing the notes to unsanitary conditions and contaminating organ-isms [14] . From the results obtained in Tables 1-3a, the microbial content of the paper currencies revealed the presence of numerous isolates including enteric organisms such as; Shigella spp, Salmonella spp, Escherichia coli. These organisms when granted access into foods, could present a potential health hazard. Some fungal species like Aspergillus Saccharomyces spp., Penicillium which were isolated from the paper currency have been reported in Tagoe and co-workers [15]. It is evident that due to the microbial burden on paper money, food vendors can accidentally introduce microbes into the food sold since most of them handle money without the knowledge of the microbial load on it. From the obtained result in (Table 2.0), there were occurrences of similar microbes from the contaminated hands and foods handled by the vendors. The microorganisms include Staphylococcus aureus; Escherichia coli and Salmonella typhi.

Food-borne illness has become not only a problem to developing countries but also to devel-oped countries. One of the ways food-borne illnesses are caused is by ingestion of contami-nated food products by microorganisms. From this study, it was obvious that this trend is cer-tain since most food vendors rarely have knowledge of the microbial burden nor comply with food safety hygiene practices. This report is in agreement to the studies of Monney and co-workers; Canica and co-workers [16, 17].

In other studies, of microbial assessment of some foods in Nepal, Lamichane and co-workers reported of microbial burden on currencies handled by butchers to have (78.0 %) and food sellers (62.1 %) of microbial contamination [18]. Also Ngwai and co- workers noted that pathogens found on currency note could represent a potential source of food borne illness [11] . In addition, Escherichia coli (E. coli) was reported at 5.6 % from Ghanaian Currency Notes [15]. Microorganisms when present in food will grow under favorable conditions and will produce toxin in food. Following ingestion, toxins are absorbed through gastro intestinal epithelial lining and cause local tissue damage [2]. As side from handling of currencies, the contamination of paper currency could occur through other sources such as during ceremonies where monies are sprayed on people of which some are trampled upon during dancing and such introduce microbes on the currencies [6].

5. Conclusion

In conclusion, since improper handling of money, particularly paper money exposes the popu-lation to different microorganisms capable of causing food-borne diseases, it is advocated that electronic system of payments (e-commerce) should be adopted especially in food indus-try. In addition, the regulatory bodies in charge of food safety should provide standard pro-cedures for food vendors for necessary hygiene requirements and standards that assures the safety of the food products.

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