World Scientific Research
ISSN : 2411-6661
Vol. 3, No. 1, 16-22, 2016
http://www.asianonlinejournals.com/index.php/WSR

Evaluation of Micro-Pathogens Associated with Nigerian Currency (Naira Notes)

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Abstract

Evaluation of micro-pathogens associated with the Nigerian Currency (Naira note) was examined using the standard microbiological techniques. The bacterial load of the Naira notes ranged from $4.0\pm0.6x10^3$ cfu/ml to $50.0\pm0.1x10^3$ cfu/ml which differed significantly ($p<0.05$) when compared with the control sample which had no bacterial growth. The fungal count of the Naira notes ranged from $3.0\pm0.9x10^3$ cfu/ml to $23.0\pm0.1x10^3$ cfu/ml. The following microbial species were isolated with a varying prevalence; *Bacillus* species 41 (10.3%), *Klebsiella* species 37 (9.3%), *Proteus* species 29 (7.3%), *Corynebacterium* species 28 (7.0%), *Staphylococcus epidermidis* 24 (6.08%), *Staphylococcus saprophyticus* 44 (11.0%), *Staphylococcus aureus* 31 (7.8%), *Clostridium* species 18 (4.5%), *Micrococcus* species 16 (4.0%), *Escherichiacoli* 15 (3.8%), *Fusarium* species 15 (3.8%), *Penicillium* species 13 (3.3%), *Aspergillusfumigatus* 12 (3.0%), *Aspergillus flavus* 11 (2.8%), *Rhizopus* species 5 (1.3%), *Aspergillus niger* 31 (7.8%) and *Mucors* species 29 (7.3%). The different denominations of the Naira note showed that 20 Naira recorded the highest microbial isolate of 81(20.3%), followed by 10 Naira note 70(17.5%) while the least was 1000 Naira note 18(4.5%). The different denominations of the Naira note showed that 20 Naira had the highest occurrence of bacteria (58) and fungal occurrence of 23, the least was 1000 Naira which recorded the occurrence of 13 and 5 for bacteria and fungi, respectively. The study showed that Naira notes are commonly contaminated with pathogenic microorganisms of public health importance. Therefore, the Nigerian currency (Naira note) should be handled with care so that it will not be a vehicle for disease transmission.

Keywords: Naira notes, bacteria, fungi, pathogens, prevalence, Nigeria, micro-flora

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Citation | Oha Ndubuisi; Ijeoma Iheukwumere; Ekeleme Uzochukwu G; Elijah Akachukwu Otutu; Ajunwa Kelechi Victor (2016). Evaluation of Micro-Pathogens Associated with Nigerian Currency (Naira Notes). World Scientific Research, 3(1): 16-22.

DOI:	10.20448/journal.510/2016.3.1/510.1.16.22
ISSN(E) :	2411-6661
ISSN(P) :	2518-0177
Licensed:	This work is licensed under a Creative Commons Attribution 3.0 License
Contribution/Acknowledgement:	All authors contributed to the conception and design of the study.
Funding:	This study received no specific financial support.
Competing Interests:	The authors declare that they have no conflict of interests.
Transparency:	The authors confirm that the manuscript is an honest, accurate, and transparent account of the study was reported; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
Ethical:	This study follows all ethical practices during writing.
History:	**Received:** 21 December 2015/ **Revised:** 16 February 2016/ **Accepted:** 19 February 2016/ **Published:** 24 February 2016
Publisher:	Asian Online Journal Publishing Group

1. Introduction

The official currency of the Federal Republic of Nigeria is the Naira notes, it is issued and regulated by the Central Bank of Nigeria. In most day to day cash transactions, the Naira notes pass through the hands of many as against exchange dependent on double coincidence of wants [1]. Thus, the Naira notes are widely exchange for goods and services, each currency is exchanged many times during the time it circulates [2].

Currently, there are eight denominations of the Naira notes from #5, #10, #20, #50, #100, #200, #500, #1000. The low denomination notes like #5, #10, #20, #50, #100 and #200 are the most common and more involved in daily cash transactions. They are common especially among the populace while the #500 and #1000 notes are commonly used among the wealthy and in corporate transactions [3].

Studies in different parts of the world have reported high rate of microbial contamination of currency notes in circulation [4]. The naira notes is commonly handled by various categories of people during transaction [5]. Individuals handling the notes shed some of their body floral on the notes, leading to the spread of microorganisms among the handlers [6]. The notes can be contaminated by droplets during coughing, sneezing, the saliva often used when counting the notes, dust, soil, water, wounds, micro-flora of the body of handlers (Hand, Skin etc), touching with previously contaminated hands or other materials and placement on dirty surfaces. Some money handling habits such as: Keeping Naira notes in brassiere, socks, pockets, under the carpets or rugs and squeezing in the hand, frequently introduce microbes to the notes [7]. The aim of this research is to evaluate the micro-pathogens associated with Nigerian currency (Naira notes).

2. Materials and Methods

2.1. Study Area

The Naira notes were collected from Owerri (Municipal) the capital of Imo State, South Eastern Nigeria and one of the most ancient, colonial and cosmopolitan cities in Nigeria.

2.2. Sample Collection

A total of 88 pieces of Naira notes (10 pieces of each denomination) were collected for the analyses. 80 samples of the naira notes (#5, #10, #20, #50, #100, #200, #500 and #1000) were collected randomly by exchanging notes from various people (Teachers, drivers, bus conductors, traders, store keepers and other individuals) while 8 samples were collected from Central Bank of Nigeria (CBN), Owerri branch which served as the control.

2.3. Preparation of Media for Microbial Analyses

The media used for isolation of microorganisms include nutrient agar, MacConkey agar, salmonella shigella agar, blood agar, mannitol salt agar, nutrient broth, Sabouroud dextrose agar and potato dextrose agar. The different media used in Isolation were prepared according to manufacturer's instructions.

2.4. Microbiological Analyses of the Samples

Each of the samples was collected and soaked in 100ml aliquots of sterile buffered (0.1% w/v) peptone water (Oxide) for about 60 minutes (an hour) to dislodge the cells into suspension at ambient temperature. The notes were removed and the resulting peptone water solution served as the test samples. Exactly 1ml of the test sample was added to 9.0 mls of sterile physiological saline in a test tube and ten-fold serial dilutions were made. Then 0.2 ml was aseptically transferred to plates of nutrient agar, mannitol salt agar, MacConkey agar , salmonella shigella agar, blood agar, Sabouroud dextrose agar (SDA) and potato dextrose agar (PDA) and was spread using a sterile bent glass rod. The culture plates were incubated at 37^0C for 24hrs with the exception of SDA and PDA which was incubated at room temperature for 24-72 hrs. At the end of the incubation, the plates were examined for microbial growth and counted.

2.5. Isolation of Microorganisms from Collected Samples

Bacteria were isolated and characterized using cultural identification, morphological identification, using Gram staining reaction and other biochemical tests which include; coagulase, indole, motility, oxidase, urea, triple sugar iron agar and sugar fermentation as described by Bergeys manual of determinative bacteriology [8].

While fungi were isolated and characterized using the growth rate, colonial morphological features and microscopic morphological features. The color of aerial hyphae and substrate hyphae was observed and staining procedure as described by Cheesbrough [9].

2.6. Statistical Analyses

Data generated from this study was analyzed using IBM SPSS statistical software, Chi-square test and analysis of variance. The variables were expressed in mean and standard deviation. A $p < 0.05$ was considered statistically significant.

3. Results

Table 1 shows the microbial count of Naira notes. The result revealed that 20 naira note had the highest growth of $50.0\pm0.1x10^3$ cfu/ml for bacteria, followed by 10 Naira note which had $44.0\pm0.5x10^3$ cfu/ml while the least was 50 Naira note which recorded $4.0\pm0.6x10^3$ cfu/ml . The fungal count of the Naira notes revealed that 5 Naira note has the highest fungal growth of $23.0\pm0.1 x10^3$ cfu/ml, followed by 20 Naira which recorded $19.0\pm0.7x10^3$ cfu/ml while the least was 1000 Naira note which had $3.0\pm0.9 x10^3$ cfu/ml. The result simply shows that lower

denominations of the Naira notes contain the highest microbial growth because of the frequent exchange by the poor masses (hawkers, conductors, petty-traders).

Table 2 shows the identified bacteria isolated from the Naira note, the bacteria isolated are *Staphylococcus saprophyticus, Staphylococcus aureus, Clostridium* sp. *Escherichia coli, Proteus* sp. *Staphylococcus epidermidis, Corynebacterium* species, *Bacillus* sp. *Micrococcus* species and *Klebsiella* species.

Table 3 shows the cultural and morphological characteristics of the fungi isolated from the Naira notes . *Aspergillus flavus, Aspergillus fumigates, Aspergillus niger, Rhizopus* spp., *Mucor* spp., *Penicillium* spp. and *Fusarium* species were all isolated from the Naira notes.

Table 4 shows the distribution of the microbial isolates according to different denominations. The result showed that 20 Naira recorded the highest microbial isolate of 81(20.3%), followed by 10 Naira note 70(17.5%) while the least was 1000 Naira note 18(4.5%). However, it is an indication that 20 Naira and 10 Naira are use more in the day to day transactions by the populace. Fig 1 shows the overall frequency of the organisms isolated from the Naira notes. *Staphylococcus saprophyticus* had the highest frequency of occurrence of 44, followed by *Bacillus* species which had 41 while *Rhizopus* species had the least frequency of occurrence of 5 .

Fig. 2 shows the comparison of microorganisms isolated from the different denominations of the Naira note. 20 Naira had the highest occurrence of bacteria (58) and fungal occurrence of 19, the least was 1000 Naira which recorded the occurrence of 13 and 5 for bacteria and fungi, respectively.

Table-1. Microbial Count of Naira Notes

NAIRA DENOMINATION	BACTERIA CFU/Ml X 10^3	FUNGI CFU/Ml X 10^3	BACTERIA CFU/Ml X 10^3	FUNGI CFU/Ml X 10^3
1000	9.0 ±0.5	3.0 ±0.9	NBG	NFG
500	13.0 ±0.7	7.0 ±0.3	NBG	NFG
200	25.0 ±0.5	11.0 ±0.4	NBG	NFG
100	29.0 ±0.1	11.0 ±0.5	NBG	NFG
50	4.0 ±0.6	12.0 ±0.1	NBG	NFG
20	50.0 ±0.1	19.0 ±0.7	NBG	NFG
10	44.0 ±0.5	17.0 ±0.2	NBG	NFG
5	34.0 ±0.4	23.0 ±0.1	NBG	NFG

Keys: CFU = Colony forming unit; NBG = No bacteria growth ; NFG = No fungal growth

4. Discussion

The present study have shown that most Nigerian currency (Naira notes) in circulation are contaminated with a variety of microorganisms, some which are pathogenic. However, microorganisms (bacteria and fungi) were not recovered from the fresh Naira notes (control) examined in this study. This could be as a result of the currency was impregnated with disinfectant to inhibit the microorganisms. The Pathogens isolated from the currency notes were as a result of mishandling of the money as stated by Takora [10]. The microorganisms found on the Naira notes supports reports from other part of the world that currency notes are usually contaminated by microorganisms that cause a wide range of diseases [11]. Dirty notes are usually moist and thus provides favourable conditions such as substrate acquired from human body and due to handling as well as dust from the environment [12].

The study revealed that the lower denominations (#5, #10, #20, #50, #100, #200) had the highest microbial counts than the higher denominations (#500, #1000). The reasons for this might be that the lower denominations are more frequently exchanged and handled in petty and daily monetary transactions. The result revealed that 20 naira note had the highest growth of 50.0 x10^3 cfu/ml for bacteria, followed by 10 Naira note which had 44.0 x10^3 cfu/ml while the least was 50 Naira note which recorded 4.0 x10^3 cfu/ml . The fungal count of the Naira notes revealed that 5 Naira note has the highest fungal growth of 23.0 x10^3 cfu/ml, followed by 20 Naira which recorded 19.0 x10^3 cfu/ml while the least was 1000 Naira note which had 3.0 x10^3 cfu/ml. The result simply shows that lower denominations of the Naira notes contain the higher microbial growth because of the frequent exchange by the masses (hawkers, conductors, petty-traders). This study is consistent with the work of Haquu [13] who studied Currency Notes as germ carriers.

The bacterial isolates from the Naira notes were *Staphylococcus saprophyticus, Staphylococcus aureus, Clostridium* sp. *Escherichia coli, Proteus* sp. *Staphylococcus epidermidis, Corynebacterium* species, *Bacillus* sp. *Micrococcus* species and *Klebsiella* species. These microorganisms could have contaminated the Naira notes through soil, clothing, food or hands of users. Some of these microorganisms are potential disease agents.

Table-2. Identification of Bacteria Isolated From the Naira Note

			MICROSCOPY				BIOCHEMICAL REACTIONS										CARBOHYDRATE UTILIZATION						
Isolates	**COLONY FEATURES**	**NO**	**Cell Arrangement**	**spore**	**Motility**	**Capsule**	**Catalase**	**Oxidase**	**Coagulase**	**Indole**	**Nitrate**	**MethylRed**	**V.P**	**Urease**	**H_2S**	**citrate**	**Glucose**	**Sucrose**	**Lactose**	**maltose**	**Manitol**	**xylose**	**ORGANISM**
Q1	Smooth circular colonies creamy and butyrous and translucent on Nutrient Agar (NA)	20	Gram positive Group of oval cells	-	-	-	+	-	-	+	+	+	+	+	+	-	+	+	+	+	+	+	*Staphylococcus saprophyticus*
Q2	Circular smooth colonies with light-yellow pigments on Mannitol Salt Agar (MSA).	31	Gram positive Group of oval cells	-	-	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	*Staphylococcus aureus*
Q3	large, regular and convex, slightly opaque colonies on (BA)	18	Gram positive rods in pairs	+	-	-	+	-	-	+	-	-	-	+	-	-	+	+	+	+	+	-	*Clostridium* sp.
Q4	Small pink shiny smooth colonies on MacConkey Agar (MA).	15	Gram negative short rods in singles	-	+	-	+	-	-	+	-	+	-	-	-	-	+	±	+	+	+	+	*Escherichia coli*
Q5	Large swarmy creamy and translucent colonies on NA	29	Gram negative single short rods	-	+	-	+	+	-	-	+	+	-	+	+	+	+	+	+	-	-	-	*Proteus* sp.
Q6	Smooth circular colonies, creamy and translucent on NA	24	Gram positive Group of oval cells	-	-	-	+	-	-	+	+	+	+	+	+	-	+	+	+	+	+	+	*Staphylococcus epidermidis*
Q7	Gray non haemolytic colonies on BA	28	Gram positive rods in clusters	-	-	-	+	-	-	-	+	-	-	-	-	-	+	+	-	+	-	-	*Corynebacterium species*
Q8	Cream raised dull colonies, waxy with projection margins	41	Gram positive rods in pairs and some singles	+	-	+	+	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	*Bacillus* sp.
Q9	Smooth cream colonies and translucent on NA	16	Gram positive cocci in clusters and some in tetrads	-	-	-	+	+	-	-	-	+	+	-	-	+	+	+	+	+	-	+	*Micrococcus* species
Q10	Large mucoid pink colonies on MA	37	Gram negative short rods in singles	-	-	+	-	-	-	-	+	-	+	+	-	+	+	-	+	-	-	-	*Klebsiella* species

KEY:+=Positive,-=Negative,V.P=Voges-Proskauer,NA=NutrientAgar,MA=MacConkeyAgar,BA=Blood Agar.

Table-3. Identification of fungi isolated from the various Naira notes

Isoates	MICROSCOPY		MACROSCOPY/COLONY MORPHOLOGY				
	Characteristics	**NO**	**Nature of Colony**	**Reverse Side**	**Texture**	**Nature of Growth**	**ORGANISM**
Q11	Unbranched conidiophore and septate hyphae. Smooth conidiophore with variable lengths. Sterigmata covers the rside and forms a radiate head.	11	Black powdery, myceliated, spreading	Yellow	Velvety	Rapid	*Aspergillus flavus*
Q12	Septate hyphae with unbranched conidiophores arising from specialized foot cell. The conidiosphore is enlarged at the tip forming a rounded vesicle which are covered with flask-shaped that has chains of round conidia	12	Powdery, at first white then turns dark green	White to tan	Powdery	Rapid	*Aspergillus fumigatus*
Q13	Septate hyphae with unbranched conidiophores arising from specialized foot cell. The conidiosphore is enlarged at the tip forming a rounded vesicle which are covered with flask-shaped that has chains of smooth conidia	9	Wooly, at first white to yellow, then turns dark brown to black	White to yellow	Wooly	Rapid	*Aspergillus niger*
Q14	Numerous stolons run among the mycelia connecting groups of long unbranched sporangiosphores	5	Quickly covers agar surface with dense white cottony mycelia which later turns gray.	White	woolly	Rapid	*Rhizopus* spp
Q15	Non-septate hyphae, long branched sporangioshores and bear terminal round, spore-filled sporangia	29	White fluffy colony that later turns gray	White	fluffy	Rapid	*Mucor* spp
Q16	Septate hyphae with branched conidiosphores that have secondary branches.	13	White surface at first, then becoming very powdery, bluish green with white borders	White	Powdery	Rapid	*Penicillium* spp
Q17	Septate hyphae with crescent conidia on the conidiphores	15	Flat surface fuzzy yellow-white colonies	white	Powdery	Moderate	*Fusarium* species

Table-4. Distribution of Microbial Isolates According to the Different Denominations of the Naira Note.

Bacterial and fungal isolates	N1000%	N500 %	N200 %	N100 %	N50 %	N20 %	N10 %	N5 %	TOTAL %
Bacillus species	3(7.3)	3(7.3)	4(9.8)	5(12.2)	7(17.1)	9(21.9)	6(14.6)	4(9.8)	41(10.3)
Clostridium sp.	0(0.0)	1(5.6)	2(11.1)	3(16.7)	3(16.7)	4(22.2)	3(16.7)	2(11.1)	18(4.5)
Corynebacterium sp	0(0.0)	2(7.1)	4(14.2)	0(0.0)	5(17.9)	6(21.4)	6(21.4)	5(17.9)	28(7.0)
Micrococcus sp.	0(0.0)	0(0.0)	0(0.0)	2(12.5)	3(18.8)	4(25.0)	4(25.0)	3(18.8)	16(4.0)
Proteus sp	0(0.0)	0(0.0)	3(10.3)	4(13.8)	6(20.7)	6(20.7)	5(17.2)	5(17.2)	29(7.3)
Escherichia coli	2(13.3)	1(6.7)	1(6.7)	2(13.3)	2(13.3)	3(20.0)	2(13.3)	2(13.3)	15(3.8)
S. aureus	2(6.5)	2(6.5)	3(9.3)	4(12.9)	4(12.9)	5(16.1)	6(19.4)	5(16.1)	31(7.8)
Staphylococcus saprophyticus	2(4.5)	2(4.5)	4(9.1)	4(9.1)	6(13.6)	10(22.7	9(20.5)	7(15.9)	44(11.0)
Staphylococcus epidermidis	2(8.3)	2(8.3)	3(12.5)	3(12.5)	2(8.3)	5(20.0)	4(16.7)	3(12.5)	24(6.0)
Klebsiella sp.	2(5.4)	3(8.1)	5(13.5)	7(18.9)	6(16.2)	6(16.2)	5(13.5)	3(8.1)	37(9.3))
Aspergillus niger	1(3.2)	3(9.7)	5(16.1)	4(12.9)	3(9.7)	6(19.4)	5(16.1)	4(12.9)	31(7.8)
Aspergillus flavus	1(9.1)	1(9.1)	1(9.1)	1(9.1)	2(18.2)	2(18.2)	2(18.2)	1(9.1)	11(2.8)
Aspergillus fumigatus	1(8.3)	1(8.3)	2(16.7)	1(8.3)	2(16.7)	2(16.7)	1(8.3)	2(16.7)	12(3.0)
Fusarium sp.	0(0.0)	0(0.0)	1(6.7)	3(20.0)	4(26.7)	2(13.3)	3(20.0)	2(13.3)	15(3.8)
Mucor sp.	2(6.9)	3(10.3)	4(13.8)	4(13.8)	2(6.9)	6(20.7)	4(13.8)	4(13.8)	29(7.3)
Penicillium sp.	0.(0.0)	1(7.7)	1(7.7)	0.(0.0)	2(15.4)	3(23.1)	4(30.8)	2(15.4)	13(3.3)
Rhizopus sp.	0.(0.0)	0.(0.0)	0.(0.0)	0.(0.0)	1(20.0)	2(40.0)	1(20.0)	1(20.0)	5(1.3)
Total	18(4.5)	25(6.3)	43(10.8)	47(11.8)	60(15.0)	81(20.3)	70(17.5)	55(13.8)	399(100)

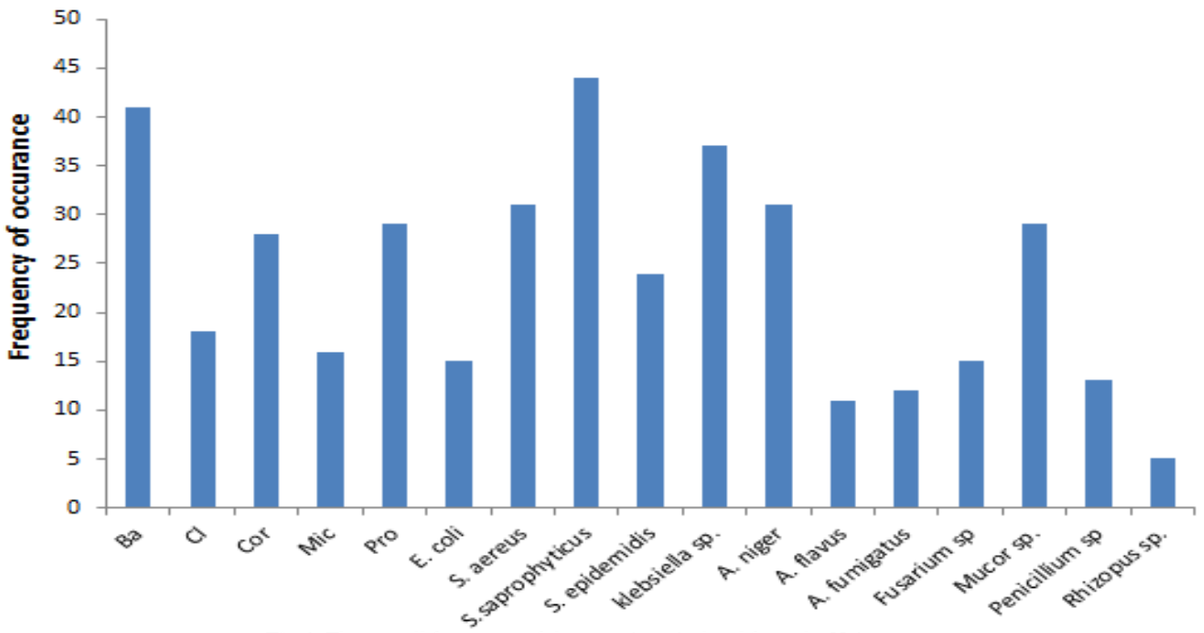

Fig-1. The overall frequency of the organisms isolated from the Naira notes

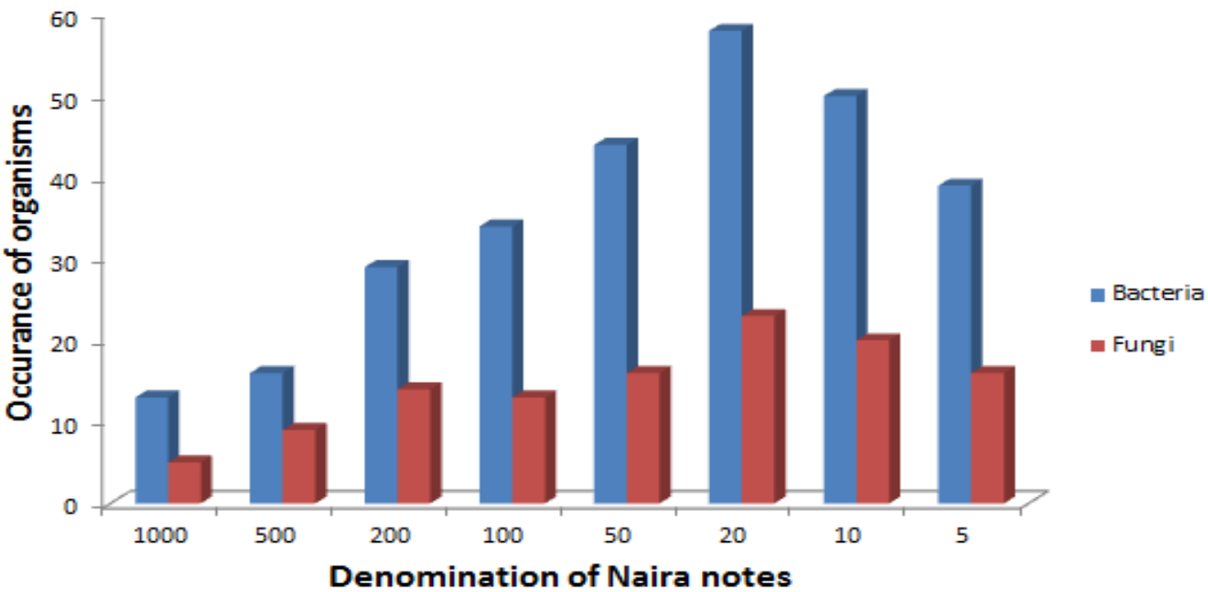

Fig- 2. Comparison of microorganisms isolated from the different denominations of the Naira note.

Bacillus which was isolated is a vast group of hardy spore forming species that live in the soil and when found in the environment; it could be transferred on the Naira notes due to its placement on dirty surfaces or handling with soiled hands. This is particularly common among traders and meat sellers. *Bacillus* species causes an emetic and diarrheal type food poisoning in man as revealed by Silma [14]. *Clostridium* and *Staphylococcus* species have been known to be responsible for food intoxication and poisoning [15]. The presence of *Staphylococcus* species on the Naira notes could have been due to rubbing off or may be surfing from a skin flake. Pathogenic Staphylococci haboured either by an asymptomatic carrier or a person with a disease, can be spread by the hands or expelled from the respiratory tract. *Staphylococcus* are ubiquitous, being found on normal skin and the nose, mouth and intestine as well as in the air, water, milk and sewage and on fomites. Infections occur when staphylococci enter the body through breaks, cuts and abrasions in the skin [16]. *Corynebacterium* species has been known as agent of respiratory and skin infections, enteritis, meningitis, stomach disorders and sinusis [17]. *Klebsiella* and *Proteus* species found on the Naira notes can cause wide range of disease such as wound infection, urinary tract infection and septicemia, when they are in contact with susceptible individuals [18]. These bacteria could have been introduced via contaminated water used to moisten the fingers while counting the Naira notes or cross contamination from offal's.

Most of the fungi isolates (*Aspergillus flavus, Aspergillus fumigates, Aspergillus niger, Rhizopus* spp., *Mucor* spp., *Penicillium* spp. and *Fusarium* species) could elaborate mycotoxins in food, which are dangerous to human health [19]. The habit of keeping money in bags, pockets, wallets, brassier, local pots and table covers have been observed among the majority of Nigerians, which may have largely contributed to the high fungal loads observed in this study.

5. Conclusion

The present study has shown that the Naira notes in circulation are contaminated with various microbial agents. Handlers of notes especially those who put them in their brassieres or other areas where there is intimate contact with the skin, dirty bags and pockets, local pots, under rug and carpets should exercise cautions, as there is risk of infection by microbial residents on the notes. Also the habit of wetting fingers with saliva while counting Naira notes should be avoided, organism on the notes could be transferred to the mouth by this actions. Dirty and mutilated notes should be withdrawn from circulation from time to time. The CBN should put in place a retrieval system, which insures that notes do not remain in circulation for too long. Money handlers should generally improve on their habit and ensure that the notes are not abused or mishandled.

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