Fungal flora of Nigerian currency notes in circulation in Benin City, Nigeria

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Abstract A mycological survey of Nigerian currency (naira) notes in circulation in Benin City was undertaken to determine the fungal species present, so as to bring to light the health implications of their presence. A total of 84 naira notes comprising 20, 50, 100, 200 and 500 naira denominations were obtained randomly from a bank, commuter bus, food canteen, and open market. Four-day old Potato Dextrose Agar cultures of diluted water diffusate of the currency notes were examined under the microscope and fungi were isolated and identified. The isolated fungi and their frequencies of isolation were *A. flavus* (90.5), *A. fumigatus* (42.9), *A. terreus* (57.1), *A. flavipes* (26.2) *A. niger* (59.5), *Candida albicans* (92.3), *Rhizopus sp* (2.7), *Penicillium sp* (4.0), *Fusarium sp* (12.8), and *Saccharomyces cerevisiae* (16.1%). The frequencies of fungi isolated from the various denominations varied significantly at 0.05 probability. While the 50 naira denomination had the highest colony count (mean of means = 41 colonies/ml) the 500 naira had the lowest colony count (mean of means = 8.3 colonies/ml). The high occurrence of fungi in the currency notes is of public health concern.

Keywords Currency · Notes · Fungi · Health · Nigeria

Introduction

Paper currency notes absorb moisture which encourages the growth of micro-organisms on them. Fungi get into money especially from air, soil and where it is kept (for instance, sacks pockets and socks). Money is contaminated as it circulates from hand to hand. Besides reducing the life span of the notes, some of these fungi have the potential to cause skin, eye and gastrointestinal infections [1, 2] infections of internal organs [3, 4] as well as serious diseases of the respiratory tract [5] in man. Here in Nigeria, currency notes are often manhandled and mutilated by different categories of people, including traders, churches, beggars and commuter bus conductors [6]. Fungi easily contaminate and grow on food, wood, paper, and walls [7–9]. The aim of this study was to determine and document the fungal species which commonly contaminate Nigerian currency (naira) notes in circulation in order to bring to light the health implications.

Eighty-four samples (3 each) of circulating naira (₦) notes (5, 10, 20, 50, 100, 200 and 500 denominations) were obtained randomly from 4 sources - a bank, commuter bus (a mixture of middle class and low-class people), food canteen (at the University of Benin) and an open market (with traders of mainly low-class people), in Benin City. Three new, crisp, unexposed bank notes of each denomination served as control. Each sample of the different denominations was separately left in 100 ml sterile distilled water for 48 hours. The resulting mixture containing currency diffusate was used as inoculum stock solution. A 1 ml aliquot of the stock inoculum was added to 9 ml sterile distilled water and 1 ml of each diluted stock transferred to triplicate Potato Dextrose Agar (Oxoid) plates (containing

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0.5 ml Chloramphenicol 500 mg, Pfizer) and was spread with a sterile glass spreader. The plates were incubated at room temperature ($28 \pm 2^\circ\text{C}$) for 4 days. The grown cultures were examined under the $\times 10$ and $\times 40$ powers of an optical microscope and the fungi identified by using conventional procedures and illustrations (comparing and matching cultural, pictorial and microscopic characteristics with descriptions of [7, 10, 11]. The germ-tube and chlamydospore tests were also done for *C. albicans*. The fungal cultures were confirmed by comparison with stored laboratory strains at the Mycology Unit of the Department of Botany, University of Benin, where culture samples were also deposited. Student *t*-test was used to test the difference in frequency of isolation of fungi as well as fungal load while the relation-

als exposed to the atmosphere [14, 15] suggesting that the fungal contaminants are mainly from soil and atmosphere when currency notes are exposed; this is corroborated by the absence of fungal growth on the control notes. The higher frequency of isolation from ₦50 denomination and ₦20 denominations could be due to these notes being more in circulation and, therefore, most frequently handled. In March 2007, the Nigerian Government changed the ₦20 note from paper to polymer (plastic). This is a strategy which reduces contamination of currency by microbes [16]. For instance, plastic currency can be washed easily without damage to it. There was no correlation between denomination and type of fungi isolated and between source of currency and type of fungi present. However, the high colony

Fig. 1 Total frequency of isolation of fungal species from currency notes.

ship between source of currency notes and fungi present or between currency denomination and fungi isolated was determined by correlation.

The isolated fungi were *Aspergillus flavus*, *A. fumigatus*, *A. terreus*, *A. flavipes*, *A. niger*, *Candida albicans*, *Rhizopus* sp., *Penicillium* sp., *Fusarium* sp., and *Saccharomyces cerevisiae*, with total frequency of isolation of 90.5, 42.9, 57.1, 26.2, 59.5, 92.3, 2.7, 4.0, 12.8, and 16.1%, respectively (Fig. 1). Colony counts of fungi in the ₦50 denomination notes were consistently high (mean of means = 41 colonies/ml) while the ₦500 naira notes had the lowest colony counts (mean of means = 8.3 colonies/ml) as in Table 1. No growth was seen on the control currency notes. The prevalence of the isolated fungi in this work had been reported in soil and air samples [12, 13] and from materi-

Table 1 Mean colony counts (Cfu/ml) of fungi isolated from currency notes from different sources (values are means of three replicates)

Denom. (Naira)	Colony count (Cfu/ml) *				Mean of means	
	Market	Bus	Bank	Canteen	Control	
5	25 ¹	7 ²	4 ²	20 ¹	14	0.0
10	35 ¹	20 ²	32 ¹	22 ²	27	0.0
20	33 ¹	22 ²	36 ¹	47 ³	35	0.0
50	41 ¹	43 ¹	46 ¹	34 ¹	41	0.0
100	40 ¹	24 ²	15 ²	13 ²	23.3	0.0
200	23 ¹	44 ²	13 ³	13 ³	2.3	0.0
500	9 ¹	7 ¹	9 ¹	8 ¹	8.3	0.0

*Values in the same row which have same numbers in superscript are statistically insignificant.

counts in market samples could be as a result of the high rate at which money changes hands in the market. Some of these fungi reported here were also isolated from currency notes previously [2, 16]. The health risk in handling money and ready to eat food with same hands without caution was reported by Michaels [1]. Therefore, the high colony count recorded in the current study for ₦20 naira denominations from canteen is worthy of note. There is no documented report of mycological survey of currency notes in Nigeria.

Conclusions

Although there is no direct evidence that microbes on currency notes result in infection, but still the public should be enlightened on the possibility of acquiring infections through inhalation of fungal spores and application of saliva on fingers while counting money, and eating with unwashed hands after handling currency notes. Keeping money in body locations supposedly for safety should be discouraged.

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