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Assessment of Microbial Contamination of Ethiopian Currency Notes.

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ABSTRACT

Microbial contaminations of the Ethiopian currency have been receiving very poor attention. The objective of this study was to investigate the extent of degree of bacterial contamination of Ethiopian paper currency notes. A total of 25 old paper currency notes and 15 fresh paper notes, with five representatives of each denomination, were collected from artisans (supermarkets, bakeries, butcheries, taxi drivers, milk sellers, merchants, fruits and vegetable sellers and bajaj drivers) and commercial bank of Ethiopia respectively. By means of broth wash and appropriate culturing the microbes were isolated, characterized, and then identified to genus level. Results showed that all the samples had bacterial growth of which count varied based on the degree of dirtiness of the birr. Old paper notes bear much more microbial colonies and gram positive bacteria were much higher in number than those of the gram negative ones. But there was no any relationship between the degree of contamination and denominations which probably might have resulted from the same constructional substance of the paper notes. As confirmed by biochemical tests the following pathogenic and potentially pathogenic bacterial genera were isolated from the currency notes: *Escherichia coli*, *Staphylococcus spp.*, *Bacillus*, *Klebsiella*, *Streptococcus*, *Serratia*, *Salmonella*, *Pseudomonas*, *Citrobacter*, *Shigella*, *Listeria*, *Enterobacter* and *Micrococcus*. The only two fungal genera found on Ethiopian paper notes investigated here were *Aspergillus spp* and *Penicillium spp*. Moreover the estimated number of microbes on each paper note is also given. The Ethiopian currency notes are found contaminated with pathogenic or potentially pathogenic microbes; in rare cases these contaminated paper currencies could act as a vehicle of transmission of diseases. So, an efficient public awareness and raising conciseness seem to be necessary. Therefore, it seems that creating public awareness on this issue may help minimize the occurrence of disease from microbial contamination.

Keywords: Microbial Contamination, Ethiopian currency notes, Public health

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INTRODUCTION

The Ethiopian birr (Amharic) is the nomenclature of currency in Ethiopia. Before 1976 dollar was the official English translation of birr. Today it is officially referred to as birr in English as well. In 1931 the Emperor of Ethiopia, Haileselassie formally requested that the international community use the name Ethiopia instead of Abyssinia and the issuing bank of Abyssinia also became the bank of Ethiopia. The Ethiopia birr is the second most used currency in Africa with 88 million users after Nigerian Naira. One hundred eighty six billion birr was in circulation in 2008(en.wikipidan. org).

Paper currency is widely exchanged for goods and services in Ethiopia and in most other countries worldwide. In 1999 the United States department of Treasury printed more than 35 billion one dollar bills each with life span of about 18 months. In recent study 94% of United States one dollar bills were found to be contaminated with potentially pathogenic microorganisms. The possibility that currency notes might act as vehicles or fomites for transmission of pathogenic microorganisms was suggested in 1970s (Pope *et al.*, 2002, Pinner, *et al.*, 1996).

Bacteria have been shown to be spread from person to person via contact with fomites. Paper currency is commonly and routinely passed among individuals. Thus bacteria could be spread on the surface of paper currency. Paper currency can be contaminated by droplets during coughing, sneezing, touching with previously contaminated hands or other materials and placement on dirty surface and it is commonly handled by various categories of people during transaction. Contamination of objects by pathogenic microorganisms is much public health concern that can be source of transmitting pathogens (Pope, *et al.*, 2002).

Paper currencies are widely used and each currency is exchanged many times during the time it circulates. If some of these papers are contaminated with pathogenic bacteria, there is a possibility to spread these microorganisms, to uncontaminated ones.

Comprising a large number of organisms, microbes are found everywhere including on paper notes frequently exchanged among different people of different social classes and occupations; even among children. Therefore contaminated paper notes can result in spreading dangerous diseases caused by pathogens. People with different skins, sweat pH, skin secretions, activities and diseases (skin, digestive and respiratory tract diseases) bear too many different and probably disease causing microbes which can be transferred easily via handling money (Abrams BL and Waterman NG, 1972).

There are several studies on the microbial contamination of currency notes worldwide (Abrams BL and Waterman NG, 1972; El- Dars FM and Hassan WM, 2005; Goktas P and Oktay G, 1992; Jakir hosen M *et al.*, 2006; Khin NO *et al.*, 1989; Oyero OG and Emikpe BO, 2007; Pope TM *et al.*, 2002; Shekarforoush Sh *et al.*, 2009; Umeh EU *et al.*, 2007 and Xu J, Moore JE and Millar B Ch, 2005) and many pathogens have been identified including *Staphylococcus*, *Escherichia*, *Klebsiella*, *Shigella*, *Salmonella*, *Bacillus*, *Pseudomonad*, *Diphtheroids*, *Citrobacter* and so on. However, degrees of contamination and types of microbes may be area-dependent because of the texture of paper notes, sanity condition and microbe endemism (El, Dars, FM and Hassan WM, 2007).

Microbial contamination of paper money is not only confined to developing nations. Several studies from the United States reported contamination of coins and paper bills and identification of the presence of pathogenic microbes like *Staphylococcus aureus*, *E.coli* *Klebseille*, *Enterobacter* and others (Abrams BL and Waterman NG, 1972).

A study in Egypt also reported that 65% of the paper bills had bacteria like *Staphylococcus albus*, *Staphylococcus aureus* and *Klebseille pneumonia*. In addition to this various pathogenic microbes associated with tuberculosis, meningitis, pneumonia, tonsillitis, peptic ulcers, genital tract infections, gastroenteritis and throat infection had been identified in damaged or spoiled notes held together with bits of sticky tapes (Goktas P and Oktay G, 1992).

In Bangladesh, research studies reported high rates of microbial contamination of currency notes in circulation. The micro organisms implicated included members of family Enterobacteriaceae, *Mycobacterium* spp., *Vibrio* spp., *Bacillus* species, *Staphylococcus* species, *Micrococcus* species and *Corynebacterium* species.

Most likely contaminants of paper money are environmental organisms such as gram positive flora (especially bacillus species) and those arising from human normal skin flora such as *Staphylococcus aureus* (Charnock. C, 2005).

Since money is very important for human life as it facilitates the needs and currency notes have vital role for exchange of goods and services worldwide, these paper notes and coins can be contaminated by microbes when they come in to contact with skin, anal region, wounds, nasal secretions generated by sneezing, coughing and some persons entering these paper notes and coins in to their mouth. So this microbial contamination of currency notes could lead to transmission of diseases from person to person that causes different types of diseases such as tuberculosis, pneumonia and other communicable diseases. These can be spread by different means such as food, water, air, soil etc., and thus have risk on public health of the world population. To minimize the risk of microbial contamination by paper currency notes, it requires special consideration to conduct complex studies and to prove the pathogenic nature of the microbes.

The main concern of this study was to confirm whether the Ethiopian paper currency notes are contaminated by bacteria & fungi; then to isolate, characterize, identify the microbes and then raising public awareness during currency handling.

MATERIALS AND METHODS

Sample collection

A total of 25 readily available old paper notes (paper notes in circulation) and 15 intact fresh paper notes (paper notes newly minted and were not entered in currency system) in Axum, Ethiopia were used in this study. The notes selected for the study comprised nine series of 5 currency notes each. Three of which included Birr 100 (units of currency in Ethiopia is Birr) fresh notes and the rest included old notes of Birr 1, Birr 5, Birr 10, Birr 50 and Birr 100 (table 1). Samples were collected wearing sterile gloves from different occupation groups such as supermarkets, bakeries, butcheries, taxi drivers, milk sellers, merchants, fruits and vegetable sellers, Bajaj drivers and so on and fresh paper notes from Commercial Bank of Ethiopia, Axum Branch, Ethiopia. Each paper note was kept in separate sterile nylon bag until the preparations took place.

Table 1: Numbers of old and fresh paper notes examined for each denomination

Type of Currency Notes	Birr 1	Birr 5	Birr 10	Birr 50	Birr 100	Birr 100 (1)	Birr 100 (2)	Birr 100 (3)
New Notes	0	0	0	0	0	5 ^b	5 ^b	5 ^b
Old notes	5 ^a	5 ^a	5 ^a	5 ^a	5 ^a	0	0	0

^aPaper notes collected in sterile condition from artisans

^bPaper notes collected in sterile condition from bank treasury

Microbe isolation, culturing and characterization

For microbial isolation each paper note was treated by 100 cc broth wash. Using a sampler 0.1 cc of the microbe bearing liquid was transferred into sterile appropriate media (Abrams BL, Waterman NG, 1972; Goktas P and Oktay G, 1992; Khin NO *et al.*,1989 and Pachter B R *et al.*, 1997). The number of colonies were then counted using colony counter after incubation for 72 hours at 37°C and pure colonies were isolated by using streaking and restreaking method where pure colonies can be identified by using colony morphology, growth patterns, colony pigmentation, etc. Once pure colonies were isolated, they were categorized into gram positive and gram negative by using the gram-staining technique. After gram staining the colonies were identified to genus level by using biochemical tests. Here to identify the microbes to genus level Mac-conkey agar, blood agar, and chocolate agar were used for the bacterial colonies. For the fungal identification, potato dextrose agar (PDA) was used and they were identified based on their morphological features, growth pattern, spore formation and others. The total number of cells on each paper note was calculated by using the formula which was given below; the results were tabulated in table2 and table3.

$$\text{Total Number of Cells} = \text{Number of Colonies} \times \frac{1}{\text{Dilution Factor}}$$

Table 2: Data acquired on old paper notes: the number of colonies on each paper note, the types of gram positive and gram negative bacteria and the number of fungal colonies.

Old Currency Note Birr 1								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	8x10 ³	1	1	-	1	-	5	9x10 ³
2	6x10 ³	2	2	-	-	2	-	
3	15x10 ³	9	3	2	-	-	1	
4	7x10 ³	3	1	1	-	-	2	
5	9x10 ³	6	3	-	-	-	-	
Old Currency Note Birr 5								
S No	No. of colonies (CFU)	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	21x10 ³	12	9	-	-	-	-	24x10 ³
2	58x10 ³	4	-	1	-	30	23	
3	4x10 ³	4	-	-	-	-	-	
4	32x10 ³	26	3	2	1	-	-	
5	5x10 ³	2	3	-	-	-	-	
Old Currency Note Birr 10								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	44x10 ³	1	38	-	5	-	-	23x10 ³
2	3x10 ³	1	2	1	-	-	-	
3	3x10 ³	-	3	-	-	-	-	
4	28x10 ³	4	21	-	1	-	2	
5	37x10 ³	35	2	-	-	-	-	
Old Currency Note Birr 50								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	29x10 ³	-	28	-	-	-	1	20x10 ³
2	23x10 ³	8	10	-	-	2	3	
3	15x10 ³	12	3	-	-	-	-	
4	4x10 ³	1	3	-	-	-	-	
5	29x10 ³	28	1	-	-	-	-	
Old Currency Note Birr 100								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	14x10 ³	10	4	-	-	-	-	15x10 ³
2	15x10 ³	9	6	-	-	-	-	
3	10x10 ³	10	-	-	-	-	-	
4	12x10 ³	6	6	-	-	-	-	
5	13x10 ³	6	1	-	-	-	6	

Table 3: Data acquired on fresh paper notes: the number of colonies on each paper note, the types of gram positive and gram negative bacteria and the number of fungal colonies.

New Currency Note Birr 100								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	2x10 ³	-	-	-	-	2	-	2x10 ³
2	0	-	-	-	-	-	-	
3	3x10 ³	1	-	-	-	1	1	
4	2x10 ³	-	2	-	-	-	-	
5	3x10 ³	-	-	-	-	3	-	
New Currency Note Birr 100								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	4x10 ³	-	-	-	-	2	2	2x10 ³
2	0	-	-	-	-	-	-	
3	3x10 ³	-	-	-	-	2	1	
4	0	-	-	-	-	-	-	
5	3x10 ³	2	-	-	-	1	-	
New Currency Note Birr 100								
S No	No. of colonies CFU	Gram +ve		Gram -ve		Fungi		Average No. of colonies
		Bacillus	Coccus	Bacillus	Coccus	Asp.	Pen.	
1	3x10 ³	-	-	-	-	1	2	3x10 ³
2	2x10 ³	-	-	-	-	-	2	
3	2x10 ³	-	-	-	-	-	2	
4	3x10 ³	-	-	-	-	-	3	
5	5x10 ³	-	-	-	-	2	3	

DISCUSSION

Noting the significant occurrence of microbes on old paper notes and their negligible occurrence on the fresh ones gave clues that their sources should be the places where the paper notes were collected. The skin, respiratory system, digestive system and also other places where notes are deposited or come into occasional contact such as earth, mud and so on, are the major sources of the microbes.

Owing to their constructional substance (which is pure cotton), the Ethiopian paper notes cannot be suitable media for microbial growth, and multiplication. So notes may play a major role as a vehicle and a surface area for microbial transfer. It means that frequency and duration of presence of a specific microbe should not be expected to prevail the others. Naturally, microbes found on paper notes come from the sources with which they come into contact.

Since Paper notes are commonly contaminated with frequently high pathogenic or potentially pathogenic microbes, they may cause serious diseases. As reported earlier, there is no strong relationship between demonstrations and degrees of contamination, probably because of the same substance (pure cotton). However, use of polymer paper notes may decrease contamination to a large extent; it has been well shown that currency provides a surface area for microbe establishment and functions as a strong vehicle in their transmission. The microbial load of the currency note may vary depending on the source of the sample. For example, the highest intestinal pathogen contamination was reported in butcheries and the lowest isolates were observed on paper notes obtained from office workers. As a result, the poorer the sanitary condition, the more the contamination will be. The matter of great importance is that not only children and foods are susceptible to microbial infections, but also vulnerable people and patients of weakened immune system as well as healthy people are prone to serious dangers, due to presence of different and abundant pathogens on paper notes.

The pathogenic or potentially pathogenic bacterial genera found on these Ethiopian currency notes, namely *Escherichia coli*, *Staphylococcus spp.*, *Bacillus*, *Klebsiella*, *Streptococcus*, *Serratia*, *Salmonella*, *Pseudomonas*, *Citrobacter*, *Shigella*, *Listeria*, *Enterobacter*, and *Micrococcus* (which are similar to previous studies in different countries) may cause a wide variety of diseases from food poisoning, wound and skin

infections, respiratory and gastro intestinal problems to life threatening diseases such as meningitis, septicemia and the like. The pathogenic genus *Aspergillus*, reported earlier on the Nigerian, Iranian and other countries currency, was found frequently on the paper notes investigated in this study even on the intact newly minted ones. The inhalation of its spores may lead to severe pulmonary aspergillosis. Moreover the *Penicillium* spp., are occasional causes of infection in man, the resulting disease is called penicilliosis. The above mentioned diseases and many others threaten Ethiopian Children, hospital hosts, immunocompromised patients and even healthy people who are in contact with paper notes.

Therefore, the following recommendations and suggestions have been given to reduce currency contamination and improve public health:

- Enhancement of public awareness of currency contamination through media in order to keep currency clean, out of children reach and away from foods and more care is taken while handling money
- Use of washable polymer paper notes
- Disinfection of paper notes in banks by ultra violet light, supersonic and chemicals (Singh *et al.*, 2002).
- Of course electronically transaction replaces the traditional methods of trading in which paper notes play a key role. The later can greatly decrease wasting national resources on replacing tattered paper notes.

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