

## Efficacy of Essential Oils in the Control of Microbes in Contaminated Currency Notes in India

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### Abstract:

The environment plays a vital role in the transmission of diseases and also in the spread of resistant strains of microbes to humans. These routes of transmission are of great importance in the health status of many populations in developing countries like India. Paper currency notes that are passed from hand to hand are likely to be contaminated with disease-causing microorganisms especially if handled in an unhygienic way. The present study was made to investigate the bacterial contamination of currency notes collected from people of different walks of the society and the efficacy of three essential oils for controlling the bacterial contamination of currency notes in India. The study reported here found that the extent of contamination was found related to the denominations of the currency. The prevalence occurrence of pathogenic microorganisms isolated from Indian paper currency notes from different occupational groups showed that all the currency denominations groups had microbial contamination and Rs.500 had less contamination than other denominations. It was derived from the result that cinnamon oil was proved to be the best essential oil in warding off harmful microbes much more effectively than the other essential oils.

**Keywords:** Indian currency, E.coli, Cinnamon bark oil, Lemon grass oil and Clove oil.

### 1.0 Introduction:

Health care-related infections are the most frequent adverse event in health-care worldwide and millions of patients are affected by health care-associated infections worldwide each year, leading to significant mortality and financial losses for health (Basavarajappa *et al* ;2005) . Health care-associated infections have long been established as the biggest cause of avoidable harm and unnecessary death in the health systems of developing countries. India faces the challenge of a range of infectious diseases. Every fifth new tuberculosis case in the world lives in the Indian subcontinent. India has been less severely affected by the HIV epidemic than many other countries, despite early predictions of disaster, but still has almost three million people living with the virus. Bacterial resistance is an emerging peril because of the widespread misuse of broad-spectrum antibiotics(Emory *et al* ;1993).

Microorganisms are known to spread via air, water, food etc. an important mechanism of the spread of pathogens by fomites. Paper currency notes which are transferred from one individual to other are known to carry bacteria on their surface

and are responsible for transmitting them (Ayandele and Adeniyi, 2011). Microorganisms are known to spread via air, water, food etc. an important mechanism of the spread of pathogens by fomites( Awodi *et al.*, 2000). Paper currency notes which are transferred from one individual to other are known to carry bacteria on their surface and are responsible for transmitting them( Abrams, *et al* ;1972). Paper money, therefore presents a particular risk to public health, since communicable diseases can spread through contact with fomites (Sushil Kumar *et al* ;2011) . Money on which pathogenic currency microorganisms might survive represents an often overlooked reservoir for enteric disease .Paper, can be contaminated by droplets during coughing, sneezing, touching with previously contaminated hands or other materials and placement on dirty surface( Nagesh *et al* ; 2010). Numerous research on currency in several countries indicated bacterial contamination. A study by Hosen *et al.*, (2002) in Bangladesh revealed coliform contamination of 80% of thirty old two-taka notes, Pope *et al.*, 2002, isolated pathogenic or potentially pathogenic organisms from 94% of one-dollar bills, Basavarajappa *et al.*, (2005) found 96 out of 100

currencies contaminated with bacteria (*K. pneumoniae*, *E. coli*, *S. aureus*, *Pseudomonas* species and *S. Typhi*), fungal and protozoa and Umeh et al., in 2007, revealed that 89.8% of Nigerian currency notes in circulation within the University of Agriculture, Makurdi Campus has microbial contamination. Uneke and Ogbu (2007), studied that paper currency was widely exchanged for goods and services in countries worldwide. Ghanaian currency notes in circulation were found to be contaminated with pathogenic microorganisms which can spread human diseases (Patrick Feglo and Michael Nkansah; 2010).

The scarcity of information may contribute to the absence of public health policies regarding currency usage, handling, and circulation (Brady et al; 2000). This lack of information may have contributed to the absence of public health in the developing countries have fostered a higher level of public awareness about the potential for currency contamination by microorganisms. In addition, it remains ambiguous how long bacteria can survive on paper currency notes or how many organisms may be transferred from person to person. (Khin et al; 1989). Although little has been written concerning the potential of banknotes, coins and fomites to become reservoirs and vehicles for the transmission of pathogens, the data have been quietly accumulating (Goktas et al; 1992). Here, an attempt has been made to investigate the bacterial contamination of currency notes collected from people of different walks of the society in Coimbatore, Tamil nadu, India and the comparative efficacy of three essential oils, Cinnamon bark oil, Lemon grass oil and Clove oil against the microbes prevalent in the currency notes.

## 2.0 Material and Methods:

### 2.1 Sampling Technique of Currency notes collected from different sources

A total of 20 samples of Indian currency (the Rupees), comprising notes in all seven denominations (Rupees 10, 20, 50, 100, 500) were investigated. Coins were not sampled because their circulation rate is too low. The investigation was conducted from July to September 2014 in Coimbatore city of Tamilnadu. Samples were collected from many social status people at different parts of Coimbatore, Tamilnadu at their work place. Currency notes were obtained from various groups of people namely fish market, vegetable shop, rickshaw driver and bus conductor. Samples were randomly obtained by using large-denomination notes to smaller

denominations by respective group. The individuals were asked to place the currency notes into the sterile polythene bags, sealed, and were taken to the laboratory of the Department of Zoology, PSGR Krishnammal College for Women, Coimbatore, Tamil nadu for analysis.

### 2.2 Bacteriological Analysis

Isolation of various bacterial contaminants from the currency notes was performed via standard techniques described previously (Singh et al., 2002). Briefly, a sterile, cotton-tipped swab moistened with sterile physiological saline was used to swab both sides of the currency note. The swabs were directly inoculated on blood agar and MacConkey agar. The pairs of inoculated media were incubated aerobically at 35-37°C for 24 hours and then examined for bacterial growth according to standard protocol described previously (Iwakeel et al; 2011). The authors isolated bacteria by assessing colony characteristics and Gram reaction, and by conducting catalase and coagulate tests; haemolysis, sugar fermentation, and other biochemical tests, including tests for indole production, citrate utilization, and urease activity; triple sugar iron (TSI) agar tests (for glucose, sucrose, and lactose fermentation); gas and hydrogen sulphide production tests; and oxidase tests. Bacteria were identified but were not quantified.

### 2.3 Application of Essential Oils and its bio-assay:

The essential oils were purchased from the Aromatic Oil Stores, Coimbatore, and Tamil Nadu and formulated for the experiment. A stock solution at 1000 ppm is prepared by dissolving the essential oils in distilled water using 2 ml of 100% acetone respectively. The serial dilutions of essential oils at the concentration of 5%, 15% and 25% and three replicate of each concentration were made. The essential oils, Cinnamon bark oil, Lemon grass oil and Clove oil were sprayed (w/w) on currency note by using a hand spray pump in different concentration of 5%, 15% and 25 % separately and they were used for its efficacy against micro-organisms present in the currency notes. The currency notes were dried in the oven at 70°C for 6 hours was dried for half an hour at room temperature and packed in suitable air tight plastic folders and kept for 2 – 3 days for even spread of the essential herbals on the currency notes.

## 3.0 Results and Discussion:

The results of the present investigation indicates that the frequency of occurrence of *Escherichia*

*coli* was the highest in the currency notes which indicates the presence of faecal contamination via cross-contamination with raw products or poor personal hygiene. The prevalence occurrence of pathogenic microorganisms isolated from Indian paper currency notes from different occupational groups showed that all the currency denominations groups had microbial contamination and Rs.500 had less contamination than other denominations like Rs.10, Rs.20, Rs.50 and Rs.100. These lower denominations are used frequently for different normal daily activities. Higher denominations are not used as frequently

as lower denominators. Smaller unit notes appeared to be more highly contaminated than larger unit notes, probably because the smaller unit notes are most frequently handled in petty, daily monetary transactions and are often tattered, dirty (Saeed *et al*; 2011). The bacterial contamination in Indian currency ten rupee notes collected from various groups was shown in Fig. 1 and 2. It was observed that out of the five currency notes each collected from different sources, the maximum bacterial contamination occurred in the notes collected from fish market followed by bus conductor.

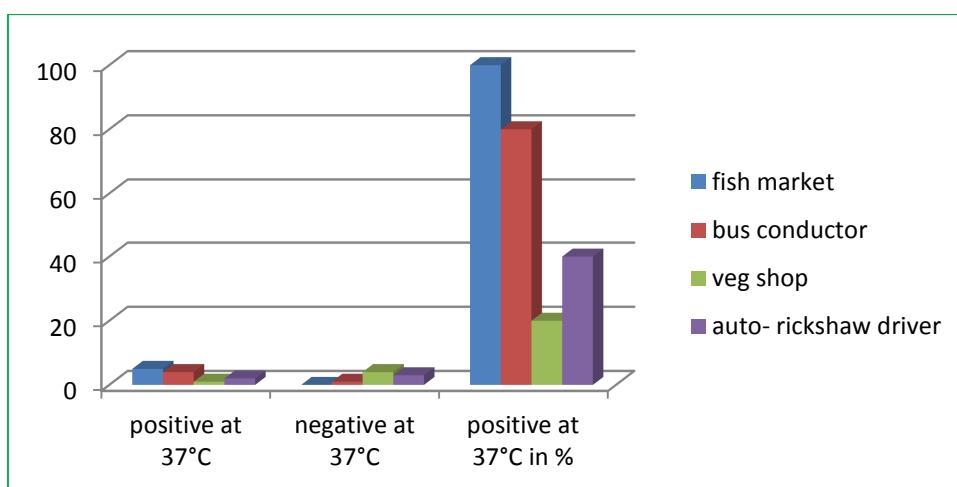


Fig. 1: Bacterial count incubation at 37°C in Indian currency ten rupee notes collected from various groups

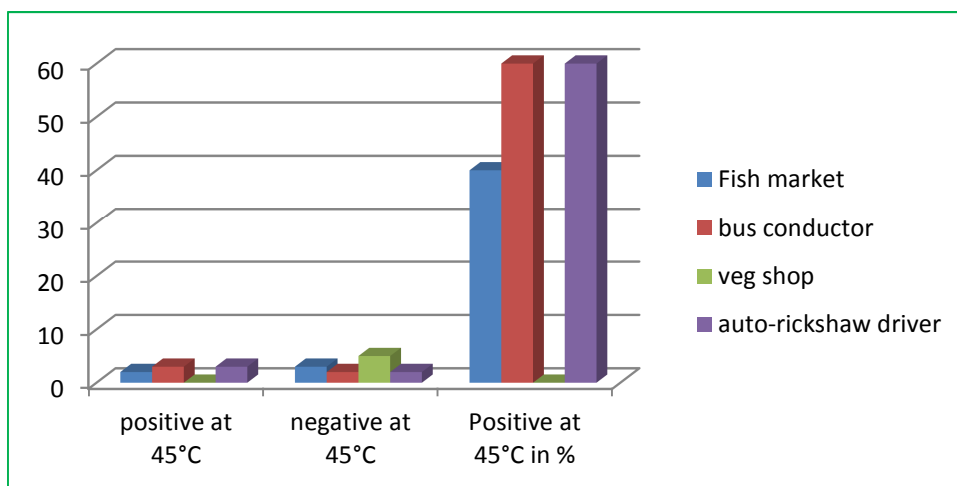


Fig. 2: Bacterial count incubation at 45°C in Indian currency ten rupee notes collected from various groups

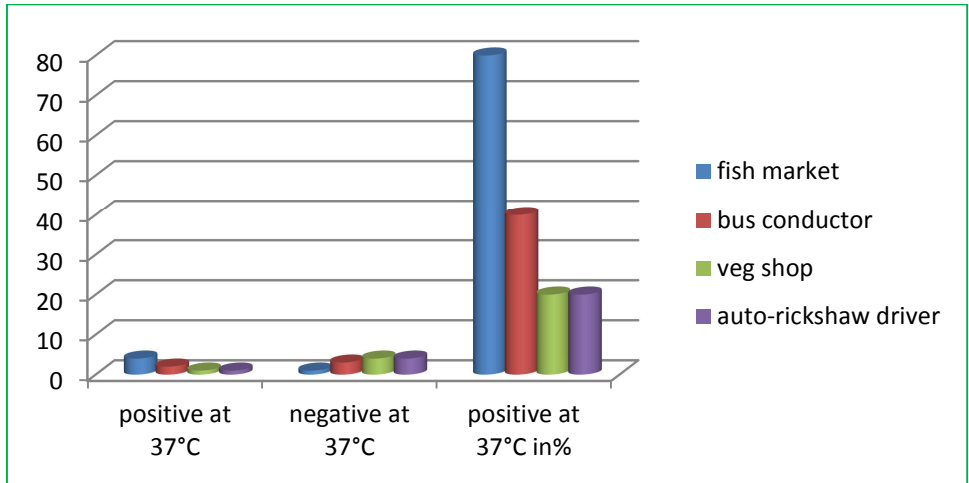


Fig. 3: Bacterial count incubation at 37°C in Indian currency twenty rupee notes collected from various groups

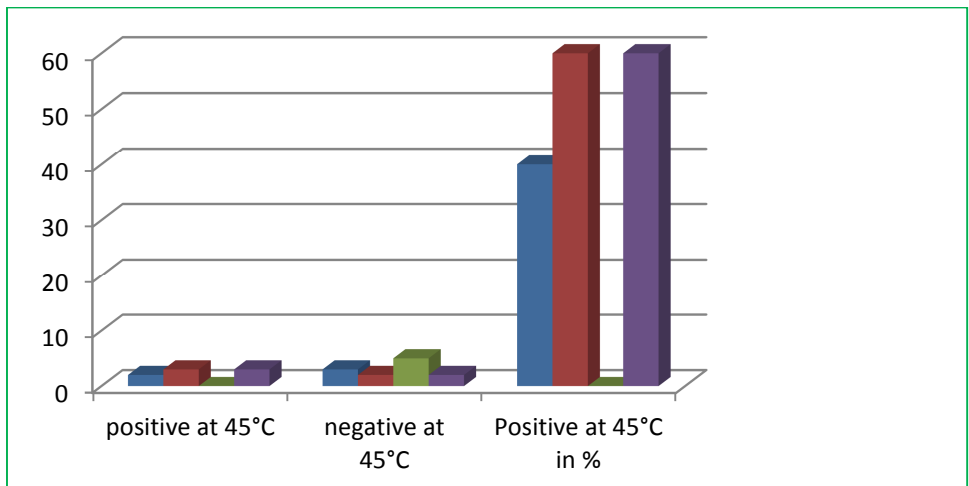


Fig. 4: Bacterial count incubation at 45°C in Indian currency twenty rupee notes collected from various groups

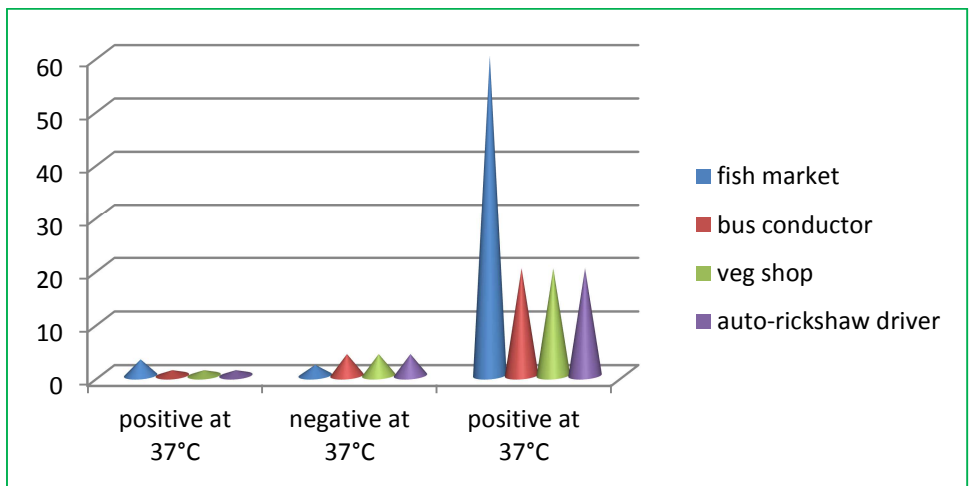


Fig. 5: Bacterial count incubation at 37°C in Indian currency fifty rupee notes collected from various groups

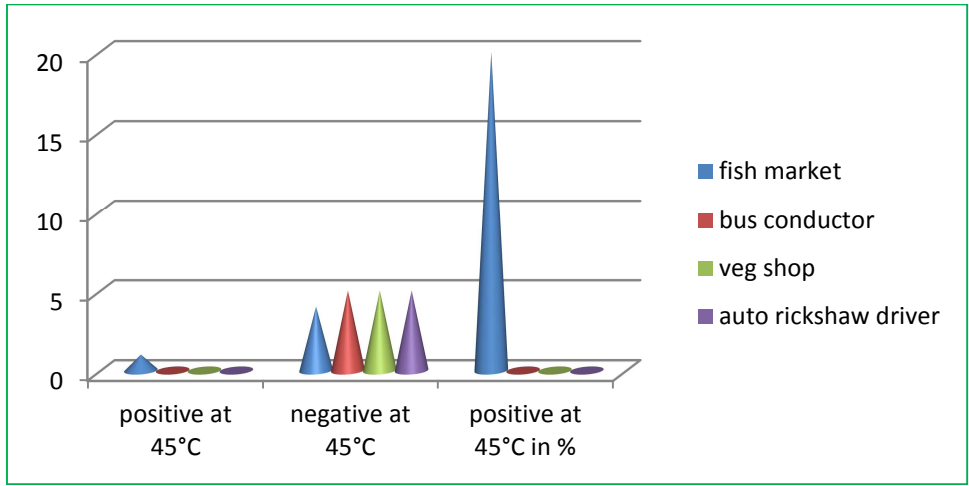


Fig. 6: Bacterial count incubation at 45°C in Indian currency fifty rupee notes collected from various groups

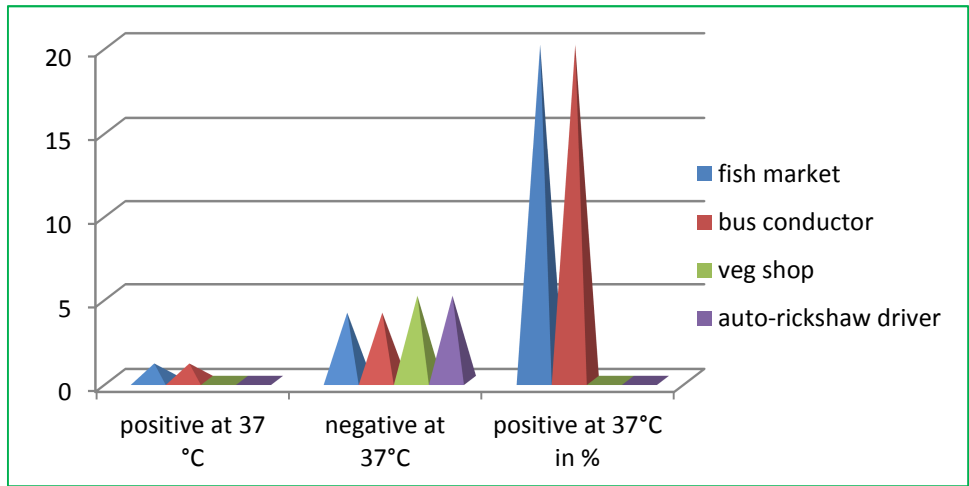


Fig. 7: Bacterial count incubation at 37°C in Indian currency hundred rupee notes collected from various groups

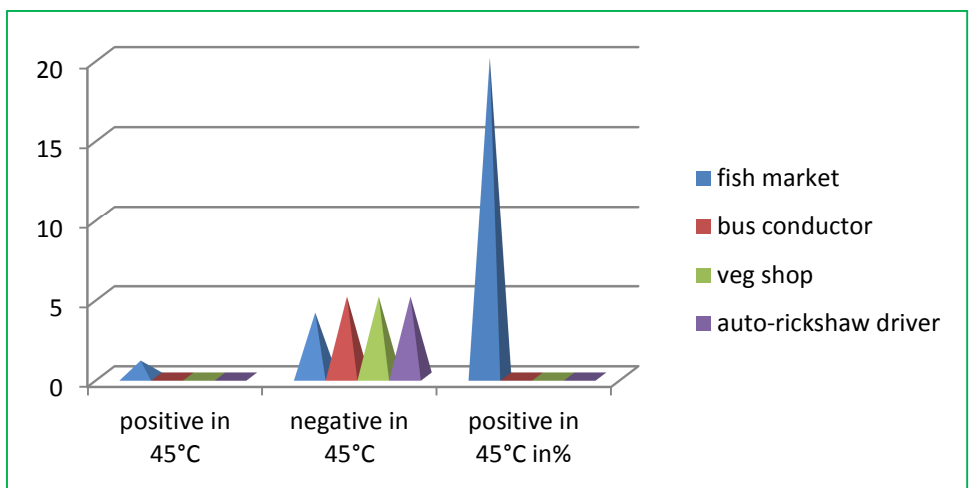


Fig. 8: Bacterial count incubation at 45°C in Indian currency hundred rupee notes collected from various groups

Table 1: Survival of E.coli on different banknotes, over time before application of essential oils

Source	Type of Indian currency	E.coli Count
Fish market	Rs 10	+++
	Rs 20	+++
	Rs 50	++
	Rs 100	+
	Rs 500	+
Bus conductor	Rs 10	+++
	Rs 20	+++
	Rs 50	++
	Rs 100	++
	Rs 500	∅
Auto driver	Rs 10	++
	Rs 20	++
	Rs 50	+
	Rs 100	+
	Rs 500	∅
Vegetable market	Rs 10	+
	Rs 20	+
	Rs 50	+
	Rs 100	∅
	Rs 500	∅

+++ = confluent growth, ++ = multiple segments, + = single colonies, ∅ = no growth

Table 2: Survival of E.coli on different banknotes, over time after the application of essential oils

Source collected	Type of Indian currency	E.coli count after the application of essential oils		
		Clove oil	Lemon grass oil	Cinnamon oil
Fish market	Rs 10	++	+	∅
	Rs 20	++	+	∅
	Rs 50	+	+	∅
	Rs 100	∅	∅	∅
	Rs 500	∅	∅	∅
Bus conductor	Rs 10	++	+	∅
	Rs 20	++	+	∅
	Rs 50	+	+	∅
	Rs 100	∅	∅	∅
	Rs 500	∅	∅	∅
Auto driver	Rs 10	++	+	∅
	Rs 20	+	+	∅
	Rs 50	+	+	∅
	Rs 100	∅	∅	∅
	Rs 500	∅	∅	∅
Vegetable market	Rs 10	+	+	∅
	Rs 20	+	+	∅
	Rs 50	+	+	∅
	Rs 100	∅	∅	∅
	Rs 500	∅	∅	∅

+++ = confluent growth, ++ = multiple segments, + = single colonies, ∅ = no growth

Currency notes in general were bacteriological contaminated, especially with enteric pathogens and potentially pathogens, it was thought that some measures have to be taken to reduce these ill effects. Among the pathogenic bacteria isolated, *Escherichia coli* is a virulent organism that can cause urinary tract infections, community-acquired pneumonia, sepsis, recurrent meningitis (Jayaseelan *et al.*, 2007; Sun *et al.*, 2006; Chang *et al.*, 2006). The location of the microbe may be recognized to the fact that some people ignore hand wash after using toilets. Such finding is similar to the research work reported that currency banknotes are contaminated with pathogens (Goktas and Oktay, 1992; Xu *et al.*, 2005). Figure 3 and 4 demonstrates the contamination of microbes in Indian currency twenty rupee notes collected from various groups. The currency notes collected from the vegetable shop showed less microbes at 45 °C and more at 40 % +ve at 45 °C from the bank notes collected from fish market.

The bacterial contamination in Indian currency fifty rupee notes and hundred rupees collected from various groups respectively are shown in Figure 5 and 6. The currency notes collected from fish market showed remarkable increase in microbes when compared to the notes collected from bus conductor, vegetable shop and auto rickshaw driver.

Figure 7 and 8 explains the bacterial count incubation at 37°C and 45°C in Indian currency hundred rupee notes collected from various groups. Only the currency notes collected from fish market showed a remarkable increase in microbes when compared to the other currency notes. The hundred currency notes collected from fish market was 20 % +ve at 45 °C and for all other sources, it was 0%. The extent of contamination was found related to the denominations of the currency. The study reported here found relatively less prevalence of microbial contamination among higher denomination notes presumably as a result of a lower rate of handling and hand to hand exchange (Pinner *et al.*; 1996). The results did not suggest to or protected against contamination, since pathogens were found on all denominations of the currency notes. The present study suggests that currency notes may carry enteric pathogens. This goes a long way to reveal the poor sanitary condition of the environment as well as poor personal hygiene practices observed by most of the occupational groups. Feglo and Nkansah concluded in their study that a total of 70

Ghanaian currency notes were analyzed for bacterial contamination. 112 different bacteria were isolated from 69 currency notes and one did not grow any bacterium, giving percentage of contamination to be 98.57%. Pope and co-worker (2002) demonstrated in their study in western Ohio that bacteria were capable of growing on currency notes.

The survival of *E.coli* on different banknotes, over time before application of essential oils was suggested in Table1. It was observed that the currency notes of Rs 10 collected from fish market showed confluent growth of *E.coli* and the currency notes of Rs 100 and Rs 500 showed only single colony or negligible growth. Table 2 shows the survival of *E.coli* on different banknotes, over time after the application of essential oils. The essential oils taken for experimentation were lemon grass oil, clove oil and cinnamon oil. It was derived from the result that cinnamon oil can ward off harmful microbes much more effectively than the other essential oils.

During experimentation, it was found that *E.coli* colonies were found absent in Cinnamon oil treated currencies followed by Lemon grass oil and Clove oil. Even the currencies collected from the fish market lack coli form bacteria. This clearly showed the bactericidal activity of Cinnamon essential oil. The ancient system of Indian medicine used cinnamon oil to prevent air-borne pathogens. Cinnamon oil is used to prevent infections and irritation in insect stings. It is used to treat respiratory issues, such as asthma. Cinnamon oil has been shown to help regulate blood sugar. It helps decrease the inflammation and promote healing by massaging the diluted cinnamon oil over the abdomen daily. Cinnamon bark oil is very warming and may increase circulation, blood flow to the brain and energy levels when used aromatically. Diluted cinnamon oil may assist in fighting infections. Other possible uses include: circulation booster, fighting colds or coughs, aiding in digestion, increasing energy, eases inflammation associated with rheumatism, and even removing warts. Money has got the possibility to transform through many different hands and could be exposed to many different environments at a relatively high rate. From the results of the present investigation, it is concluded that Indian paper currency is commonly contaminated with harmful pathogenic bacteria and this contamination may play a significant role in the spread of different diseases. The general understanding about the risk of acquiring infection

while applying saliva on fingers for counting currency notes; and practicing good personal hygiene should be created in the public. Personal hygiene to reduce risk of infection is recommended especially for those who simultaneously handle foodstuff and money.

#### 4.0 Conclusion:

Money has got the potential to change through many different hands and could be exposed to many different environments at a relatively high frequency (Kuria *et al*; 2009). From the present study it is concluded that Indian currency notes are commonly contaminated from pathogenic and non-pathogenic organisms that represents risks and public health hazards to the community and individuals. Thus individuals should improve upon their personal health consciousness by washing their hands regularly after handling of currency notes, prevent babies from handling currency notes and avoid the use of saliva during counting of currency notes as well as desist from placing money in the mouth, sticking currency notes in brassieres and biting off corners of banknotes (El-Dars *et al*; 2005). Currency notes must be handled with caution and great care especially during the preparation and handling of food to avoid contamination. There should be public awareness of the fact that currency notes could be a source of infection and dangerous to health. It is recommended that the use of cinnamon oil is recommended to control microbial fauna in the currency notes. The study also suggested to introduce anti-microbial spray using essential oil to prevent the growth of microbes in the currency notes. In conclusion, the findings of this study have highlighted the need to implement caution in handling currency notes as they can be a serious source of transmission of *E.coli*. The need to develop health consciousness, especially in basic hygiene practices such as washing hands properly after handling currency notes before eating and avoiding using saliva during counting of notes should be practised among the public. Furthermore, the study also provides information on the likely choice of essential oils to treat infections that might arise from this organism.

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