

EVALUATION OF HEALTH RISK FROM HANDLING PAKISTANI CURRENCY NOTES AND COINS IN LAHORE

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ABSTRACT

Paper currency is extensively swapped for goods and services in countries worldwide. It is a actual good route for transmission of diseases and this is why the exchange of paper currency from one individual to another actually spreads microorganisms. If pathogenic bacteria contaminate these moneys, the ratio of infection and demise rate from these infectious means will continue to upswing. The research work aimed at the isolation and biochemically identified of microorganisms that are found on Pakistani currency notes and coins and to check either money is source of transmittance. Pakistani currency notes and coins of different denominations were collected from different professions of people in city of Lahore, Pakistan. The

samples were analyzed for bacterial contaminants. A total of thirty one different types of bacteria including Gram positive and Gram negative were isolated from money. Most of microorganisms that found were human pathogens and may be a key source of disease cause. Therefore an effective health awareness campaign program should be fully executed to advise the public of the deathtraps of contaminated currency notes and even coins. We recommend that currency notes must be handled with carefulness and the handling currency is a serious problem of safety.

KEYWORDS: Bacteria, Currency notes and Coins, Pathogens, Disease, Pakistan.

INTRODUCTION

Money is an invention of the human mind. Before the advancement of money interchange was done by barter, which involved the direct alteration of one good for some amount of another good. The barter economy is a simple economy where persons yield things either for

self-consumption or for interchange with other things which they want. However, the barter scheme is troublesome as it included much exertion on the part of people in trying to interchange goods for services (Kemka *et al.*, 2013).

Communicable diseases spread through contact with fomites and transmission through paper currencies is a very potential route (Pope *et al.*, 2002). Fomites are life less entities that are accomplished of engrossing, harboring and transmitting infectious microorganisms. Paper currency, a redeemable fomite, is frequently exposed article to contamination. Money is handled by people of varying health and hygienic values and is stowed underneath varying environmental and individual hygienic situations (Ghamdi *et al.*, 2011).

Packing of these notes in leather, cotton, polythenes bags in dark and moist environments also favor the growth of bacteria on these notes. It is potential to notice the occurrence of specific bacteria on these notes by isolating the pathogenic bacteria on their particular growth media followed by their identification by polyphasic method. However, this is too arduous. Hence, the most common method is to look for indicator. *E. coli* is one such bacterium which is used as an indicator entity for fecal contamination of water. It ferments lactose with the yield of acid and gas occurrence of *E. coli* in a food or water sample indicator the fecal contamination and also recommended that other pathogenic enteric bacterium may also be found in the sample. Many researchers observed that the transmitting of bacteria from currency notes to humans through food (Lamichhane *et al.*, 2009; Ministry of Health, 2007; Reither *et al.*, 2007).

The environment plays significant part in transmission of microbial entity to humans, with many environmental tools serving as vehicles (Anderson, 1991). These means of transmission are of great significance in the health of many people in developing countries, where the rate of infection is a common warning of local hygiene and environmental sanitation levels (Cooper, 1991).

In Ghana, the currency notes are used for purchasing uncooked meat from the market, ready to eat food, milk, drugs and charcoal at a local store are used in all varieties of trade. Many Ghanaians do not care how dirty their fingers are when touching money. So, the artisan with dirty dusty and oily fingers, the butcher with the bloody fingers, the street-food vendor with the wetly-oily fingers and the teacher with the chalky and inky fingers etc., will just obtain or pick the Ghanaian currency notes with the unclean fingers, leading to the contamination of

the notes with microorganisms. A majority of the people does not carry money in wallets and squeezing of currency notes is common, specifically among bus drivers and their conductors, market women, motorcyclists, butchers, restaurant operator's and meat sellers etc. For example, men frequently place money in their socks and women beneath their brassier with sweat; Market men and women squeeze currencies and put them into their dirty pockets (Mensah *et al.*, 2002).

Bacteria have huge abilities to let them to survive in adverse environments. Two of the most important approaches for existence are their capability to adhere to surfaces and the capability to procedure biofilms (multicellular aggregates). Bacterial cells on banknotes are measured by the number of colony-forming units (C.F.U) per cm^2 of banknote. A banknote may hold up to 10^6 C.F.U. cm^2 whilst a coin may contain up to 10^3 C.F.U. cm^2 . Studies have revealed that polymer-based banknotes frequently have a rather low bacterial count compared with the cotton-based 'paper' banknotes. This may be due to numerous physicochemical parameters of polymers. The Possible role of influenza virus on banknotes in the spread of this disease has been documented. One strain, H3N2, can persist infectious for up to 3 days on banknotes, and other strains may be active for up to 17 days (Vriesekoop F *et al.*, 2010). Numerous pathogens associated with throat infection, tonsillitis peptic ulcers, pneumonia, gastro enteritis, urinogenital tract infection and lung abscess had been reported (Saeed and Rasheed, 2011).

Adherence of bacteria and other micro-organisms to surfaces like paper money depends on factors that contain surface charge, surface roughness, stiffness and hydrophobic properties (Vriesekoop F *et al.*, 2010). Microbial contaminants may be transmitted directly, through hand-to-hand contact, or indirectly, via food or other inanimate objects like fomites used as a vehicles (Rote *et al.*, 2010). If this paper money is contaminated with pathogenic bacteria, there is a potential to spread these microorganisms and hence serve as a potential health hazard (Ahmad *et al.*, 2010).

Paper Currency can be contaminated by droplets during sneezing, coughing, touching with previously contaminated hands or other materials and placements on dirty surfaces (Oyero and Emikpe, 2007). The route of contamination could be as a consequence of poor or Negative money handling practices like spraying during ceremonies where such notes may be trampled upon when they fall on the ground (Ogo *et al.*, 2004).

The immediate handling of food and money also adds to the rate of food-related public health incidents (Food Science Australia, 2000). Such reports are available for India (Singh *et al.*, 2002); in Egypt (El-Dars and Hassan, 2005) etc. Meat sellers in slaughter houses and in market places collect money from buyers with hands contaminated with blood and animal wastes. In the hands of bus conductors and fish and meat sellers, currency notes become literally pestilent. Currency notes carry various bacteria (Barro *et al.*, 2006). The case in restaurants is not different in transferring most to the banknote and coins (FSA, 2002).

People living in unhygienic environments having unhygienic practices will contaminate the notes with bacteria e.g. practices such as using saliva to count the paper notes also leads to the contamination and these notes will act as a vehicle carrying bacteria to contaminate the hands of the next user (Sushil Kumar *et al.*, 2011). Paper currency compromises a larger surface area as a breeding ground for pathogens (Ayandele and Adeniyi, 2011).

Coins generally have metals such as silver, copper and lead and these are identified to have inhibitory properties on some bacteria. It has been recommended that humans retain firm adherence to hygienic practices before handling food and water after contact with currency notes and counting machines (Prasai *et al.*, 2008). Some gram-Negative bacteria can persist as long as eleven days on coins. Many coins have copper which can hinder growth of microbes (El-Dars and Hassan, 2005).

For those in the health care professions, food and catering industry and hand washing after handling banknotes is necessary. On daily basis, millions of bacteria are spread from person to person through the handling of currency notes and coins. The simple precaution is that hands should be properly washed and thoroughly dried before handling food and after handling money. Studies of the contamination of money with microbial entities is lacking in most developing countries. Shortage of information may contribute to the absence of public health policies regarding currency usage, handling, and circulation (Ghamdi *et al.*, 2011).

Microorganisms commonly associated with banknotes include *Staphylococcus aureus*, *Escherichia coli*, α -haemolytic Streptococcus, Acetobacter spp, Bacillus spp, Salmonella spp, Enterobacter spp, Pseudomonas spp, fungi, viruses and eggs, larvae of worms, parasites and helminthes. Some banknotes associated bacteria may cause opportunistic infections while other bacteria are pathogenic and it is also a common cause of food poisoning (Vriesekoop F *et al.*, 2010).

Microbial contamination of paper money is not only limited to developing countries. Numerous studies from United States reported contamination of paper bills and coins and the identification revealed the incidence of pathogenic microbes like *Staphylococcus aureus*, Klebsiella, Enterobacter spp., *Escherichia coli*. Contamination of articles by pathogenic microbes is of much public health concern as contaminated tools can be sources of transmitting pathogens (Ghamdi *et al.*, 2011).

The microorganisms implicated included members of the family *Enterobacteriaceae*, *Mycobacterium tuberculosis*, *Vibrio cholerae*, Bacillus species, Corynebacterium spp, *Staphylococcus aureus*, and Micrococcus spp. Most contaminants of money are environmental organisms such as Gram-Positive flora especially Bacillus spp. and those arising from human normal skin flora such as *Staphylococcus aureus* (Xu *et al.*, 2005 and Igumbor *et al.*, 2007).

A study by (Umeh *et al.*, 2007; Hosen *et al.*, 2006), revealed that 89.8% of Nigerian currency notes in circulation has microbial contamination, while (Hugo *et al.*, 1983) found that 100% of currency notes in circulation by bacterial contamination and they isolated Coagulase Negative Staphylococci (23.4%), *Staphylococci aureus* (8.4%), *Escherichia coli* (5.6%), Bacillus species (23.4%), Klebsiella species (5.6%), Enterobacter species (2.8%), Enterococci species (10.3%), and Proteus species (8.4%) among others (Igumbor *et al.*, 2007).

In Sudan, many fungal genera were isolated such as Trichophyton spp, Microsporium spp, Epidermophyton spp, Taenia spp, Aspergillus spp and Saccharomyces spp, while the genera of bacteria that isolated were *Escherichia coli*, Citrobacter sp, Klebsiella spp., Proteus spp, Bacillus spp, Corynebacterium spp and Staphylococcus spp (Abrams and Waterman, 1972).

MATERIALS AND METHODS

A total of 260 samples in which one hundred and thirty notes of different denominations as Rs.10, Rs.20, Rs.50 and Rs.100 and one hundred and thirty coins Re.1, Rs.2 and Rs.5 were collected from doctors and hospital staff, bankers, hawkers, vegetables/fruit vendors, sweepers, public transport conductors, beggars, butchers/fish vendors, cobblers and hotels staff in different places in Lahore city of Pakistan in 2014.

Currency notes processing method

With the help sterile forceps, each currency note was transferred aseptically into a sterile test tube containing 10 ml of sterile normal saline water. The test tube was capped and shaken vigorously for about 2 min to dislodge the microorganisms into the fluid. The resulting fluid served as the test sample, whilst the currency note was removed aseptically from the test tube, rinsed with water and dried to recover the note. Serial dilutions were prepared from the test sample as shown thus $1:10^1$, $1:10^2$, $1:10^3$ and $1:10^4$. This was done by transferring dispensed 1 ml of test sample into 9 ml of sterile normal saline water, vortexed, and then 1 ml aliquot transferred into the next tube using a micropipette. Starting with the highest dilution 0.1 ml of the test dilution was spread on Nutrient agar plates using a sterile bent spreader for bacterial growth (Patrick *et al.*, 2010).

In case of coins, a sterile cotton-tipped swab moistened with sterile physiological saline was used to swab both sides of the coins. The swabs were directly inoculated on Nutrient agar. The inoculated media were incubated aerobically at 37°C for 24 hours and then examined for bacterial growth characteristics according to standard protocol described previously (Cheesbrough, 2000). The viable colonies observed on nutrient agar plates for each sample were then counted against the source from which samples were collected using the colony counter.

Bacterial isolation and identification

The observed and isolated colonies were streaked on the nutrient agar plates by streaking method for bacterial purification (Uraku *et al.*, 2012). Using a sterile microbiological loop, the inoculums were sub-cultured evenly on other selective and differential media's Mannitol Salt Agar (MSA), Eosine Methylene Blue (EMB), Salmonella Shigella agar (SS-agar), Polymyxin Pyruvate Egg Yolk Mannitol Bromothymol Blue Agar Base (PEMBA), Pseudomonas Cetrimide agar, Blood agar and MacConkey agar from pure culture by streak plate method. All the plates were incubated aerobically at 37°C for 24 hours. After incubation, plates were examined for growth. These sub-cultured plates were then used in the identification and characterization of the organisms (Ayandele *et al.*, 2011).

Identification and characterization of bacteria's

The individual colonies of bacteria were examined for their macroscopic traits such as color, size and morphology. The microscopic morphology and arrangement of purified bacteria

were examined using gram staining, spore staining, Ziehl-Neelsen staining and capsule staining (Cappucino and Sherman, 2007).

Different biochemical tests such as Catalase test, Coagulase test, Oxidase test, Indole production test, Methyl red test, Voges-Proskauer test, Citrate utilization test (IMViC), Urease test, Hydrogen Sulfide test (H₂S), Triple Sugar Iron (TSI) test (for dextrose, sucrose, and lactose fermentation), Nitrate Reduction test, Litmus milk reactions and Starch, Lipid, Gelatin hydrolysis tests were done for confirmation of isolated bacterial cultures on species level according to protocols described previously (Cheesbrough, 2000; Cappucino and Sherman, 2007).

RESULTS

After 260 Pakistani currency notes and coins samples analysis, bacteria were present on both currency notes and coins. The overview of isolated bacterial colonies is shown in Table 1.

Table 1: Isolation and morphological Identification of Bacterial isolates through different media obtained from currency notes and coins.

Serial No.	Colony characteristics on Nutrient agar	Cell morphology	Gram reaction	Mannitol Salt Agar	Eosine Methylene Blue agar	MacConkey agar	Cetrimide agar	Salmonella Shigella agar	Blood agar	PEMBA
1	Golden yellow, large, round in shape	Cocci in cluster	Pos	Yellow growth, yellow media	NG	NG	NG	NG	Cream to white, β -hemolysis	NG
2	creamy white, pinpoint	Cocci in cluster, diplococci	Pos	white growth, pink media	NG	NG	NG	NG	γ - hemolysis	NG
3	Creamy Wavy Margin	cocci in cluster	Pos	colorless growth, yellow media	NG	NG	NG	NG	bright white, creamy colonies, α -hemolytic,	NG
4	pinpoint colorless, shiny	lancet shaped diplococci	Pos	NG	NG	NG	NG	NG	α -hemolysis, green color, small, mucoid, central depression	NG
5	pinpoint, colorless	cocci in chain	Pos	NG	NG	NG	NG	NG	α -hemolytic, tiny colonies	NG
6	round, small, white, convex	cocci in chain	Pos	NG	NG	NG	NG	NG	β -hemolysis, domed greyish in color	NG
7	very small sized, white, regular, glossy	diplococci, short chain	Pos	NG	NG	NG	NG	NG	γ - hemolysis, small, grey	NG

8	small, circular, smooth, entire, convex, Lime yellow color colony	tetrad, cocci	Pos	yellow growth, pink media	NG	NG	NG	NG	Bright yellow, γ -hemolysis	NG
9	circular, smooth, entire, convex, orange color growth	tetrad, cocci	Pos	NG	NG	NG	NG	NG	orange color, γ -hemolysis	NG
10	circular, smooth, entire, convex, pink color	tetrad, cocci	Pos	NG	NG	NG	NG	NG	γ -hemolysis	NG
11	Red color, circular, smooth, entire, convex	tetrad, cocci	Pos	pink color growth, pink media	NG	NG	NG	NG	γ -hemolysis	NG
12	large, cream/white, spreading, dull texture, irregular, undulate, lobate margin	diplobacillus, central endospore	Pos	NG	NG	NG	NG	NG	β -hemolysis,	Good growth; peacock blue colonies with precipitate and peacock blue medium
13	spreading colonies, forming rhizoid filaments curving clock- or counter-clockwise	rod bacilli as chains of cells	Pos	NG	NG	NG	NG	NG	β -hemolysis,	blue colonies with rhizoidal and filamentous growth
14	whitish to cream, circular to irregular, smooth, undulate, crenate to fimbriate edge	subterminal spore, rod	Pos	NG	NG	NG	NG	NG	β -hemolysis,	blue colonies

15	White, cuboid or diamond shaped parasporal crystals	Straight or slightly curved slender bacilli with square ends singly or in short chains.	Pos	NG	NG	NG	NG	NG	β -haemolytic large flat or slightly convex, irregular, dull grey colonies with a slight green tinge	blue color with crystalline formation
16	Medium, cream/white, dull texture, round, slightly undulate	diplobacillus, subterminal endospore	Pos	yellow, mucoid growth	NG	NG	NG	NG	β -hemolysis,	Growth; straw coloured colonies
17	Whitish, round to irregular with undulate to fimbriate margins, entire, smooth, convex, glistening, and mucoid, hairlike outgrowth	Slightly curved rod, paracentral spores	Pos	NG	NG	NG	NG	NG	γ - hemolysis	NG
18	opaque, smooth, circular, mucoid	central spore, rod	Pos	mucoid yellow growth	NG	NG	NG	NG	NA	NG
19	Medium sized, offwhite, mucoid, regular	rod, single	Neg	NG	dark blue-black colonies with metallic green sheen	dark pink, nonmucoid	NG	Partial to complete inhibition; pink colonies with purple centers	γ -hemolysis, Large, gray, moist colonies	NG
20	large, smooth, convex, greenish blue pigment	rod	Neg	NG	colorless	pink to green colony	yellowish green	NG	β - hemolysis, with green pigment	NG

21	cream, diffuseable pigment, circular, smooth, shiny, entire	rod	Neg	NG	light purple	peach color	white growth	NG	Y- hemolysis	NG
22	Medium sized, offwhite, regular, glossy	rod, single	Neg	NG	purple	peach color	NG	Growth; colonies with large black centers with clear perimeter	Y- hemolysis	NG
23	pinpoint white	rod	Neg	NG	colorless, pinpoint	colorless	NG	colorless pinpoint	Y- hemolysis	NG
24	Medium sized, offwhite, regular, mucoid	short rod, single	Neg	NG	navy blue to pink mucoid	baby pink, mucoid	NG	NG	Y- hemolysis	NG
25	white, mucoid, medium	straight rod	Neg	NG	pink growth	pink mucoid, round	NG	NG	Y- hemolysis	NG
26	colorless, round, entire or undulated edges	Rod	Neg	Yes	light blue	light pink with dark center	NG	pink	NA	NG
27	fishy odor, swarming growth, pinpoint, round, entire and flat colony	Rod	Neg	NG	colorless, pinpoint, swarming	colorless, swarming	NG	Growth; pale pink or tan colonies with small light to dark brown centers	α -hemolysis	NG

28	thick, white, glistening growth	Rod	Neg	NG	brown, dark-centered, mucoid colonies, like fish eye	pink colony with dark center	NG	NG	Y- hemolysis, greyish white	NG
29	yellowish peach with addition of Nacl	rod, comma shaped	Neg	Yes	NG	colorless to light pink	NG	NG	β -hemolysis	NG
30	Medium sized, red, regular, glossy	short rod, single	Neg	NG	purple and pink	redish pink	NG	NG	Y- hemolysis, orange color	NG
31	brownish, small sized, circular, convex, entire, friable	short red, diplobacillus	Neg	Yes	NG	NG	NG	NG	β - hemolysis, flourish on blood agar	NG

Table 2: Biochemical Identification of Bacterial isolates obtained from currency notes and coins.

Sr. No	Motility	Catalase	Coagulase	Indole	MR	VP	Citrate	Oxidase	Urease	H ₂ S	Nitrate	Lactose	Glucose	Sucrose	Bacterial isolates
1	Neg	Pos	Pos	Neg	Pos	Neg	Neg	Neg	Neg	Neg	Pos	Pos	Neg	Pos	<i>S. aureus</i>
2	Neg	Pos	Neg	Neg	Pos	Pos	Neg	Neg	Pos	Pos	Pos	Pos	Pos	Pos	<i>S. epidermidis</i>
3	Neg	Pos	Neg	Neg	Pos	Pos	Neg	Neg	Pos	Neg	Pos	Pos	Pos	Pos	<i>S. saprophyticus</i>
4	Neg	Neg	Neg	NA	NA	NA	NA	Neg	NA	NA	NA	NA	NA	NA	<i>S. pneumoniae</i>
5	Neg	Neg	Neg	NA	NA	NA	NA	Neg	NA	NA	NA	NA	NA	NA	<i>S. viridans</i>
6	Neg	Neg	Neg	NA	NA	NA	NA	Neg	NA	NA	NA	NA	NA	NA	<i>S. pyogenes</i>
7	Pos	Neg	Neg	Pos	Neg	Pos	Pos	Neg	Neg	Neg	Neg	Pos	Pos	Pos	<i>E. faecalis</i>
8	Neg	Pos	Neg	Neg	Neg	Neg	Neg	Pos	Pos	Neg	Pos	Neg	Neg	Neg	<i>M. luteus</i>
9	Neg	Pos	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	NA	Neg	Pos	Neg	<i>M. nishinomiyaensis</i>
10	Neg	Pos	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	NA	NA	NA	NA	<i>M. agilis</i>
11	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Pos	Neg	Pos	Neg	<i>M. roseus</i>
12	Pos	Pos	Neg	Neg	Neg	Pos	Neg	Pos	Neg	Neg	Pos	Neg	Pos	Pos	<i>B. cereus</i>
13	Neg	Pos	Neg	Neg	Neg	Pos	Neg	Neg	Neg	Neg	Pos	Neg	Pos	Pos	<i>B. mycoides</i>
14	Pos	Pos	Neg	Neg	Neg	Pos	Neg	Neg	Neg	Neg	Pos	Neg	Pos	Neg	<i>B. weihenstephanensis</i>
15	Pos	Pos	Neg	Neg	Neg	Pos	Neg	Pos	Neg	Neg	Pos	Neg	Pos	Neg	<i>B. thuringiensis</i>
16	Pos	Pos	Neg	Neg	Neg	Pos	Pos	Neg	Neg	Neg	Pos	Neg	Neg	Pos	<i>B. subtilis</i>
17	Pos	Pos	Neg	Neg	Neg	Pos	Pos	Pos	Pos	Neg	Neg	Pos	Pos	Pos	<i>B. licheniformis</i>
18	Pos	Pos	Neg	Neg	Neg	Pos	Neg	Pos	Neg	Neg	Pos	Neg	Pos	Pos	<i>B. vallismortis</i>
19	Pos	Pos	Neg	Pos	Pos	Neg	Neg	Neg	Neg	Neg	Pos	Pos	Pos	Pos	<i>E. coli</i>
20	Pos	Pos	Neg	Neg	Neg	Neg	Pos	Pos	Pos	Neg	Pos	Neg	Neg	Neg	<i>P. aeruginosa</i>

21	Pos	Pos	Neg	Neg	Neg	Neg	Neg	Pos	Neg	Neg	Neg	Neg	Neg	Neg	<i>P. putida</i>
22	Pos	Pos	Neg	Neg	Pos	Neg	Pos	Neg	Neg	Neg	Pos	Neg	Pos	Neg	<i>S. enterica</i>
23	Pos	Pos	Neg	Neg	Pos	Neg	Pos	Neg	Neg	Neg	Neg	Neg	Pos	Neg	<i>S. enteritidis</i>
24	Neg	Pos	Neg	Neg	Pos	Pos	Pos	Neg	Pos	Neg	Pos	Pos	Pos	Pos	<i>K. pneumonia</i>
25	Neg	Pos	Neg	Pos	Neg	Pos	Pos	Neg	Pos	Neg	Neg	Pos	Pos	Pos	<i>K. oxytoca</i>
26	Neg	Pos	Neg	Neg	Pos	Neg	<i>S. sonnei</i>								
27	Pos	Pos	Neg	Neg	Pos	Neg	Neg	Neg	Pos	Pos	Pos	Neg	Pos	Neg	<i>P. mirabilis</i>
28	Pos	Pos	Neg	Neg	Neg	Pos	Pos	Neg	Neg	Neg	Pos	Pos	Pos	Pos	<i>E. aerogenes</i>
29	Pos	Pos	Neg	Pos	Neg	Neg	Pos	Pos	Neg	Neg	Pos	Neg	Pos	Pos	<i>V. cholera</i>
30	Pos	Pos	Neg	Neg	Neg	Pos	Pos	Neg	Neg	Neg	Pos	Neg	Pos	Pos	<i>S. marcesens</i>
31	Neg	Pos	Neg	Neg	Pos	Neg	Neg	Pos	Neg	Neg	Neg	Neg	Pos	Neg	<i>A. salmonicida</i>

DISCUSSION

Microorganisms are present everywhere in the environment, in which some are pathogenic and some are nonpathogenic to human life. In this study, a large number of bacteria species were isolated from Pakistani currency notes and coins. It confirmed that currency notes and coins play a key role in the disease transmission in humans.

Staphylococcus epidermidis is an eternal and ubiquitous flora of the skin and mucosa of humans (Otto, 2009). It usually produces infections in healthy people with low rate but can cause more severe infections in the immunocompromised and can prompt life threatening meningitis and septicaemia (Schaenfelder *et al.*, 2010). *S. epidermidis* is also accomplished of producing infections where individuals have had some a surgical practice or an in dwelling device fitted such as cardiac devices, catheters and vascular grafts or prosthetic due to its persistence in biofilms (O’Gara and Humphrey, 2001).

Staphylococcus aureus is also ubiquitous in nature and a familiar colonizer in humans. Community acquired soft tissue infections due to *S. aureus* is comparatively common. During the past four decades, Methicillin-resistant *Staphylococcus aureus* has evolved from a controllable nuisance into a severe public alarm (Neel and Ragini Deshpande, 2012). *S. aureus* is a prominent nosocomial pathogen to look out for as it is present as skin or nasal flora (Adegoke and Komolafe, 2009). *S. aureus* can cause a variety of illnesses, from immaterial skin infections, such as pimples, cellulitis, boils (furuncles), impetigo, carbuncles, folliculitis, scalded skin syndrome and abscesses to life threatening illnesses such as bacteremia, meningitis, pneumonia, endocarditis, osteomyelitis, sepsis and toxic shock syndrome (TSS). Its incidence ranges from skin, bone, joint, soft tissue, respiratory, endovascular to wound infections. It is still one of the five most common reasons of nosocomial infections and is often the cause of Postsurgical wound infections (Bowersox, 1999). *S. aureus* can persist on dogs (Boost *et al.*, 2008), horses, cat (Hanselman *et al.*, 2009) and can cause bumble foot in chickens (Burton *et al.*, 2008). *S. aureus* is one of the fundamental means of mastitis in dairy cows (Cenci-Goga *et al.*, 2003).

S. saprophyticus is a common cause of community-acquired urinary tract infections (Kuroda *et al.*, 2005 and Levinson, 2010). It is present in the normal flora of genital tract of female (Levinson, 2010) and perineum in humans. It has been isolated from other sources too including meat, vegetables, cheese products, the environment, human and animal gastrointestinal tracts (Widerstrom *et al.*, 2012). Sexual activity increases the threat

of *S. saprophyticus* UTI because bacteria are displaced from the normal flora of the vagina and perineum into the urethra (Levinson, 2010). Symptoms comprise a burning feeling when urination, the urge to urinate more frequently than normal, a 'dripping consequence' after urination, frail bladder, a distended sensing with sharp razor pains in the lower abdomen around the bladder and ovary areas, and razor-like pains during sexual intercourse (Jordan *et al.*, 1980).

S. pyogenes is the cause of many important human diseases, ranging from mild superficial skin infections to life-threatening systemic diseases. Infections usually instigate in the throat or skin. Examples of mild *S. pyogenes* infections include pharyngitis (strep throat) and localized skin infection (impetigo). Erysipelas and cellulitis are categorized by multiplication and lateral spread of *S. pyogenes* in deep layers of the skin. *S. pyogenes* invasion and multiplication in the fascia can lead to necrotizing fasciitis a life threatening disorder requiring surgery (Ryan and Ray, 2004).

S. pneumoniae is found generally in the upper respiratory tract, including the nasal passages and throat (Lanie *et al.*, 2007). *S. pneumoniae* exist asymptotically in the nasopharynx of healthy carriers. The organism causes many sorts of pneumococcal infections other than pneumonia. These aggressive pneumococcal diseases include bronchitis, peritonitis, osteomyelitis, acute sinusitis, meningitis, otitis media, conjunctivitis, bacteremia, endocarditis, sepsis, pericarditis, septic arthritis, cellulitis and brain abscess (Siemieniuk *et al.*, 2011). Symptoms of pneumonia include a cough followed by shortness of breath, yellow or greenish mucous, chills, fever and chest pain. The bacteria most commonly enter the body via inhalation of small water droplets (Todar, 2007).

Streptococcus viridans are most common in the mouth, or gingival infections as pericoronitis. Viridans streptococci have the capability to formed dextrans from glucose which permits them to adhere to fibrin-platelet aggregates at damaged heart valves. This tool underlies their capability to cause subacute valvular heart disease ensuing their entry into the bloodstream (e.g., following dental extraction) (Patterson, 1996).

E. faecalis is commensal bacterium found in the gastrointestinal tracts of humans and other mammals. *E. faecalis* can cause life-threatening infections in humans, especially in the nosocomial (hospital) environment, where the naturally high levels of resistance of antibiotics found in *E. faecalis* participate to its Pathogenicity (Ryan and Ray, 2004). They

also are generally found in intestinal flora in mammals and birds. The Enterococci are also found in water, soil and plants (Gilmore and Michael *et al.*, 2002). *E. faecalis* can cause urinary tract infections (UTI), meningitis, bacteremia and endocarditis other infections in humans (Hidron *et al.*, 2008).

M. luteus on human skin breaks down compounds in sweat into compounds with bad odor. *M. luteus* can grow well in environments with little water or high salt concentrations. An obligate aerobe, *M. luteus* has been isolated from human skin, animal, dairy products, and beer. It can be found in water, dust and soil environment. The bacterium also colonizes the human mouth, mucosa, upper respiratory tract and oropharynx (Greenblatt *et al.*, 2004).

Bacillus cereus is responsible for a minority of foodborne illnesses (2–5%), causing severe nausea, vomiting and diarrhea (Kotiranta *et al.*, 2000). other strains can be beneficial as probiotics for animals (Ryan and Ray, 2004). *Bacillus* foodborne illnesses occur due to survival of the bacterial endospores when food is improperly cooked (Turnbull, 1996). Cooking temperatures less than or equal to 100°C allows some *B. cereus* spores to survive. Cooked foods not meant for either immediate consumption or rapid cooling and refrigeration should be kept at temperatures above 60°C (Roberts *et al.*, 1996). This problem is compounded when food is then improperly refrigerated, allowing the endospores to germinate (McKillip, 2000). Ingestion leads to two types of illness, diarrheal and emetic (vomiting) syndrome. Most emetic patients recover within 6 to 24 hours (Ehling-Schulz *et al.*, 2004) but in some cases the toxin can be fatal (Naranjo *et al.*, 2011).

Bacillus subtilis is commonly present in soil and normal gut commensal in humans (Nakano *et al.*, 1998). *B. subtilis* cause disease in severely immunocompromised patients, and can be used as a probiotic in healthy individuals (Oggioni *et al.*, 1998). It rarely causes food poisoning (Ryan and Ray, 2004). Some *B. subtilis* strains produce the proteolytic enzyme subtilisin. *B. subtilis* spores can survive the extreme heat during cooking. Some *B. subtilis* strains are responsible for causing ropiness (Pepe *et al.*, 2003).

B. licheniformis is a Gram-positive spore formers bacterium. These spores are quite tolerant of cold, heat, radiation, and other environmental stresses. Under suitable environment, the spores will germinate and produce vegetative cells (Veith *et al.*, 2004). *B. licheniformis* is also known for contaminating dairy products. Food borne outbreaks usually involve cases of cooked meats and vegetables, raw milk, and industrially produced baby food contaminated with *B. licheniformis*. *B. licheniformis* is a bacterium that is commonly found in soil and bird

feathers. Birds that tend to stay on the ground more than the air (i.e. sparrows) and on the water (i.e. ducks) are common carriers of this bacterium; it is mostly found around the bird's chest area and back plumage (Salkinoja-Salonen *et al.*, 1999). *B. licheniformis* is commonly associated with food spoilage and poisoning. It causes bread spoilage, or more specifically, a condition called "ropy bread". Contamination with this bacterium will make the bread sticky and stringy; the ropy bread will also start to develop a strong odor after contamination (Pepe *et al.*, 2003). *B. licheniformis* can also cause food-borne gastro-enteritis, which is infection of the gut that can lead to a life threatening condition called septicaemia. Septicaemia is blood poisoning, and is classified as having a large amount of bacteria in the blood. Dairy products are at increased risk of being contaminated with toxin-producing isolates of *B. licheniformis*. Cooked meats, raw milk, vegetables, and processed baby foods are also at risk. *B. licheniformis*, although usually associated with the gut and gastrointestinal tract, can also cause distress in other parts of the body. It can cause ophthalmitis, which is the inflammation of the eye. It can even go as far as causing abortions in pregnancies and impair sperm motility (Salkinoja-Salonen *et al.*, 1999).

B. mycoides forms spreading colonies with a repeating spiral pattern. The direction of curvature of the pattern in a given strain is known as its chirality and is a hereditary trait (Di Franco *et al.*, 2002). *Bacillus mycoides* are found in common pesticides and are used to inhibit the growth of harmful bacteria and fungi. There seems to be no Negative effects on humans or the environment (Stratford *et al.*, 2013).

B. polymyxa is an endospore-forming bacterium that is non-pathogenic and found in environments such as plant roots in soil and marine sediment (Timmusk *et al.*, 2005; Ravi *et al.*, 2007). It is capable of fixing nitrogen. It is found in soil, plant roots, and marine sediments (Lal *et al.*, 2009). *B. polymyxa* produce polymyxin antibiotic compounds (Shaheen *et al.*, 2011).

B. megaterium is amongst the biggest known bacteria (Bunk *et al.*, 2010). *B. megaterium* has been recognized as an endophyte and is a potential agent for the biocontrol of plant diseases. Nitrogen fixation has been demonstrated in some strains of *B. megaterium* (De Vos *et al.*, 2009).

B. thuringiensis (Bt) grows at body temperature and produces a diamond shaped crystal from its crystal proteins (Cry proteins) and uses it to fend off insects, predators, and other

pathogens (Jimenez-Juarez *et al.*, 2007). Common insect targets are "moths, mosquitoes, blackflies, beetles, hoppers, aphids, wasps and bees as well as nematodes" (Dorsch *et al.*, 2002; Vadlamudi *et al.*, 1995; Zhang *et al.*, 2005). *B. thuringiensis* is biological pesticide and occurs naturally in the gut of caterpillars of various types of moths and butterflies, as well on leaf surfaces, aquatic environments, animal faeces, insect rich environments, flour mills and grain storage facilities (Madigan *et al.*, 2005 and du Rand and Nicolette, 2009).

B. weihenstephanensis is a soil dwelling, Gram Positive, rod-shaped, β -hemolytic bacterium (Lechner *et al.*, 1998). Strains of *B. weihenstephanensis* may carry genes coding for endotoxins generally associated with *Bacillus cereus* (Stenfors *et al.*, 2002).

E. coli is generally present in the lower intestine of warm blooded organisms (Singleton, 1999). Most *E. coli* strains are harmless, but some strains can cause severe food poisoning in their hosts, and are responsible for food contamination (CDC, 2012; Vogt and Dippold, 2005). The harmless strains are part of the normal flora of the gut and can benefit their hosts by producing vitamin K₂ (Bentley and Meganathan, 1982) and preventing colonization of the intestine with pathogenic bacteria (Hudault *et al.*, 2001; Reid *et al.*, 2001). Strains contained flagella with peritrichous arrangement (Darnton *et al.*, 2007). Virulent strains of *E. coli* can cause urinary tract infections, gastroenteritis and neonatal meningitis. In rarer cases, virulent strains are also responsible for hemolytic uremic syndrome, peritonitis, mastitis, and septicemia and gram negative pneumonia. UPEC (uropathogenic *E. coli*) is one of the main causes of urinary tract infections (Todar, 2007).

Infections commonly attributed to *E. aerogenes* are gastrointestinal, respiratory, and urinary tract infections, specifically cystitis, in addition to wound, bloodstream and central nervous system infections (Brooks *et al.*, 2007; Lederberg *et al.*, 2000; Sankaran *et al.*, 2000).

K. pneumoniae is commonly present in the nasopharynx. It is not only restricted to humans but is ubiquitous to the animals and other ecological environment including surface water, sewage, and soil etc. (Brisse and Verhoef, 2000). It has pathogenic effects worldwide. There are a large number of infections acquired when it affects different organs of the body such as liver, urinary tract, lungs (Wen-Chien, 2002).

It can also cause infections in the urinary tract, lower biliary tract, and surgical wound sites. The range of clinical diseases includes pneumonia, bacteremia, thrombophlebitis, urinary tract

infection (UTI), meningitis, cholecystitis, upper respiratory tract infection, diarrhea, wound infection, osteomyelitis and septicemia (Rashid and Ebringer, 2007). *K. oxytoca* is used in industrial ethanol fuel production (Dien *et al.*, 2003). It can cause colitis and sepsis disease (Hogenauer *et al.*, 2006).

P. mirabilis has distinct fishy odor and swarming motility (Belas, 1996). *P. mirabilis* can be found as a free-living microbe in soil and water. The organism is also normally found in the gastrointestinal tract of humans (Coker *et al.*, 2000). *P. mirabilis* infection can also responsible in the production of stones in kidney and bladder. The bacteria colonize the stones as they form, making them less accessible to antibiotic attack (Pearson *et al.*, 2008). The most common infection involving *Proteus mirabilis* occurs when the bacteria moves to the urethra and urinary bladder. Symptoms for urethritis are mild including frequency of urination and pyuria. Cystitis symptoms include back pain, concentrated appearance, urgency, hematuria and suprapubic pain as well as increased frequency of urination and pyuria. Pyelonephritis can occur when the bacteria migrates from the lower urinary tract. Symptoms for pneumonia include fever, chills, chest pain, rales, and cough. Prostatitis can occur as a result of *P. mirabilis* infection, causing fever, chills, and tender prostate in men. *Proteus mirabilis* infections can be treated with broad-spectrum penicillin or cephalosporin except in severe cases (Esipov *et al.*, 1998).

Proteus vulgaris inhabits the intestinal tracts of humans and animals. It can be found in soil, water and fecal matter. It is grouped with the *Enterobacteriaceae* and is an opportunistic pathogen of humans. It is known to cause urinary tract infections and wound infections. Symptoms attributable to struvite stones are uncommon. More often, women present with UTI, flank pain, or hematuria and are found to have a persistently alkaline urine pH (>7.0). Known antibiotics that *P. vulgaris* is sensitive to Ciprofloxacin, Ceftazidime, Netilmicin, Meropenem, Piperacillin/tazobactam (Guentzel, 1996).

P. aeruginosa is a ubiquitous organism, because it can be found in all kinds of environments as soil, water, animals, plants, sewage, hospitals, soil, water, skin flora and most man-made environments throughout the world (Costerton *et al.*, 1994). It is a common bacterium that can cause disease in animals, including humans. Most targeted sites are body organs, such as the lungs, the urinary tract, and kidneys, the results can be fatal (Balcht *et al.*, 1994). *P. aeruginosa* secretes a variety of pigments such as pyocyanin, pyoverdine and pyorubin (Meyer *et al.*, 2002 and Lau *et al.*, 2004). Urinary tract infections are the second most

important infections of body and Catheter-associated UTI (CAUTI) is responsible for 40% of nosocomial infections. In this review it was studied that *Escherichia coli* and *Pseudomonas aeruginosa* cause pathogenesis of UTI infections. So it was summarized that new strategies should be design to eradicate the infection percentage (Mittal *et al.*, 2009).

Pseudomonas putida is found in most soil and water habitats where there is oxygen. It grows optimally at 25-30°C and can be easily isolated (Espinosa *et al.*, 2000).

The main habitat of *V. cholerae* is human and aquatic sources such as brackish water and estuaries, frequently in association with shellfish, copepods or other zooplankton and aquatic plants. Cholera infections are most commonly acquired from drinking water in which *V. cholerae* is found naturally or into which it has been introduced from the feces of an infected person (Davis, 2003).

Salmonella enterica can cause four different types of clinical diseases: bacteremia, enteric fever, gastroenteritis (Bronze and Greenfield, 2005). Human infection frequently occurs when consuming contaminated foods and water, contact with infected feces, as well as contact with infective animals, animal feed, or humans (Bronze and Greenfield, 2005; Ryan and Ray, 2004; Krauss *et al.*, 2003). Foods that pose a higher hazard include meat, poultry, milk products, and egg products (Ryan and Ray, 2004; Brock *et al.*, 2000). Secreted proteins are of major importance for the pathogenesis of infectious diseases caused by *Salmonella enterica*. A large number of fimbrial and non-fimbrial adhesins are found in *Salmonella*, and facilitate biofilm formation and contact to host cells. Secreted proteins are also complicated in host cell invasion and intracellular proliferation, two hallmarks of *Salmonella* pathogenesis (Hensel, 2009).

Shigella can found in fecal contaminated material but has a low survival rate without the optimal acidic environment in the intestinal tract as its surrounding (Warren *et al.*, 2007). *Shigella sonnei* cause an enterobacterium disease called Shigellosis (Wei *et al.*, 2007). *Shigella sonnei* is spread mostly by means of fecal-oral transmission. Other Possible modes of transmission can be from ingestion of contaminated food or water, and subcutaneous contact with inanimate objects and most rarely, sexual contact (Sureshbabu and Venugopalan, 2006).

S. marcescens is commonly found growing in bathrooms (especially on tile grout, shower corners, toilet water line, and basin), where it reveals as a pink, pink-orange, or orange discoloration and slimy film feeding off phosphorus-containing materials or fatty substances such as soap and shampoo residue. In humans, *S. marcescens* can cause infection in several sites, including the urinary tract, respiratory tract, wounds and the eye, where it may cause conjunctivitis, keratitis, endophthalmitis and tear duct infections. It is also a rare cause of osteomyelitis (particularly in people who use intravenous drugs), endocarditis, pneumonia, and meningitis (Ania, 2008).

Aeromonas salmonicida is a pathogenic bacterium. *A. salmonicida* is an etiological representative for furunculosis; a disease that causes septicemia, muscle lesions, hemorrhage's, the lower intestine inflammation, enlargement of spleen, and death in freshwater fish inhabitants. It is geographically found worldwide with the exception of South America (McCarthy, 1980). The major path of contamination is poor water quality. The bacterium is pathogenic for fish, and causes the disease such as furunculosis. In fish, symptoms are external and internal hemorrhaging, swelling of the vents and kidneys, boils, ulcers, liquefaction, and gastroenteritis. Furunculosis is typically identified as tail rot in fish and is common in goldfish and koi. Infected fish with open sores are capable to spread the disease to other fish (Staley *et al.*, 2001). It is also one of several bacteria that can cause bald sea urchin disease. Since *A. salmonicida* cannot grow at 37°C, it is not pathogenic in humans (Altwegg *et al.*, 1990).

The Pakistani currency notes and coins may be responsible for the occurrence, spread and maintenance of the above mentioned disease in human population.

CONCLUSION

The Pakistani currency notes in circulation were found to be contaminated with various types of microorganisms. Therefore handling of paper currency deserves special attention. There should be public awareness of the fact that currency notes could be a source of infection and could be dangerous to health. To help control the spread of these pathogens, it is recommended that the central Bank of Pakistan should enforce laws on unethical handling of the Pakistani notes. Dirty and mutilated notes should be withdrawn from circulation from time to time.

RECOMMENDATIONS

Some recommendations of use of paper money and coins are as under:

1. It is suggested that regular disinfection of currency deposited in banks with ultraviolet light, fumigation or formalin vapors should be done.
2. It is advised to change the paper currency into plastic/polymer-based currency notes which could be easily washed to reduce contamination.
3. It is recommended that more awareness campaign and seminars should be created both in rural and urban areas because it is only our identity in terms of transaction.

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