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Full Length Research Paper

Detection of cockroaches as mechanical carrier of *Escherichia coli* and *Salmonella* species

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Cockroaches are cosmopolitan and are found in warm snug places. They are active at night and like to live in humid cracks, behind appliances, cabinets and drawers. They carry microbes on their external body surfaces as they often live in unsanitary places and are thus dangerous to human. This study was carried out in Quetta city. 50 samples of cockroaches were collected from washroom, kitchen and gardens from different areas of Quetta city. The collected cockroaches were brought to the laboratory for further investigation. The cockroaches were inoculated in brain heart infusion (BHI) broth and were incubated at 37°C for 24 h. The subcultures were made on Mac Conkey, SS and EMB agar for the isolation and purification of microorganisms. Biochemical tests that were catalase, simon citrate, methyl red and Voges-Proskauer (MR-VP) and motility tests were applied and the results show the presence of 82% *Salmonella* and 64% *Escherichia coli* on the external surfaces of cockroaches. It is deduced from the study that cockroaches are vital carriers of infectious pathogens; therefore, their control is necessary to minimize the spread of such infectious diseases.

Key words: Cockroaches, broth, agar, biochemical tests, *Salmonella*, *Escherichia coli*, pathogens.

INTRODUCTION

Insects are cosmopolitan and have the most successful history of life and exists since Pennsylvanian period (about 325 million years before) (Atkinson et al., 1992, Salehzadeh, 1992; Cloarec et al., 1992; Kopanic et al., 1994; Mohammadi, 1998; Daly et al., 1998; Cochran, 2001). In the world almost 3500 species of cockroaches have become adopted to live in human habitations (Stankus et al., 1990; Ebeling, 1978). Cockroaches consume cheese, meat, starch, grease, vegetables and fruits and are thus omnivores (Chamavit et al., 2011). The habitat, morphology, and mobility of cockroaches make them mechanical vectors for the tansmission of diseases (Fotedar et al., 1991). They transmit diseases through mechanical routes (Rivault et al., 1993). Cockroaches harbor numerous pathogenic and potentially pathogenic bacteria; they may carry bacteria on their cuticle or in the gut (Cloarec et al., 1992). The bacterial load on their bodies may be up to a million and in each of their fecal droppings can be 7 million (Bennett, 1993). Cockroaches are found to be potential vector in spreading nosocomial infections in hospital (Fotedar et al., 1991). Cockroaches are present everywhere, but

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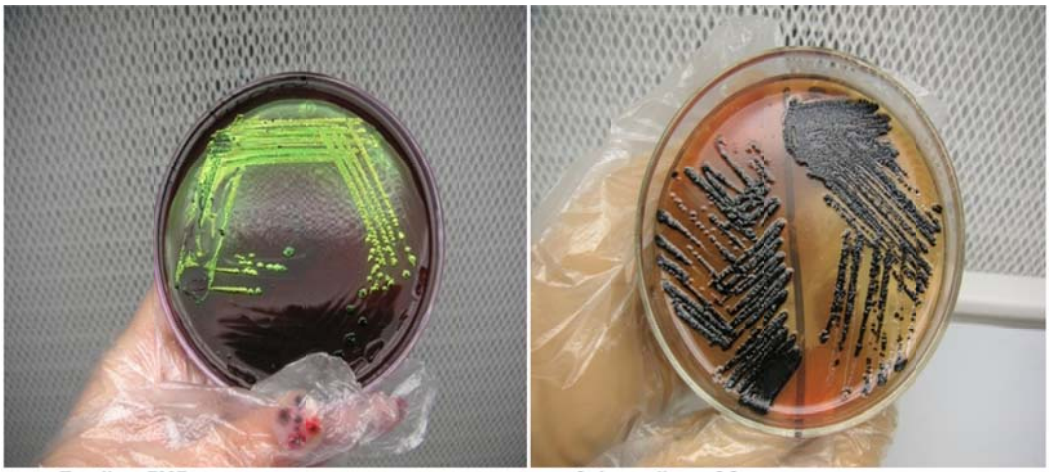


Figure 1. *E. coli* and *Salmonella* on EMB and SS agar.

mostly in hospitals, homes, kitchens, hotels and restaurants (Burgess, 1984). The increased infestation with the German cockroach (*Blattella germanica*) has caused concern because of its ability of contaminating food with disease causing germs. Thus food hygiene is compromised which results in health hazards (Tanaka and Motoki, 1993). The American cockroach (*Periplaneta americana*) is also one of the possible vectors of bacteria and the sewers are not only safe habitat but also provide them with access to bathrooms and basements (Brenner et al., 1978).

Cockroaches cause many health problems, but two of them are potentially serious. First they cause allergic reaction and second, they are a vector of multidrug resistant pathogens (Tungtrongchitr et al., 2004). For example, members of the genus *Salmonella* (fam. Enterobacteriaceae) can be found in the intestine of the host (Popoff et al., 2004). They are capable to resist dehydration and freezing and can survive for several years in harsh environment (Tortora et al., 2005). *Salmonella* species can persist at least 4 four years in the feces of cockroaches (Rueger and Olson, 1969). Contaminated meat is the most common and most frequent source of infections, caused by *Salmonella* species (Gatto et al., 2006). *Escherichia coli* also belong to the family Enterobacteriaceae and is a gram negative bacterium (the cells get pink color after Gram staining). *E. coli* can remain alive in food and water for a long period. The cells grow best at 37 ^{0}C which is the body temperature of a healthy human. Once they enter the human body they begin to reproduce rapidly, their treatment is restricted (Brown, 1993; Libkin, 1995; Meeker- Lowry, 1995). There are different strains of *E. coli*. The harmless strains are part of our normal flora of gut (Kubitschek, 1990). The harmful strains of *E. coli* cause food poisoning in humans (Vogt and Dippold, 2005). Cockroaches are capable of carrying microorganisms if they come in contact with contaminated materials (Burgess et al. 1973).

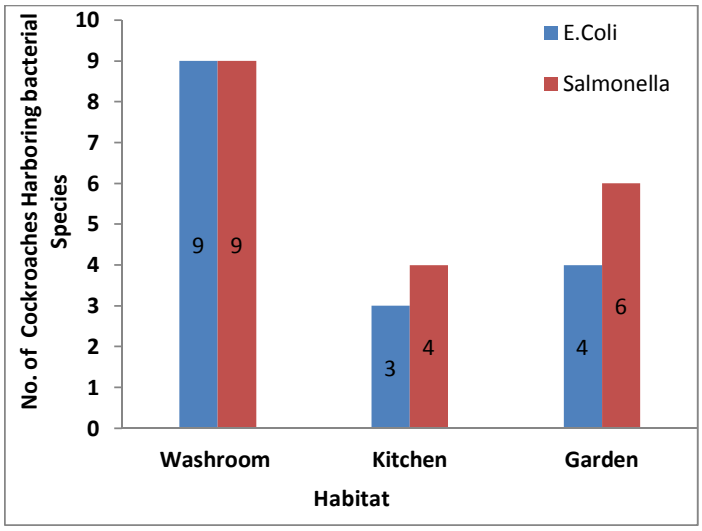
The open conduit carrying sewages are high in Quetta city which is an ideal habitat for cockroaches so the population of cockroaches' carrying infectious pathogen is increasing. This is the first study of its kind conducted in Quetta city to find out the role of cockroaches as mechanical carrier of *Salmonella* species and *E. coli*. Findings of this study would help in assessing the role of cockroaches in spread of enteric disease such as typhoid and food poisioning.

MATERIALS AND METHODS

The study was carried out in Quetta city. Out of 50 cockroaches, 19 (38%) were collected from washrooms, 18 (36%) were collected from kitchens, while only 13 (26%) cockroaches were collected from the garden. Twenty six individuals were American cockroaches and 24 were German cockroaches. The cockroaches were collected by hand randomly from different localities such as washrooms, kitchens and gardens by using rubber gloves. They were kept in sterilized sample bottles then placed those sample bottles until they died to avoid the use of insecticides. The collected cockroaches were brought to the laboratory. They were identified at species level. Cockroaches were kept in brain heart infusion broth (BHI Oxoid UK) for few minutes in order to transfer bacteria from the external surface of cockroaches to the BHI broth (Oxoid UK). The test tubes were incubated at 37°C for 24 h. Subcultures were made from the BHI bottles on Mac Conkey agar (Oxoid UK), Salmonella Shigella agar (SS agar Oxoid UK) and Eosin Methylene Blue agar (EMB Oxoid UK). Prolonged incubation period was given for the maximum chance of isolation of low number of possible bacteria. Morphological characters and biochemical tests identified the grown bacteria (Edwin et al, 1985). *E. coli* has metallic sheen colonies on EMB agar which is selective medium only for *E.coli* while *Salmonella* forms black colonies on SS agar (selective medium for *Salmonella*) (Figure 1). All the isolates, obtained from selective media (EMB and SS), were identified on the basis of their biochemical properties using catalase, Simon citrate, MR-VP and Sulphur Indole Motility test and gram staining reactions test (Talaro, 2007).

Table 1. Total number of American and German cockroaches in different locations

Location	Total number of cockroaches	
	American cockroach	German cockroach
Washroom	10	9
Kitchen	8	10
Garden	8	5
Total	**50**	



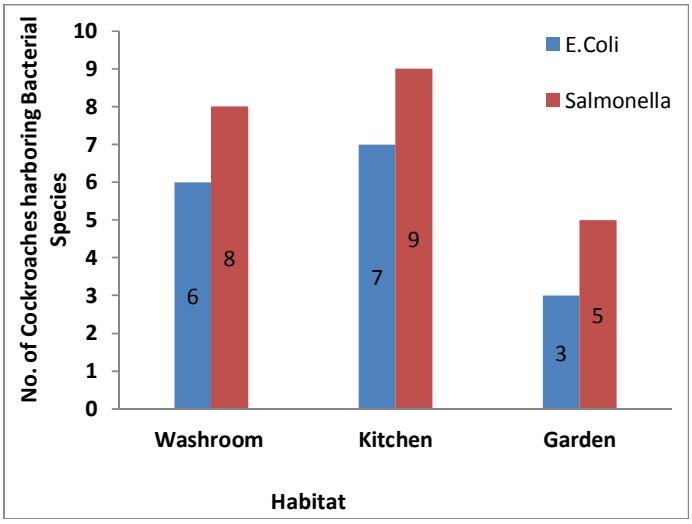
Graph 1. Bacterial species in three habitats isolated from American cockroaches.

RESULTS

Bacterial species were isolated from all 26 American cockroaches, and 24 German cockroaches which were collected randomly from three habitats of several areas (Table 1, Graph 1 and 2). The bacterial species isolated from no. of American and German cockroaches collected from each habitat is represented in Graph 1 and 2 respectively. Among the American cockroaches, maximum number of infested cockroaches was collected from washrooms while minimum no. of infested cockroaches was captured from kitchen. In the case of German cockroaches the maximum no. of cockroaches captured from kitchen have bacterial load while few Garden cockroaches were infested. From the total of 50 collected cockroaches, 32 (64%) showed bacterial load of *E. coli* and, 41 (82%) showed a bacterial load of *Salmonella.* The presence of *E. coli* and *Salmonella* was confirmed by having metallic sheen colonies on EMB agar and black colonies on SS agar respectively. Further biochemical tests were applied using catalase, Simon citrate, MR-VP and Sulphur Indole Motility test to confirm the bacterial species. This study thus revealed that cockroaches contain more bacterial load of *Salmonella* compared to *E. coli* (Graphs 1 and 2).

DISCUSSION

The sampled habitats represent the urban sites where cockroaches come into contact with humans and they also reflect that a cockroach infestation and invasion might play an important role in transmission of bacterial species. Elgderi et al. (2006) isolated 55 species of bacteria from German cockroaches collected from five habitats, and 18 bacterial species were known to be pathogenic or potentially pathogenic. Our study, which was performed in Quetta city, reveals that those localities where cockroaches are found abundantly and come into contact with humans in daily routine play an important role by carrying and spreading bacterial species. The presence of bacterial species on cockroaches in residential habitats might be a temporary reservoir that could lead to a rapid recovery of bacterial population infestation in near future (Hossein et al., 2003). Many studies have revealed the dominance (up to 88%) of isolated Gram-negative bacteria on the surface or cuticle of cockroaches (Paul et al., 1992). Most of the bacteria belong to the family



Graph 2. Bacterial species in three habitats isolated from German cockroaches.

Enterobacteriaceae (Sramova et al., 1992; Rivault et al., 1993).

Our study supports that cockroaches are a mechanical carrier of bacterial species. *E. coli and Salmonella species* were present on the exoskeleton of cockroaches and both belong to family Enterobacteriaceae. Other pathogenic bacteria were also isolated from coakroaches thatis *Klebsiellla* species, *Proteus* species, *Pseudomonas aeruginosa* and *Staphlococcus aureus* (Fotedar et al., 1991). Insecticides and bactericides in more sensitive areas could not inhibit the bacterial species, which are present on cockroaches successfully in the end or even though the cockroaches were killed a lot temporarily there but the quantity of bacteria carried by cockroaches were inhibited because of the decline of cockroach population (Graczyk et al., 2005). Our work suggests that bactericide and insecticide should be used simultaneously and constantly to reduce the cockroach population and bacterial densities in sensitive areas and other disinfectants should also be used at the household level.

Conflict of Interest

The author(s) have not declared any conflict of interests.

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