Short Communication

Potential public health significance of faecal contamination and multidrug-resistant Escherichia coli and Salmonella serotypes in a lake in India

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Objective: To assess the prevalence of faecal coliform bacteria and multiple drug resistance among Escherichia coli and Salmonella serotypes from Vembanadu Lake.

Study design: Systematic microbiological testing.

Methods: Monthly collection of water samples were made from ten stations on the southern and northern parts of a salt water regulator constructed in Vembanadu Lake in order to prevent incursion of seawater during certain periods of the year. Density of faecal coliform bacteria was estimated. E. coli and Salmonella were isolated and their different serotypes were identified. Antibiotic resistance analysis of E. coli and Salmonella serotypes was done and the MAR index of individual isolates was calculated.

Results: Density of faecal coliform bacteria ranged from mean MPN value 2900 - 7100/100ml. Results showed multiple drug resistance pattern among the bacterial isolates. E. coli showed more than 50% resistance to amikacin, oxytetracycline, streptomycin, tetracycline and kanamycin while Salmonella showed high resistance to oxytetracycline, streptomycin, tetracycline and ampicillin. The MAR indexing of the isolates showed that they have originated from high risk source such as humans, poultry and dairy cows.

Conclusions: The high density of faecal coliform bacteria and prevalence of multi drug resistant E. coli and Salmonella serotypes in the lake may pose severe public health risk through related water borne and food borne outbreaks.

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Faecal contamination is considered to be the main contributor of enteric pathogens to natural water resources. Infections originating from such sources, especially diarrhoea and typhoid fever, are highly endemic to India, and are also a major public health concern among children in other developing countries. The main pathogens accountable for these illnesses are diarrhoeagenic serotypes of Escherichia coli and Salmonella enterica serotypes typhi and paratyphi. Infections are further aggravated by the emergence and dissemination of antimicrobial resistance among these pathogens, and reported
outbreaks due to multidrug-resistant diarrhoeagenic E. coli and Salmonella serotypes from India further challenges the efficiency of antibiotic treatment in the country.  

Vembanadu Lake, the largest lake in India, lies 0.6–2.2 m below mean sea level along the south-west coast of India (9° 35′ N 76° 25′ E). Its maximum depth is 12 m. The lake is used by over 1.6 million people, directly or indirectly, for agriculture, fishing, transportation and recreation; therefore, the monitoring of microbiological quality and related risk assessment is of particular health significance. The present study analysed the prevalence of faecal coliform bacteria at 10 stations, and the incidence of multidrug resistance among E. coli (n = 33) and Salmonella (n = 26) serotypes isolated from Vembanadu Lake.

Each month, water samples were collected aseptically from a depth of 1 m from five stations on the southern side (enclosed region) and five stations on the northern side (open region) of the saltwater regulator in Vembanadu Lake. This regulator was constructed to prevent incursion of seawater during certain periods of the year. Samples were collected in sterile screw-capped bottles (500 ml) and transported to the laboratory in an ice box. Prevalence estimate of faecal coliform bacteria were made, and E. coli and Salmonella were isolated. The three-tube most probable number (MPN) method was used to estimate the prevalence of faecal coliform bacteria and for isolation of E. coli. Membrane filtration followed by the selective enrichment method was used for the isolation of Salmonella. The procedures for the isolation of E. coli and Salmonella have been described in detail elsewhere. Serotyping of E. coli and Salmonella strains were carried out at the National Salmonella and Escherichia Centre, Kasauli, Himachal Pradesh, India.

Antimicrobial susceptibility testing was performed using the disc diffusion method as described previously. In total, 10 antibiotics were used: ampicillin (10 μg); amikacin (30 μg); chloramphenicol (30 μg); ciprofloxacin (10 μg); gentamycin (10 μg); kanamycin (30 μg); nalidixic acid (30 μg); oxytetracycline (30 μg); streptomycin (30 μg) and tetracycline (30 μg). Multiple antibiotic resistance (MAR) indices for the individual isolates were calculated by dividing the number of antibiotics to which the isolate was resistant by the total number of antibiotics to which the isolate was exposed, as described previously. A MAR index >0.2 is considered to have originated from a high-risk source of contamination.

The density of faecal coliform bacteria ranged from a mean MPN value of 2900–7100 per 100 ml; this exceeds the limits set by the World Health Organization for recreational water (200 faecal coliforms per 100 ml). Fourteen different “O” antigenic serotypes of E. coli were isolated: O75; O63; O92; O41; O132; O32; ROUGH; UT (untypable); O114; O20; O26; O9; O2 and O7. This is the first report on the isolation of certain E. coli serotypes (pathogenic O114, O26 and O7; non-pathogenic O75, O92, O41 and O132) from this lake. Salmonella serotypes including paratyphi A, B and C, and S. newport were also isolated. All E. coli serotypes tested (33 strains) were resistant to more than three antibiotics. MAR indices ranged between 0.4 and 0.8. The highest resistance was found for amikacin (96.96%), followed by oxytetracycline (93.93%), kanamycin (90.90%), streptomycin (84.84%), tetracycline (69.6%), nalidixic acid (45.45%), ampicillin (33.33%) and gentamycin (27.27%). The lowest resistance was found for ciprofloxacin (6.06%) and chloramphenicol (9.09%). More importantly, uropathogenic serotypes of E. coli (O2, O7) and enteropathogenic serotypes (O114, O20, O9) were resistant to more than four antibiotics, with MAR indices from 0.4 to 0.7.

The Salmonella serotypes tested (26 strains) were also resistant to more than three antibiotics. The highest resistance was found for oxytetracycline (88.46%), followed by tetracycline (76.92%), streptomycin (73.07%), ampicillin (65.38%), amikacin (34.61%), kanamycin (42.3%) and nalidixic acid (23.07%). The lowest resistance was found for gentamycin (3.84%). However, all tested Salmonella strains were completely sensitive to chloramphenicol and ciprofloxacin, with MAR indices between 0.3 and 0.7.

The presence of pathogenic serotypes of E. coli and Salmonella in the lake is a serious health concern for the local population. Sporadic outbreaks of diarrhoea due to the prevailing clonal diversity among different categories of diarrhoeagenic E. coli and enteric fever due to S. enterica serovars paratyphi A, B and C and S. newport have been reported in India with an annual incidence of 3 million cases. As S. enterica serovar paratyphi A has emerged as an important cause of enteric fever in India, and humans are the only reservoir of this serovar, the source of S. enterica serovar paratyphi A in Vembanadu Lake could be faecal discharge by infected persons/carriers, indicating its high range of contamination. The problem could become more serious when these organisms acquire resistance against multiple drugs, because infection caused by such organisms will be difficult to treat. Relatively high levels (95%) of multidrug-resistant E. coli including pathogenic serotypes have been reported from aquatic environments. It has also been demonstrated that within S. enterica subsp. enterica, there has been a serovar-dependent increase in acquired resistance to several antibiotics such as ampicillin, chloramphenicol and tetracycline, along with an increase in multidrug-resistant strains.

The MAR indices (>0.2) of E. coli and Salmonella isolates indicate that they have originated from high-risk sources of contamination, such as humans, poultry and dairy cows. This shows that the lake is experiencing severe pollution from different sources. The results show that the water quality is poor in terms of faecal coliform density and multidrug-resistant pathogenic E. coli and Salmonella serotypes, and may pose severe health risks to the population who use the water for different purposes. Government authorities need to take effective measures (e.g. proper sanitation facilities and wastewater treatment) to reduce pollution of the lake to avoid serious consequences for healthcare management within local communities.

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**Competing interests**

None declared.
REFERENCES


