A STUDY ON E.COLI CONTAMINATION IN DRINKING WATER RESOURCES IN AND AROUND VIJAYAWADA CITY OF ANDHRA PRADESH, INDIA.

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ABSTRACT

A study was carried out to assess the E. coli content in various drinking water sources of Vijayawada city. An aggregate of 100 samples were collected from different sources like tap water, ground water, river water, bottled water and sachet. Total coliform counts in the samples were determined using Multiple Tube Fermentation Technique (APHA, 2005). Out of 100 samples examined 35% samples were positive to the presence of E. coli. All river water samples contained E. coli, followed by ground water (50%), municipal tap water supplies (15%) and sachet samples (15%). The present study identified higher E. coli count in water sources falling in the vicinity of Municipal Solid Waste dump sites. The study also highlights the reasons for higher E. coli count associated with the water bodies and suggested management measures for their control.

Keywords: Vijayawada city, E. coli contamination, Ground and surface sources.

INTRODUCTION

Water is one of the most important of all natural resources known on Earth. It is important to all living organisms, most ecological systems, human health, food production and economic development (Postel et al., 1996). Coliform bacteria do not impart taste, smell or colour to water and they can only be detected through laboratory tests. Bio films are coating of organic and inorganic materials in pipes that can harbour, protect and allow the proliferation of several bacterial pathogens, including Legionella and Mycobacterium Avium Complex (MAC) (Hunter et al., 2009). Various factors like water type, temperature, type of disinfectants used and residual concentrations, biodegradable organic carbon level, degree of pipe corrosion and treatment / distribution system characteristics etc. affect the growth of bacteria on biofilms. Escherichia coli (E. coli) are widely distributed in the gastro-intestine tract of humans, pests, ruminants, non-ruminants and wild animals, where they are known to live as commensals (Feng and Weagant, 2009; Frederick 2011). They are gram negative facultative anaerobic bacteria (Feng and Weagant, 2009; Anonymous, 2012) from the family Enterobacteriaceae and ferments glucose or lactose (Feng and Weagant, 2009; CDC, 2014a). Although most E. coli live in commensalism with their host, pathogenic E. coli strains exist and normally cause haemolytic uremic syndrome, that can be fatal (Feng and Weagant, 2009; Anonymous, 2012; CDC, 2014a). E.coli is generally considered as a reliable indicator for the presence or absence of other pathogenic bacteria such as Salmonella, Shigella and Campylobacter spp. (WHO, 2017). There are also many studies which had isolated E. coli from humans, farm animals, wild animals, milk, water and environmental samples, some of which have been responsible for food borne illnesses and deaths (Zubeir et al., 2009; Surendraraj et al., 2009; Adzitey et al., 2010; Adzitey et al., 2011; Adzitey et al., 2012; Adzitey et al., 2013; Adzitey et al., 2014; Islam et al., 2011; Geidam et al., 2012; CDC 2014a; CDC 2014b; and Carnot et al., 2014). Through poor processing and handling of foods or farm animals, E. coli can cross contaminate a variety of sources including drinking water. Humans and farm animals can get E. coli infection by drinking water from such sources.

In the present study, the occurrence of E. coli was monitored in different drinking water sources of Vijayawada city. The materials and methods followed are discussed below.
MATERIALS AND METHODS

Study Area
This study was conducted from December 2017 to June 2018, on a monthly basis in Vijayawada city of Andhra Pradesh. For the study, drinking water samples from different sources like municipal tap water, sachet water, bottled water and other sources like ground water and river water were collected. The ground water collected was from different sections of the city, including sources falling in the vicinity of a municipal solid waste dumpsite.

Site Description
Pathapadu Dumpsite
Pathapadu village (16°37' 39.35" N latitude and 80°40' 10.49" E longitudes) is situated in the Vijayawada suburban area at a distance of 15 km from Vijayawada city. Pathapadu village has residential establishments surrounded by hills, agricultural fields and forest (Figures 1). An expanse of 100 acres has been used for dumping. So far about a million tonnes of waste has been dumped at Pathapadu dumpsite. The site consists of greenery, with a good diversity of flora and fauna. The nearest human habitation was located at 2 Km.

Ajith Singh Nagar Dumpsite
The Ajith Singh Nagar dumpsite (16°32' 27" N latitude and 80°38'52" E longitude) was spread in an area of 106.61 acres in the suburban area of Vijayawada (Figure 3 & Photo 2).

Collection of sample
A total of hundred water samples were randomly collected from five different sources within the city on a monthly basis for period of seven months. The sources include that of tap water (Municipal supplies) (n=20), bottled water (n=20), sachet water (n=20), ground water (n=20) and river water (n=20). The collected water samples were then analyzed for E. coli content, following standard procedures. The samples which were positive for E. coli contamination are listed in the table 2.

Isolation of Escherichia coli
Total coliform counts in the samples were determined using Multiple Tube Fermentation Technique (ISO 1990a; APHA 2005). E. coli (CFU/ml) was isolated from water samples by Membrane Filtration using a Simultaneous Detection Technique (MI
Experimental Procedure
The MF method provides a direct count of bacteria in water based on the development of colonies on the surface of the membrane filter. A water sample is filtered through the membrane which retains the bacteria. After filtration, the membrane is placed on a selective and differential medium, mTEC, incubated at 35°C ± 0.5°C for 2 ± 0.5 hours to resuscitate injured or stressed bacteria, and then incubated at 44.5°C ± 0.2°C for 22 ± 2 hours. Following incubation, the filter is transferred to a filter pad saturated with urea substrate. After 15 minutes, yellow, yellow-green, or yellow-brown colonies are counted with the aid of a fluorescent lamp and a magnifying lens. The confirmatory test was performed. It is important to carry out confirmatory tests on pure subcultures. To confirm the membrane results for total coliforms, each colony (or a representative number of colonies) is subcultured to tubes of lactose peptone water and incubated at 35 or 37 °C for 48 hours. Gas production within this period confirms the presence of total coliforms. To confirm thermotolerant coliforms and E. coli on membranes, whether incubated at 35, 37 or 44 °C, each colony (or a representative number of colonies) is subcultured to a tube of lactose peptone water and a tube of tryptone water. Tubes are incubated at 44 °C for 24 hours. Growth with the production of gas in the lactose peptone water confirms the presence of thermotolerant coliforms. Confirmation of E. coli requires the addition of 0.2-0.3 ml of Kovac’s reagent to each tryptone water culture. Production of a red colour indicates the synthesis of indole from tryptophan and confirms the presence of E. coli.

Calculation of the concentration of E. coli (CFU / mL) in the undiluted spiking suspension according to the following equation:

\[
E.\text{coli}_{\text{undiluted spike}} = \frac{\sum \text{CFU}_i}{\sum V_i}
\]

Where, \(E.\text{coli}_{\text{undiluted spike}}\) = E. coli (CFU / mL) in undiluted spiking suspension

\(\text{CFU} = \) Number of colony forming units from TSA plates yielding counts within the countable range of 30 to 300 CFU per plate

\(V = \) Volume of undiluted sample on each TSA plate yielding counts within the countable range of 30 to 300 CFU per plate

\(n = \) Number of plates with counts within the countable range (30 to 300 CFU / plate)

RESULTS AND DISCUSSION
The report on the occurrence of E. coli in drinking water sources in Vijayawada city of Andhra Pradesh is inevitable in terms of public health issues. A better knowledge on the source, prevalence and distribution of fecal contaminants in drinking water sources could...
be an important input for the development of strategies to reduce associated public health risk (Ahmed et al., 2016).

The prevalence of *E. coli* in the drinking water sources of the present study area is depicted in Table 1. Out of 100 samples examined, 35 (35%) samples were positive for *E. coli*. All river water samples (100%) were positive for *E. coli* and were significantly higher than that of ground water (50%), followed by tap water from municipal supplies (15%) and sachet water samples (15%). *E. coli* was not identified from most of the bottled and sachet water samples, which can be due to the quality of filtration and disinfection and other hygienic treatment processes. However, the presence of *E. coli* identified with sachet water samples might be due to contamination during packing or supply. This supports the finding that *E. coli* are more sensitive to chlorine treatment (Payment, 1999).

Globally, near to 800 million people have no access to improved water sources and about 2.5 billion people do not have access to satisfactory sanitation (WHO, 2012). Coliforms such as *E. coli* have been widely used as an indicator of the microbiological quality of surface and ground water sources (Ahmed et al., 2005). The isolation of coliform, especially *E. coli* from water sources is attributable to contamination by human and animal origin and this is of health significance as these organisms have generally been agents of gastroenteritis in humans (Ahmed et al., 2005). In the present study, the tap water was found to be contaminated; indicating 15% prevalence of *E. coli* in the water samples and this might

### Table 1. Site specification

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Source 1 Tap Water</th>
<th>Source 2 Ground water</th>
<th>Source 3 River water</th>
<th>Source 4 Bottled water</th>
<th>Source 5 Sachet water</th>
<th>Frequency of sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling locations</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Monthly</td>
</tr>
<tr>
<td>Number of Samples</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Occurrence of *Escherichia coli* in drinking water from different sources in Vijayawada city of Andhra Pradesh

<table>
<thead>
<tr>
<th>Nature of water sample</th>
<th>No. of samples collected / tested</th>
<th>No. of samples positive to the presence of <em>E. coli</em></th>
<th>Prevalence (%)</th>
<th>Overall Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap water (area 1)</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tap water (area 2)</td>
<td>5</td>
<td>2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Tap water (area 3)</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Tap water (area 4)</td>
<td>5</td>
<td>1</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Ground water (area 1)</td>
<td>5</td>
<td>3</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Ground water (area 2)</td>
<td>5</td>
<td>3</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Ground water (area 3)</td>
<td>5</td>
<td>2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Ground water (area 4)</td>
<td>5</td>
<td>2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>River water (area 1)</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>River water (area 2)</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>River water (area 3)</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>River water (area 4)</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Bottled water (area 1)</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bottled water (area 2)</td>
<td>5</td>
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<td>0</td>
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</tr>
<tr>
<td>Bottled water (area 3)</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Bottled water (area 4)</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sachet water (area 1)</td>
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<td>0</td>
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<tr>
<td>Sachet water (area 2)</td>
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<td>1</td>
<td>20</td>
<td>15</td>
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<tr>
<td>Sachet water (area 3)</td>
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<tr>
<td>Sachet water (area 4)</td>
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<tr>
<td>Total</td>
<td>100</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>
be due to the contamination from the distribution system or through the leakages in water pipes.

All samples collected from river were contaminated. This might be due to the close human habitations near to the banks of the river. Also direct animal interference with the rivers was also noted. The runoff from nearby animal husbandry centers and poultry farms might also have contributed to the fecal contamination of the river water. Studies have shown that surface and groundwater contamination by fecal pathogens generally occur through surface run-off, leaching and direct fecal deposition into the water bodies through several livestock production activities like confined animal feedlot, free range system, abattoir wastes, land spreading of manure etc. (Kuczyńska et al., 2005). Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste (Momtaz et al., 2013). The presence of fecal contamination in the river is reported to be an indicator of the potential health risk for individuals exposed to this water. The 50% of ground water samples collected in the present study were also found to be contaminated. This could be attributed to the percolation of rainfall water, carrying fecal contaminants. As ground water samples were collected from bore wells, the percolation and leakage of contaminated water to the bore wells can only be attributed as a source for contamination. Garba et al., (2009) isolated 63 _E. coli_ isolates from water samples. They also reported the prevalence of 45.5, 23.3 and 13.3% in well water, tap water and packaged water, respectively. The samples that was positive for _E. coli_ contamination in the present study for wells was higher than the study performed by Garba et al., 2009. Whereas the positive samples for tap water were lower than the study carried out by Garba et al., 2009. Momtaz et al., (2013) examined 448 water samples for _E. coli_ and found 34 (7.58%) samples to be positive for _E. coli_. They also detected _E. coli_ in 8 (2.63%) of 304 samples of bottled drinking water. In the present study, any _E. coli_ contamination was noticed in bottled water samples, but two of the sachet water samples were found to have the presence of _E. coli_.

**CONCLUSION**

This study gives base line information about the occurrence of _E. coli_ in various drinking water sources at Vijayawada city. Most of the studies also revealed the increased risk of diarrhea due to contamination of drinking water sources with _E. coli_. Hence it is recommended to have more stringent measures, both by the municipal water treatment plants and households to curb the presence of _E. coli_ in water. As the major cause of _E. coli_ is lack of safe and clean lavatories, stringent measures should be taken to control open defecation. It is also recommended to treat household water by boiling. Also it is imperative to enlighten people to maintain hygienic atmosphere in and around their living environment.

**REFERENCES**


