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Original Research Article

Bacteriological Study of Packaged Drinking Water Available In the Market during Pre Monsoon Period in Tiruchirapalli, Tamilnadu

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ABSTRACT

The general quote "water is an elixir of life" is successful when the drinking water is available in germ free condition. The cleanliness and hygienic state of drinking water play an important role in the health state of the population. On comparing with other vehicle reservoir, water is considered as a potent and fastest source of spreading various infectious diseases. The study was carried out to investigate the packaged drinking water available in Tiruchiarapalli city. In the present study, eighty five samples grouped under five brands where one was national and four were local. All the samples were subjected to viable count and presence or absence method. The samples showed positive to the test were further subjected to multiple tube method for determination of total coliform analysis. As a result twenty eight out of 85 samples had viable count higher than specified by Bureau of Indian Standard. Twenty three samples were found to be positive in presence - absence test. Further all the 23 samples subjected for total coliform analysis thereby 20 samples confirmed the presence of *Escherichia coli*. It is highly unexpected to have coliforms in packaged drinking water. It clearly indicates the laxity in exercising stringent quality control measures by the manufacturers.

Keywords: Bacteriology, Packed drinking water, Tiruchiarapalli, potability.

INTRODUCTION

The biological contamination in drinking water is a major problem of public health in developing world. Testing water quality is a key element of drinking water safety that has been gaining increasing attention, especially in reference to the close of the Millennium Development Goals (MDG) in 2015. [1,2] More number of experimentation was continuous practicing in the water purification plants as well as in the research sector on water potability, risk in unhygienic water consumption, water borne diseases and infections, water treatment and role of government and non-governmental organizations in direct involvement of water quality assessment and clean and potable water supply to public. [3,4]

Internationally, the diseases caused by contaminated drinking water consumption and poor hygienic practices are the leading cause for increasing mortality among infants and children. The water may be contaminated with pathogens at the source but contamination also occurs during distribution,

transportation or handling and packaging. The raw water without treatment is considered as sanitary risk to develop various multi organ affecting diseases. Globally 1.1 billion people rely on unsafe drinking water sources from lakes, rivers and open wells; 2.4 billion people lack adequate sanitation worldwide. Microbial contamination is responsible for the great majority of water-related health burden. [5]

WHO recommends that the microbial quality of drinking-water be measured using faecal indicator bacteria, preferably *Escherichia coli*; these bacteria are chosen to indicate the presence of faecal contamination rather than identifying pathogens directly. Conventionally, analyses take place in a laboratory environment using standard procedures, such as those described in the *Standard Methods for the Examination of Water and Wastewater (SMEWW)*, approved by the U.S. Environmental Protection Agency (EPA) or set by the International Organization for Standardization. [6] We have restricted our analysis to tests based on culturing faecal indicator bacteria as these are likely to remain the most common methods for microbial water quality monitoring in the short to medium term.

Conventional laboratory methods, such as membrane filtration and multiple tube fermentation, are complex and time-consuming. They require a wide range of basic laboratory equipment and skilled personnel to achieve consistent results. Sample transportation, especially within the recommended timeframe (<24 h, preferably <6 h) and temperature range (<8°C but not frozen), is often impractical. This is particularly the case for rural and dispersed populations, for which the nearest laboratory can be at a significant distance from water supplies. Where laboratories are accessible, these may be overstretched and only able to conduct infrequent testing of a limited number of supplies. As a consequence, testing in the locations with no access to resources such as reliable mains electricity or technically trained staff may be preferable. Pure and safe drinking water has always been a necessity. [6,7]

Traditionally pipe water distributed by the municipalities has been the trusted water supply for drinking purposes. For various reasons water supply authorities are unable to provide potable water in our country. Large majority of the population depend on packaged drinking water and further going for bulk quantity of packaged water is the present trend because of the cost factor and convenience. Availability and reasonable price has popularized bottled drinking water among the middle class. Bottled water is generally considered safe and is taken for granted by people without question. [5] The Bureau of Indian Standards (BIS) has come out with standards for packaged drinking water. Though we are not aware of any reports of transmission of waterborne diseases through bottled water, such a possibility cannot be denied. The major objectives of this study were:

1. To describe the resource settings and the purposes of testing, important characteristics which should be considered when selecting a test for faecal indicator bacteria in drinking water sources
2. To collate the information on these characteristics for available water tests and assess their suitability based on the resources available in the test area.

This study was designed to evaluate the bacteriological quality of the packaged drinking water which is marketed in Tiruchirapalli city of Tamilnadu (India).

MATERIALS AND METHODS

Water samples were collected from different areas of Tiruchirapalli city of Tamilnadu (India) from August to November 2015. All the samples were tested for its bacteriological quality. All

the water samples were collected in clean, sterilized sealed bottles and the persons responsible for collection of water samples were asked to strictly follow the standard guidelines. [8] Extreme care was taken to avoid any bacteriological contamination from environment during transportation of water samples to the laboratory. [9]

A total of 85 samples, of different batches from each of 5 brands of locally available water as 20 litres bulk pack were included in the present study. Samples were categorized in to 3 groups. Category I included water samples obtained from the market places where more than 2 bulk packs of different brands of water were used per day. These were obtained for large scale domestic/ academic/ official functions like weddings, conferences, workshops etc. Category II having water samples from the market places where not less than 2 bulk packs of water was used per day, mainly for birthday parties and other small scale functions. Category III included water samples from market places where maximum of 1 bulk pack of water was used per day like offices, shops and houses. Two hundred (200) ml from each source was collected in a sterile container as an end user. Out of 5 brands, 1 was national and 4 were local. Out of 4 local brands, 1 was non labeled and non ISI certified. Rest all were ISI certified.

The viable count (both at room temperature and 37^{o}C) and Presence - Absence test were carried out for all the samples. Samples that showed positive result in presence absence test were further subjected to multiple tube method for determination of presumptive coliform (total coliform) count. Eijkman test was performed for all the samples which showed positive result in presumptive coliform test, as per the standard procedure. All the data obtained from each tests were compared, analyzed and evaluated to identify the etiological agent of the water borne pathogen that are very prone to public health infections.

Results

In the present study, a total of 85 water samples were collected from different areas of Tiruchirapalli and examined for bacterial contamination under three major categories mentioned in the materials. On the basis of coliform test, the water samples included in this study were classified in three types. Out of 85 samples tested, 28 (32.9%) were supported for higher the detection of viable counts compared to BIS standard and further 23 (27.1%) samples determined as positive to presence - absence test, 23 (27.1%) were considered as positive to coliforms and 20 (23.6%) were positive to *Escherichia coli* (Figure 1). Positive samples indicated the presence of coliforms. The positive samples were further confirmed through culturing on selective media. The enteric bacteria, *E. coli* was further identified on the basis of colony morphology, Gram staining and Biochemical tests.

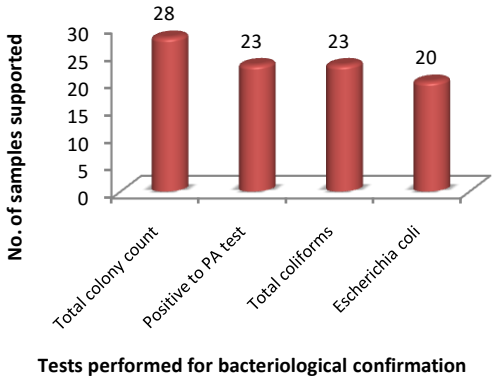

Figure 1: Details of water samples supported the bacteriological examinations

Among 28 isolated bacteria, twenty (20) were *E. coli* (Figure 1). *E. coli*, the enteric bacteria are considered as water pollution indicator organisms; however, some strains are pathogenic and may cause enteric infections. [10] The detailed description about the bacterial determination according to the three different categories of water samples were well analyzed thereby 42.8%, 32.3%, 31.9% of the category I, II and III water samples respectively showed and

supported positive to detection of viable bacterial counts (Table 1).

Table 1: Catergory wise determination of presence of bacteria in packed drinking water

Category	Total samples included (n=85)	No. of samples with viable bacterial count (n=28)	No. of samples positive to PA test (n=23)	No. of samples positive to presumptive test (n=23)	No. of samples positive to *E. coli* (n=20)
Category I	7 (8.2)	3 (10.7)	3 (13.0)	3 (13.0)	2 (10.0)
Category II	31 (36.5)	10 (35.7)	9 (39.1)	9 (39.1)	8 (40.0)
Category III	47 (55.3)	15 (53.6)	11 (47.9)	11 (47.9)	10 (50.0)

[Figure in parenthesis denoted percentages]

Nearly most of the samples were further confirmed for the presence coli forms and further detected as *E. coli*. The presence of this indicator bacterium in water samples indicates the extent of water contamination in the packed drinking water sources of the city. The brand wise description also carried out by which the bacterial populations were detected among the bulk packed water samples. By applying MPN test, we can check the quality of drinking water. Further it was identified for the presence of *E. coli* by completed test. The descriptive analysis of the presence of bacterial pathogens in the drinking water sources in brand wise were depicted in table 2. The contaminated water may be made good for use through filtration, sedimentation, disinfection by chlorination and some physical methods like osmosis, distillation and UV light. Such type of work is necessary in order to know the extent of water contamination.

Table 2: Brand wise description of bacterial analysis among bulk packed water samples

Brand	No. of samples subjected	No. of samples showed viable count	No. of samples showed colony count	Positive to PA test	Positive to presumptive test	Positive to coliforms for *E. coli*
Local Brand; ISI certified (n=42)						
1	14 (24)	8 (57.1)	8 (57.1)	8 (57.1)	8 (57.1)	8 (57.1)
2	20 (36)	12 (60)	10 (27.8)	7 (35)	7 (35)	6 (30)
3	8 (16)	4 (50)	3 (37.5)	3 (37.5)	3 (37.5)	2 (25)
National Brand; ISI certified (n=38)						
1	38	8 (21.1)	5 (13.2)	3 (7.9)	3 (7.9)	2 (5.3)
Unlabelled; non ISI certified (n=5)						
1	5	2 (40)	2 (40)	2 (40)	2 (40)	2 (40)

[Figures in parenthesis denoted percentages]

DISCUSSION

In general, a large number of microorganism including saprophytes and pathogenic organism are found in drinking water sources. Among them, many bacteria provide an indication of faecal pollution in water. [9] *E. coli* has been used as an indicator of faecal pollution in water for many decades. The bacterium is present in the intestinal tract of human and animals in large numbers and is more numerous than disease causing bacteria and viruses. *E. coli* has the advantage of not being capable of growing and multiplying in water (except warm and food laden waters). Therefore, the presence of this bacterium in water is indicator of recent faecal pollution. [11] Surface water sources are more liable to contamination as they are often loaded with various chemical and biological constituents.

Tap water gets contaminated easily from its source or while passing through pipelines. Some other factors like soil and air can also act as source of water contamination. Ground water is considered more safe and reliable for consumption because sand filters remove most of bacteria from it. [12] By contrast the packed water were undergone various sterilization and disinfection processes before it get packed. In the present study, the portability of water samples collected from packed drinking sources available in the market of Tiruchirapalli city (Tamilnadu) was determined on the basis of presumptive coliform test (MPN).

The rate of contamination of packaged drinking water sold in Tiruchirapalli is of serious public health concern. There is need for use of molecular based methods to understand microbial ecology, epidemiology, virulence factors and survival of isolated water borne pathogens in packaged drinking water sold in any places. The ever increasing demand, sale and indiscriminate consumption of packaged drinking water in developing countries, therefore, poses significant public health risks to the citizens especially individuals with compromised immune systems. [13] Most producers of packaged drinking water obtain their raw water mostly from sources such as local, municipal piped water or well water and therefore, do not follow specified standards due to lack of the appropriate drinking water technology. [6]

By this investigation we forwarded the following suggestions

- Specific laboratory requirements at state district and sub-district drinking water testing laboratories.
- Frequent testing of drinking water sources of important parameters in all places.
- Suggestive and availability of major instruments, glasswares, equipments, chemicals etc.
- Regular and routine water testing and surveillance for rural and urban water sanitation, block resource centres for testing water samples, cluster resource centres with all necessary informations, development and updation of information in Gram Panchayats (GP) on risks assessments and follow-up corrective actions.
- Generate more awareness amongst the community not to consume water for cooking and drinking purposes from the contaminated sources.
- Preventive and corrective actions for microbial and chemical contaminants by identifying safe source and identifying suitable and standard treatment technologies

Further, the buildings and equipments available in the industries should be designed and constructed so as not contaminating water. The major conditions that might lead to contamination include excessive dust, foul odours, smoke, and pest infestation, airborne microbial and chemical contamination. [5] Local brands and even some national brands of packaged drinking water were found unfit for human consumption. So, it is suggested that government should intensify the efforts in the monitoring of activities in this rapidly expanding industry with a view to supply potable and wholesome water to the public.

Pathogenic bacteria can occur in surface water in large numbers, either being excreted in faeces or occurring naturally in the environment. Bacteria typically range in size between 0.5 and 2 micrometres. Disease-causing bacteria that can be transmitted by water include *Escherichia coli*, *Vibrio cholerae*, *Salmonella* sp, *Campylobacter* sp, *Shigella* sp, and *Staphylococcus aureus.* The contamination of drinking water sources with microbial pathogens in an on-going problem. More than three million people die every year from water borne disease and 43% of water mode deaths are due to diarrhoea. The majority of diseases are infectious in nature caused by bacteria, fungi, viruses and parasites, execrated in human faeces which may lead to contaminate water supplies. [7]

CONCLUSION

As a conclusion, while most of the samples were of excellent categories and others in good satisfactory conditions, there is the need to be cautious in the consumption of packed water samples suggesting that the manufacturers still need to improve on their manufacturing steps, procedures, and raw water processing and hygienic practices.

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