Assessment of Microbial Contamination in Drinking Water from Source to End User Point in Hennur Area Bangalore City, Karnataka, India

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Abstract: Water quality is a vital concern for every mankind and it is directly affected human health. The present study aims to determine the bacteriological and physico-chemical quality of drinking water supply from source to end user point in Hennur area, Bangalore city, Karnataka, India. Water samples were collected from various hotels in and around Hennur area. The samples were analyzed for microbiological and physico-chemical parameters. In this study we used Most Probable Number (MPN) and Heterotrophic Plate Count (HPC) to assess the microbial load. Most of the water samples are contaminated with Feacal coliforms and Total Coliform Count was ranged between 2-1600 MPN/100ml respectively. The result of the study shows that most of the hotel water samples were contaminated with coliform bacteria. The dominant bacterial species are *E. coli*, *Salmonella*, *Shigella*, *Klebsiella* and *Enterobacter* & *Citrobacter*. This study highlights that consumption of water from these hotels are always at risk.

Keywords: Water quality; *E. coli, Salmonella; Shigella*; drinking water.

1. Introduction

Water is one of the most important natural resource in Earth. It is important to all living organisms and other purposes. Water provides essential elements, but when polluted it may become undesirable substance that is dangerous to human health [1]. Based on the study of World Health Organization (WHO) about 1.1 billion people do not have supply of potable drinking water. Nowadays contamination of drinking water is one of the most important health issues around the world [2]. According to World Health Organization (WHO) statistics, gastroenteritis accounts for 3.2% of all deaths worldwide each year and have the 5th highest burden of diseases, expressed in DALY's [3]. An estimated 94% of the gastroenteritis burden of disease is attributable to the environment and associated with risk factors such as unsafe drinking water, lack of sanitation and poor hygiene [4]. Generally most of the acute gastroenteritis is transmitted via contaminated food, but water-borne transmission has been well documented for recreational and contaminated drinking water [5-6]. People are getting diseases from hotel water due to unhygienic storage and handling, hence water is contaminated with pathogenic microorganisms. The aim of present study was to access the quality of drinking water from different hotels in Hennur area, Bangalore city, Karnataka, India.

2. Materials and Methods

2.1. Description of Study Area

This study was carried out in and around the Hennur area of Bangalore City, Karnataka, India, located at 13.0320° N, 77.6360° E (**Figure 1**). The city population majorly depends on Bore well, Canned water and Cauvery water source for drinking purpose.
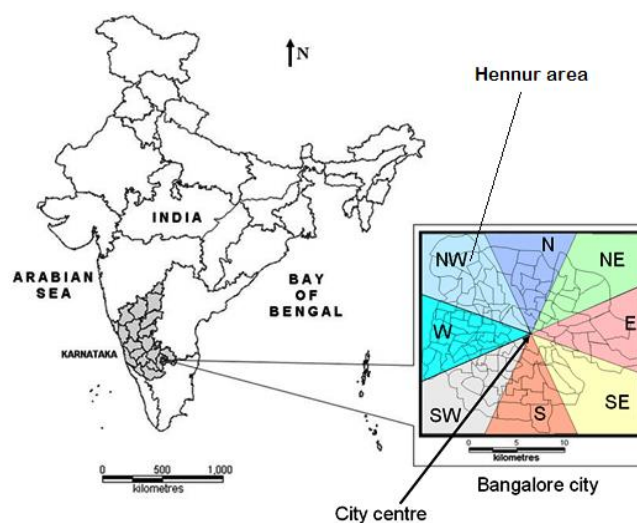

Figure1 Location map of the study area

2.2. Physiochemical Parameters
The physico-chemical parameters include pH, temperature, turbidity, conductivity; dissolved oxygen and total hardness were measured according to the standard methods [7]. All the measurements were done in triplicate and this average was considered.

2.3. Microbiological Parameters
The water samples were analyzed for the microbiological parameters such as Heterotrophic Plate Count (HPC), Total

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Coliform Count (TCC), Faecal Coliform Count (FCC) and *E. coli* using standard methods [8-9]. The total coliform count were determined by multiple tube fermentation technique using set of 3 tubes inoculated with 10 ml of lactose broth of different strength with samples of 10 ml,1 ml and 0.1ml. A pH indicator such as bromocresol purple blue is also added to lactose broth for the detection of acid. The inoculated tubes with durham's tubes were incubated at 35°C for 48 hours. The tubes were examined for gas and acid production indicate positive presumptive test for coliform organisms [10-11]. The positive presumptive tubes were used for confirmed test. Positive presumptive tubes were transferred to a special media tube of Brilliant Green Lactose Bile Broth (BGLB) and incubated at 35ºC for 48 hours and the gas positive tubes were recorded.

The positive confirmed tubes are used to determine MPN. The results were expressed as Most Probable Number (MPN) per 100 ml of the sample. In the completed test, the positive BGLB samples were streaked in EMB agar, MacConkey, *Salmonella-Shigella* agar and Nutrient agar plates and incubated at 35ºC for 24 hours. The faecal coliform and *E. coli* was detected by subculture all presumptive positive tubes of the coliform test, at the end of 48 hours into BGLB medium and incubate at 44.5ºC for 24 hours in a water bath. Gas formation within 24 hours is considered a positive reaction for faecal coliforms [8].

Bacterial pathogens related to gastroenteritis isolated on respective media were identified on the basis of their morphological and biochemical properties following Bergey's manual of determination bacteriology.

3. Results and Discussions

The microbiological and physico-chemical parameters of water samples collected from the hotels of Hennur area, Bangalore city during March 2017 to May 2017. The results were compared to the water quality guidelines of CPHEEO, BIS and WHO [3, 12-13].

3.1. Physico-chemical water quality

Hydrogen Ion Concentration (pH): The average pH values of water in all samples were within permissible limit recommended by WHO (6.5-8.5). The hydrogen ion concentration in all water samples remained alkaline throughout the study period. The average pH of water samples showed maximum of (7.9) and minimum (7.3) and results obtained can be seen in **Figure 2**.

Conductivity: Conductivity of all water samples (HWT-1 to HWT-20) showed ranges from 134 (µmho) to 564 (µmho). The conductivity of water is related to the total dissolved solids in the water [14] and results obtained can be seen in **Figure 3**.

Dissolved oxygen: Dissolved oxygen (DO) concentration water samples were observed maximum (7.2) and minimum

(5.8). For all water samples the DO values are within permissible limit (**Figure 4**). The variations of DO from water samples were shown in. In this study all samples showed not much great variation of DO.
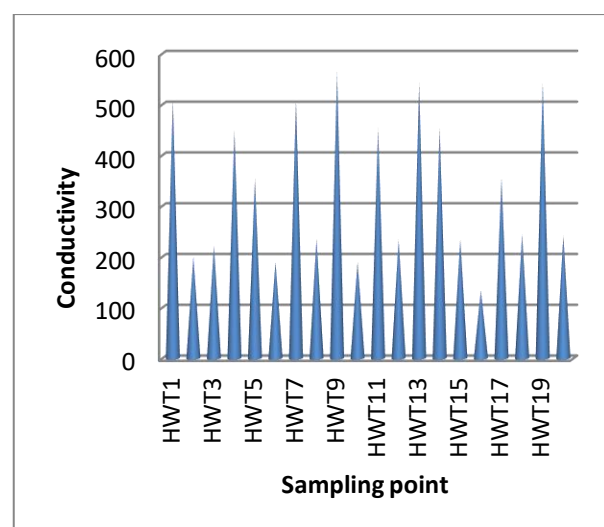
Total hardness: The Total hardness was found to be in the range of 35 mg/l (summer) to 180 mg/l. The similar patterns of results were also reported by Khayum *et al.* [15]. For all water samples the total hardness are within the permissible limit (**Figure 5**) recommended by CPHEEO, BIS and WHO [3, 12-13].

Temperature: During the study period temperature varied from 25ºC to 31ºC (**Figure 6**). The minimum temperature was recorded with sample (HWT-10) and the maximum was with HWT-12 and HWT-14.

Turbidity: In this present study the water samples contains turbidity value ranges of 0.3 NTU to 3.2 NTU (**Figure 7**). Drinking water is considered to be good quality when it contains turbidity values 1 or below. In this study some sampling stations showed exceed the limit of turbidity value WHO [3].
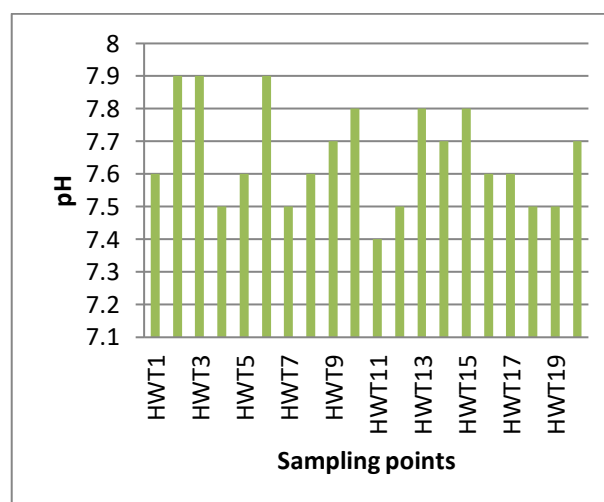
Figure 2 Graph showing variations of pH in water

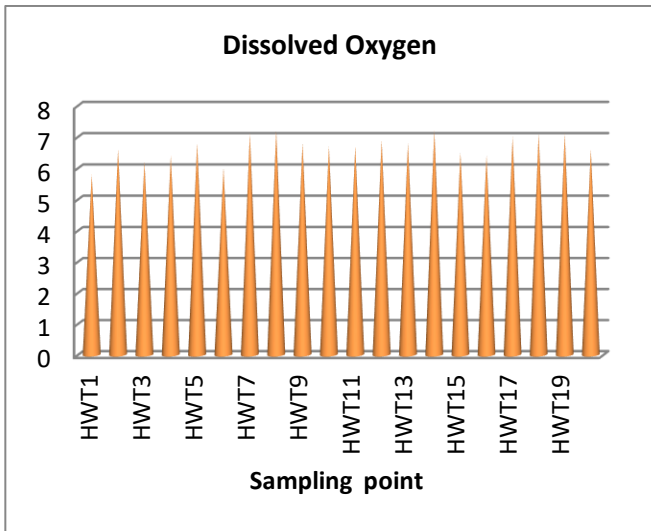**Figure 3** Graph showing variations of conductivity in water samples

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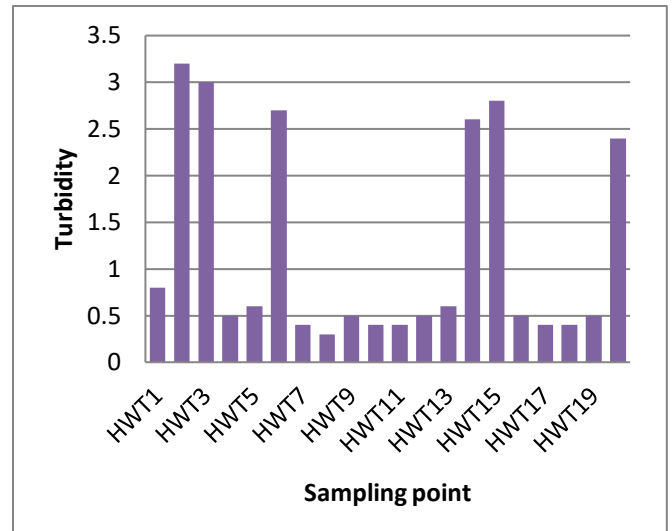*In. J. Environ. Health & Technol.*, 2017, **1(1)**, 8-12| **9**
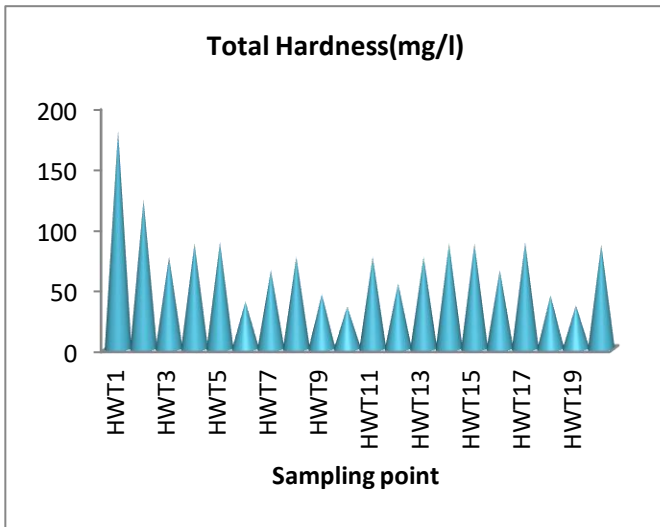
Figure 4 Graph showing variations of DO in water samples

Figure 5 Graph showing variations of TH in water sample

Figure 6 Graph showing variations of Temperature in water sample
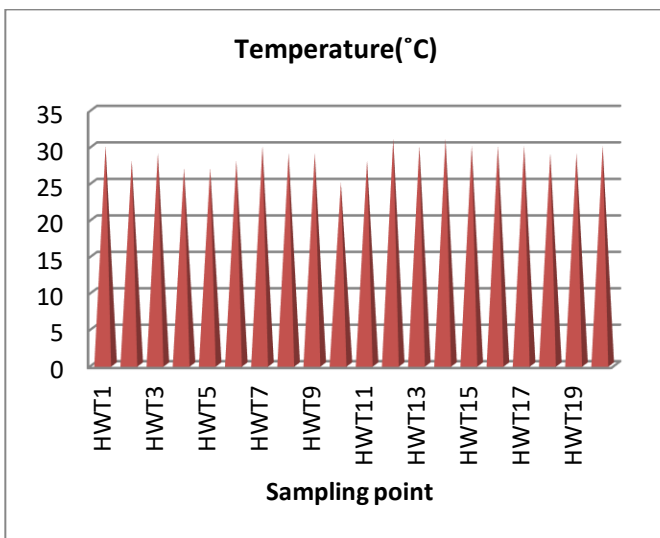

Figure 7 Graph showing variations of Turbidity in water sample

Microbiological water quality: Microbiological risk assessment of the drinking water from the end user point of hotels of Hennur Area of Bangalore city has vulnerable due to microbial pathogens. The results are summarized in **Figure 8.**
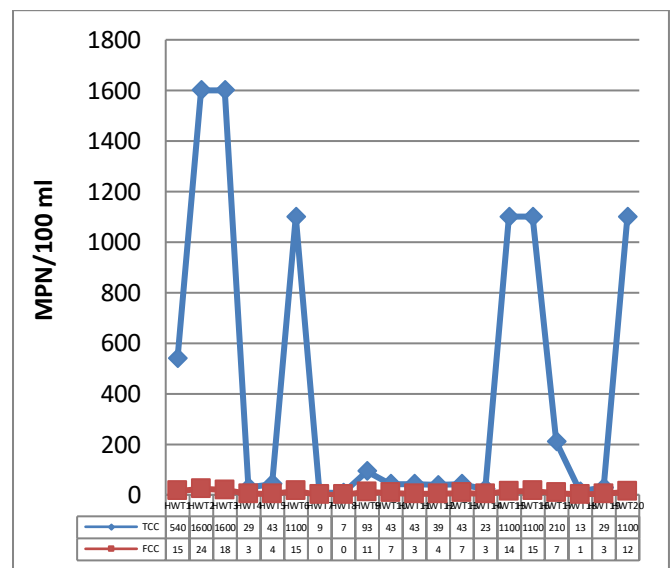

Figure 8 Microbiological results of drinking water from the hotels of Hennur Area of Bangalore city.

The result of the study shows that most of the hotel water samples in and around Hennur area of Bangalore city were contaminated with coliform bacteria. The HWT-2 and HWT-3 samples were showed higher count (1600 MPN/100 ml) among other samples. The sampling stations such as HWT-6, HWT-15, HWT-16, and HWT-20 showed similar pattern of TC count (1100 MPN/100 ml). The sample HWT-1 showed 540 MPN/100 ml and the samples such as HWT-4, HWT-5, HWT-9, HWT-10, HWT-11, HWT-12, HWT-13, HWT-14, HWT-17 and HWT-19 has similar pattern of TC count (23-210MPN/100 ml). The sampling points such as HWT-18

10 | *In.J. Environ. Health & Technol.*, 2017, **1(1)**, 8-12

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showed less contaminated in terms of TC count (13 MPN/100 ml). The samples HWT-7 and HWT-8 showed TC count within the permissible range of BIS (1991).

The FC count was higher for HWT-1, HWT-2, HWT-3, HWT-6, HWT-9, HWT-15, HWT-16 and HWT-20 (11-24 MPN/100 ml). The samples HWT-4, HWT-5, HWT-10, HWT-11, HWT 12, HWT-13, HWT-14, HWT-17, HWT-18 and HWT-19 were moderately contaminated with faecal coliforms (1-7 MPN/100 ml). The samples HWT-7 and HWT-8 showed FC count within the permissible range of WHO (2004) and BIS (1991).

The heterotrophic count of most of the samples was showed higher value. The higher value of such samples may be due to prolonged storage of water in pot. The sources storage practices and handling the water from storage container at hotels caused quality deterioration and water poses potential risk of infection to consumers.

Contamination of drinking water in hotel and restaurants is associated with domestic and personal hygiene behaviors. The diarrheal diseases are prominent among the community due to unhygienic behaviors and low education, which can be control by water hygiene education programme [16].

WHO [17] reported that hygiene education on people behaviors in storage, handling of drinking water potability in hotels and restaurants can be associated with poor hygiene environment. Tambekar and Banginwar [18] also stated that water may become contaminated by incorrect method of collection storage, serving and handling practices in hotels and restaurants, Kaltenthaler and Drasar [19] showed that hygiene education changed people's behaviors into positive domestic water hygiene practices such as regular hand washing, proper collection, storage and handling of water.

The overall result of the study shows that most of the hotel water samples were contaminated with coliform bacteria. All the Isolates confirmed with biochemical test. The dominant bacterial species are *E. coli spp* (33%), *Salmonella spp* (28%), *Klebsiella spp* (22%), *Shigella spp* (17%). The bacteria belonging to the family *Enterobacteriaceae* showed maximum occurrence in water samples. The overall results showed that the consumption of water from such contaminated end user point may cause potential health hazards to the consumers. This study highlights that consumption of water from these hotels are always at risk.

4. Conclusion

This study highlighted that certain physico-chemical parameters are within the permissible range of regulatory authorities but most of the water samples which showed microbiological parameters were exceeded the permissible limit. The WHO guidelines for bacteriological quality of drinking water require that all waters intended for drinking water must contain no *E. coli* or thermo tolerant coliforms in any 100 ml samples. In this study concluded that the water serving to the consumer point is highly contaminated with coliform bacteria. Hence the water is not fit for consumption. In addition to faecal-oral route, other vehicles of transmission namely, contaminated food, or utensils can also play a vital role. The study indicates that water quality deteriorates as a result of multiple factors linked to hygiene practices and circumstance. The poor personal and domestic hygiene can increase the incidence of water borne infection and the improvement in overall water hygiene behaviors could be interpreted as an increased awareness towards maintaining cleanliness in a more hygienic condition. This study highlights that consumption of water from these hotels are always at risk. We believe that is may be a baseline data on the water quality status in this study area.

References

[1] Sotirios Karavoltsos., Aikaterini Sakellari., Nikolaos Mihopoulos., Manos Dassenakis. and Michael J.S., Evaluation of the quality of drinking water in regions of Greece, *Desalination* **224 (1-3)**, 317-329 (**2008**).

[2] Hunter P.R., MacDonald A.M. and Carter R.C., Water Supply and Health, *PLoS Med.,* **7(11)**, (**2010**).

[3] WHO Guidelines for Drinking-Water Quality, 3rd Edition*,* Geneva., (**2004**).

[4] Pruss-Ustun A. and Corvalan C., Preventing Disease through Healthy Environments: toward an estimate of the environmental burden of disease, *The World Health Organization*, Geneva, Switzerland., (**2006**).

[5] Fewtrell L., Kaufmann R., Kay D., Enanoria W., Haller L. and Colford J., Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis, *Lancet Infect. Dis.,* **5**, 42-52 (**2005**).

[6] Jessen George., Wei An., Dev Joshi., Dongqing Zhang., Min Yang. and Suriyanarayanan S., Quantitative microbial risk assessment to estimate health risk in urban drinking water systems of Mysore, Karnataka, India, *Exposure and Health.* **7 (3)**, 331-338 (**2015**).

[7] Standard Methods for the Examination of Water and Wastewater. 21st Edition, American Public Health Association, Washington, DC., (**2005**).

[8] Bureau of Indian Standards, Indian standard Method of sampling and Microbiological examination of water, *Fourth Reprint.,* (**2003**).

[9] Standard methods for the examination of water and wastewater 20th ed. Washington, DC, USA: *American Public Health Association.,* (**1998**).

[10] George J., Magesh S.B., Divya L. and Suriyanarayanan S., An Assessment of removal efficiency for bacterial pathogens in Mysore urban water system, Karnataka, India-A case study, Desalin. Water Treat., **57(23)**, 10886-10893 (**2016a**).

[11] Jessen George., Divya Lakshminarayanan., Sajith K.S., Severeni Ashili. and Suriyanarayanan S., Evaluation of Bacterial Pathogens in Surface water of Cauvery River, Near Mysore, Karnataka, South India, *Bull. Environ. Sci. Res.,* **5(1)**, 14-18 (**2016**).

[12] CPHEEO, Manual on water supply and treatment, Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, NewDelhi, India., (**2009**).

[13] Indian standards of Drinking Water Specification, Bureau to Indian Standards (BIS), New Delhi, India., (**1991**).

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In. J. Environ. Health & Technol., 2017, **1(1)**, 8-12| **11**

[14] George J., Divya L., Karthikeyan K. and Suriyanarayanan S., The status of urban water treatment systems in Mysore, Karnataka, India: Is feasible and safe from a sustainable point of view?, *Intl. J. App. Environ Sci.*, **10(2)**, 451-461 (**2015b**).

[15] Abdul Khayum., Nandini N., Chandrashekar J.S. and Durgesh R., Assessment of drinking water quality of Bangalore West Zone, India - a case Study, Environ*. We Int. J. Sci. Tech.,* **6**, 113-122 (**2011**).

[16] Feachem R.G., Interventions for the control of diarrheal diseases among young children: Promotion of personal and domestic hygiene, *Bull. World Health Orgn.* **63**, 467-476 (**1984**).

[17] Guidelines Standards and Health Assessment of Risk and Risk Management for Water-Related Infectious Disease. World Health Organization, Geneva, Switzerland., (**2001**).

[18] Tambekar D.H. and Banginwar Y.S., Studies on potential intervention for control of water-borne diseases Promotion of storage handling and serving practices of drinking water in hotels and restaurants, *Pollut. Res.,* **24**, 371-375 (**2005**).

[19] Kaltenthaler E. and Drasar B., The study of hygiene behavior in Botswana: A combination of qualitative and quantitative methods, *Trop. Med. Int. Health.,* **1**, 690-698 (**1996**).

12 | *In. J. Environ. Health & Technol.*, 2017, **1(1)**, 8-12

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