Assessment of Bacterial Contamination in Drinking water of Schools of Tokha Municipality, Kathmandu

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Abstract

Assessment of drinking water quality is being crucial especially in school institutions since children spend most of the time in school premises. The aim of this study was to assess bacterial contamination of the selected schools of Tokha Municipality. Total of 17 water samples from Ward 1, 2 and 3 were sampled and membrane filtration (MF) technique was used to analyses total coliform and fecal coliform incubated for 37 ^{0}C and 44 ^{0}C respectively. Multiple drinking water sources were found in the study area such as natural springs, piped-line system, bottled water and private wells. Almost all of the water samples exceeded WHO guideline and National Drinking Water Standards which implied none of the water samples are safe for drinking. Very few schools were found to adopt purification measures while other used to supply directly. Water samples of school were even not tested once in many schools for microbial analysis. Therefore, school management need to be responsible in coming days to ensure safe drinking water not just for children, for the wellbeing of the society and Nation.

Keywords: *Children, total coliforms, fecal coliforms, Purification method*

Introduction

Sustainable water resource management is one of the greatest issues for developing countries like Nepal due to population growth, changing lifestyles and unmanaged urbanization (Wheater, 2015). Many south Asian cities like Kathmandu are facing water scarcity for many years and had provided with inadequate and unreliable water supply services (Chapagain, 2012). Due to which, many households depends upon multiple water sources such as groundwater like stone spouts, public/private wells as cheap and easy source whereas tanker and jar water as an expensive source (Shrestha et al., 2016). The unreliable and inadequate water supply not just increase the risk of health and safety, but also compromise quality of life for long run (Meier, 1977).

School is prominent places, after the family in child's dailylife. The maximal time duration of children is spent in school. Safe drinking water, good sanitation and hygiene in school bears remarkable role in children health and education. Good health of children

reduces school absence thereby enhancing competence and delivering better academic performance. In fact, the good health of children ultimately results in social and economic development of country (UNICEF, 2006). However, securing safe drinking water, sanitation and hygiene have been major challenge to school administrators. Schools are high-risk environments due to both the complex nature of their drinking water systems and the vulnerability of the users (Edition, 2011). Each year, 1.1 million children die due to diarrheal diseases (Steiner et al., 2007) and lose 272 million school days due to diarrhea (UNICEF, 2010). Absence in school is indicator of health status among children (Houghton 2003). Hence, provision of safe drinking water, sanitation and hygiene in school is utmost for minimizing school absence.

Therefore, with the objectives to examine total coliform and fecal coliform in drinking water and to understand measures applied by school management for safe drinking water provision in schools, this study was conducted in Tokha Municipality.

Materials and Methods

Study Area

This study aims at assessing the bacteriological quality analysis of water in selected schools of Tokha Municipality. Tokha Municipality lies in northern valley of Kathmandu districts. It has beautiful and pristine ambience with the presence of Shivapuri National Park at the back. The studied schools of this municipality (Annex 2) were based urbanization. This includes Rural (ward-1) and sub-urban (Ward-2 and 3). The access to drinking water facility was categorized accordingly with the urbanization status. Access of drinking water in ward-1 is natural stream from nearby Shivapuri forest. While majority of drinking water in ward 2 and 3 are supplied by water distributor locating in ward-2 whereas rest have water supplement from private water suppliers (bottled water) and underground water extraction (Dug well and deep boring). The study was conducted between November-December, 2020.The total of 18 schools and its location is shown in below study area map (Figure 1).

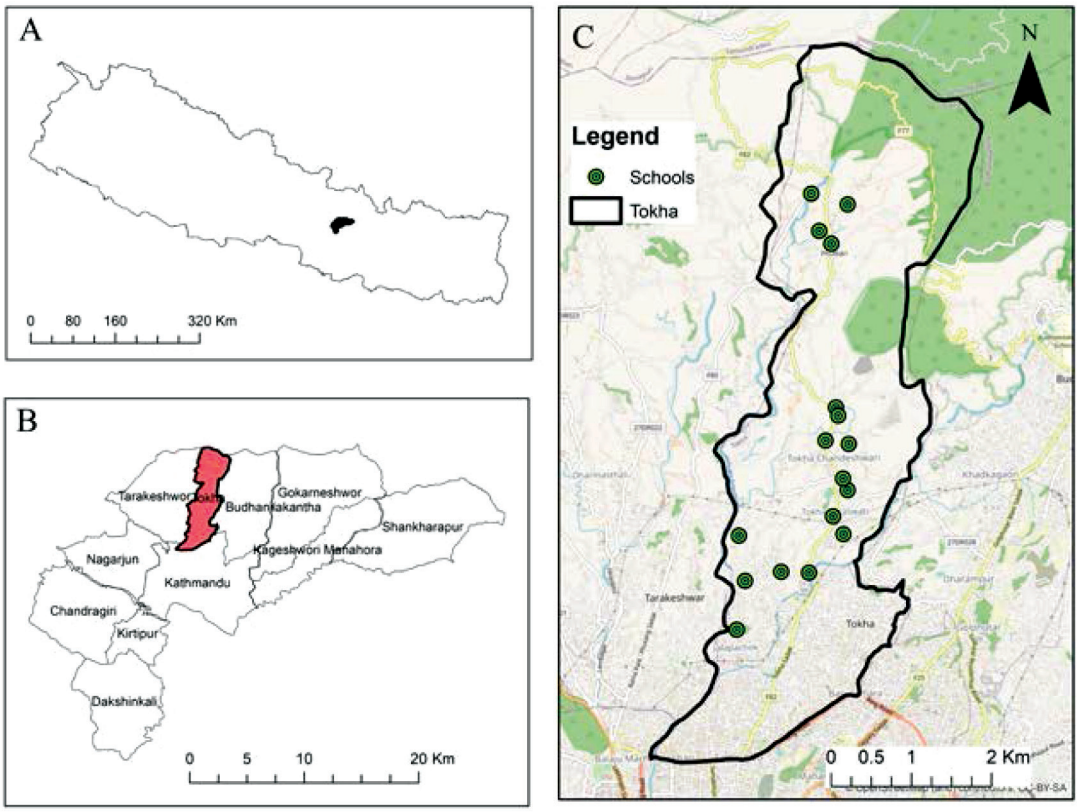


Figure 1: Map of Study area A) Map of Nepal B) Map of Kathmandu district C) Map of Study area with sampling sites

Water Sample Analysis

Water samples were collected from point of use in every schools except Divine due to winter vacation. The sample bottle was rinsed with sample itself for 3 times. Analysis was processed within 6 hours of collection. The analysis of coliform bacteria was carried out in the lab of Central Department of Environmental Science (CDES). For it, membrane filtration (MF) technique was used. In this method, the absorbent pad was placed in sterile Petri dish with sterile forceps. Then, it was soaked with 20 ml nutrient media i.e. M-endo broth. 100 ml of water sample was poured into funnel of sterile filter apparatus through filter paper size 0.45µm. After applying a vacuum to suction flask, carefully the membrane filter was removed by holding its edge and placed it above the pad or agar. The Petri dish was marked and incubated at 44 ^{0}C for fecal coliform and at 37 ^{0}C for total coliform separately for 24 hours. After incubation, the colonies were counted (Bartram & Pedley, 1996).

No. of colonies per 100 ml = [*No. of colonies* ÷ *Volume filtered*] * *100*

School Surveys

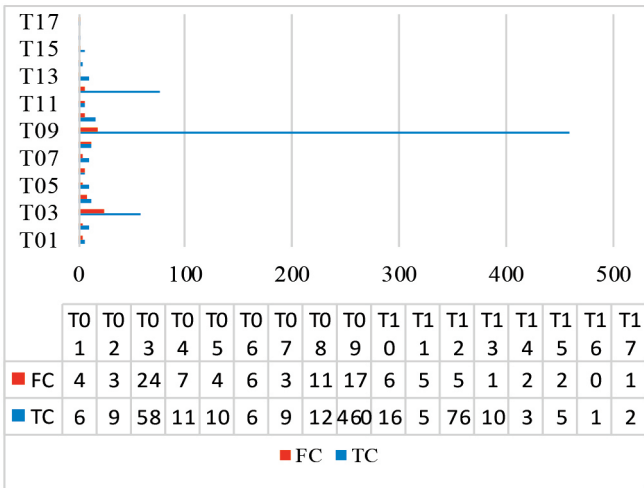
Using a structured interview and close ended type questionnaire was developed to get background knowledge of schools and its water supply. The questionnaire survey divided into sub divisions as school details, drinking water source, school absence and water borne disease. It includes sources of drinking water, water storage mechanism, previous water quality testing, drinking tap location, reason of school absence and its number and age groups etc. The survey questions are provided in Annex 3.

Results and Discussion

Water Sample Analysis

Total coliform and fecal coliform were analyzed in which range of total coliform was from 1 to 460 whereas fecal coliform ranged from 0 to 24. The values of total coliform and fecal coliform are shown in below figure 2.

Almost all water samples exceed the WHO limit (WHO, 1993) and Nepal Standards for Drinking water (National Drinking Water Quality Standards, 2005) for total coliform and fecal coliform. The U.S. EPA (Environmental Protection Agency) determined the presence of total coliforms is possible health concern. Generally total coliforms in environment are not harmful but if present in water persist for long, is a problem with water treatment or the pipes that distribute water. Whereas, fecal coliforms signify the presence of sewage contamination of a waterway and possible presence of other pathogenic organisms. Hence, bacteriologically larger proportion of water samples were found to be unacceptable.



	T01	T02	T03	T04	T05	T06	T07	T08	T09	T10	T11	T12	T13	T14	T15	T16	T17
FC	4	3	24	7	4	6	3	11	17	6	5	5	1	2	2	0	1
TC	6	9	58	11	10	6	9	12	460	16	5	76	10	3	5	1	2

Figure 2: Total coliform and fecal coliform in water sample

Schools Survey

Out of 17 schools, 6 schools have technology that treat drinking water whereas 11 of other schools are deprived of any treatment and supply directly to school children. Routine water quality testing is very much necessary as it ensures the health and safety of school students and staff. Only few percentage of schools (11.76%) tend to test drinking water time and again whereas 23.53% of schools had tested once to check the efficiency of filtration system after its installation. Otherwise majority (64.71%) have never done this before. This could be presented in below figure 3.

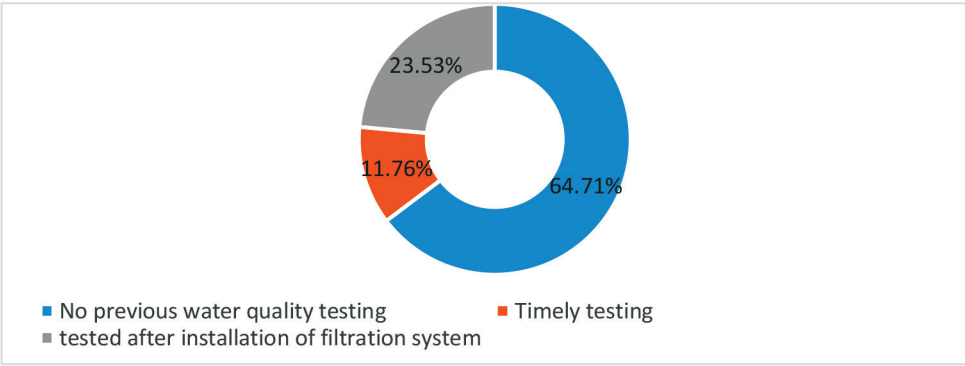


Figure 3: Status of Water quality testing

There was various reason of school absence. Among which, waterborne disease was common among the students in this study. With access of good piped water supply and proper sewage connection to houses, 1863 million days of school attendance would be gained due to less diarrheal illness (WHO, 2004).

Nitin memorial school, Satya Sai school and Angel paradise school have infirmary ward within school premises whereas others don't have. Annually, few students of age group 2 to 12 years were found vulnerable towards water borne disease like diarrhea and dysentery.

Among total samples, four samples were collected from Ward No. 1 consist of four schools (T09, T10, T11 and T12) which have same natural source of water i.e. from springs generated through Shivapuri Jungle. They do not adopt any purification method and consume directly. This may be one of the reason in observing total coliforms and fecal coliforms in water samples. According to Frisell et al. (2011), purification methods are successful in removing total coliform and fecal coliform when done properly. Comparing these four schools, T11 is found to have less total coliform (5) as well as fecal coliform (5) than T10(16,6), T12(76,5) and T9(460,17) respectively. T11 lies at the top hill with less human disturbances whereas human settlement increased as we move

downward (T10, T12 and T9). Fecal bacteria and other bacteria's densities were highly related to the density of housing, population, development, percent impervious area and apparent domestic animal density (Young & Thackston, 1999).

T01, T02, T15 and T17 have jar water as a source of drinking water to school children. They directly consume bottle water without any treatment thinking that is safe to drink. It was found total coliform and fecal coliform varying its number according to the jar company. Most population rated their drinking jar water good but found to be highly questioning as one research done by Subedi & Aryal (2010) found 91.2% contaminated with total coliforms and 59.6% contaminated with fecal coliforms. This result is also supported by another one in which it was found that about 66% were heavily contaminated with coliforms in Jan/Feb month and 89% in Feb/March (Tamrakar et al., 2017). Ghimire et al. (2013) and Bhandari et al. (2009) also supported this result. From this, it can have concluded that jar water samples are unsatisfactory for drinking purpose without doing some treatment purpose.

T03, T05, T06 and T07 have water supplement system. T03 have highest total coliform and fecal coliform than T05, T06 and T07. The reason may be due to absence of any treatment for purification of drinking water. Koju et al. (2014) found 80% of 46 piped water samples were contaminated with total coliform at consumer tap. T04 uses well water for drinking purpose and they treat water through chlorination process. According to respondent, they use piyush (chlorination agent) 3 drops in 20ml water. But the recommendation dose is 3 drops to disinfect 1 liters of water. This incorrect dose of disinfectant may be the reason of observing total coliform and fecal coliform in drinking water.

T05, T06, T07, T08, T13, T14 and T16 have automatic water purification system which consist of pre-treatment, reverse osmosis and disinfection and a hybrid dispensation system. Despite, it showed total coliform and fecal coliform. The reason may be due to use of different companies in removing total coliform and fecal coliform. Its installation time, storage tank and nozzle contamination plays important role in coliforms number. Nowadays, water vending machine (WVM) industry has experienced an increase over the past few years but its efficiency is still unknown.

Conclusion

Water samples collected from 17 schools were not free from coliform. Almost all water samples exceed WHO guideline value for drinking water and National drinking water standards. The total coliform range from 1 to 460 and fecal coliform range from 0 to 24. High number of coliforms were seen in those samples where direct water consumes from the spring source, without any pretreatment. Very few schools feel ownership regarding supply of safe drinking water to the students of Tokha since timely testing of water was not seen. This increase the threat to health from water-borne diseases leading to absenteeism and hinders children's health and education. Hence purification methods should adopt along with timely water quality testing. Along with purification, storage tanks and other vessels should be clean time and again to remove bacteria.

Acknowledgements

At first, I would like to express great gratitude to Central Department of Environmental Science, Kirtipur for providing this opportunity to conduct this study. I am grateful to all those schools who have provided me positive response during my field visit.

Finally, I would like to express my sincere thanks to my family members for their continuous help and encouragement.

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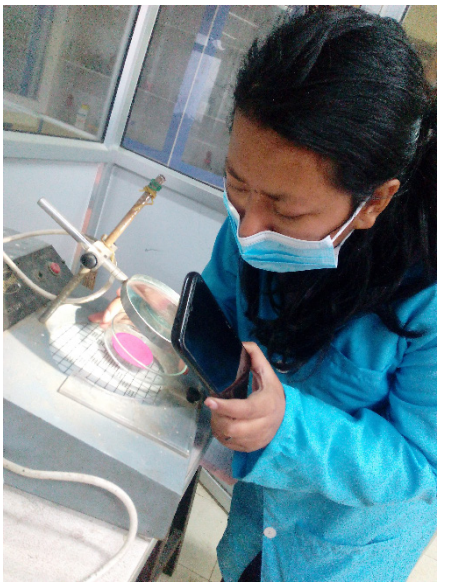
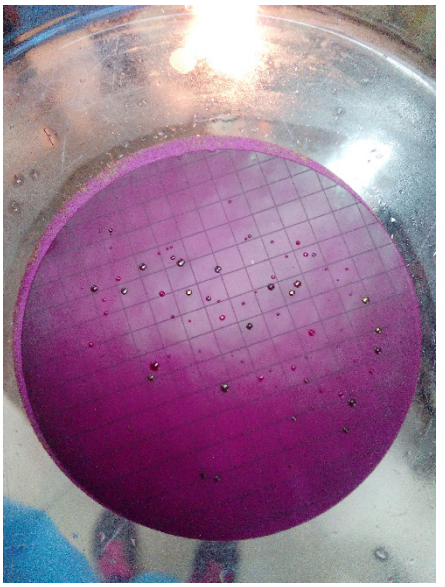
Appendices

Annex 1

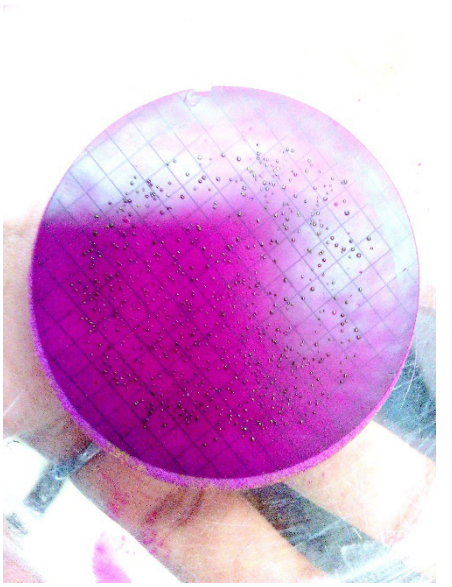
Photograph 1: Researcher conducting practical in lab



Photograph 2: Researcher counting total coliforms in colony counter



Photograph 3: Number of total coliforms present



Photograph 4: Too many to count (TMTC) number of coliforms