The Investigation of the Bacteriological Quality of Drinking Water in Schools in the Western Region of Libya

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Abstract

Water is the source of all life, the most important liquid in our ecosystem – all plants, so the quality of water is a major concern for producers, regulators and consumers, and so the occurrence of minimal water pollution is a real risk to health. Therefore, this study aimed to conduct microbiological analysis to determine the safety of water, by selecting drinking-water taps from 20 schools located in three regions from western Libya. 5 drinking water samples were taken from the city of Al-Ajailat as well as the city of Sabratha, and 10 drinking water samples were taken from the city of Sorman. Samples collection was conducted under temperature-controlled conditions and the biological tests were carried out in the microbiology laboratory at the Faculty of Medical Technology Sorman, University of Sabratha. The samples were analyzed immediately upon arrival, no later than 3 hours after sample collection, to determine the presence of fecal coliform bacteria by the total cell count of bacteria using the method of counting bacteria Non-self-feeding. Among 20 of the school drinking-water taps sampled, 15 of the sampled drinking-water taps(75%) were positive for bacterial contamination. 3 (15%) of the contaminated drinking water samples tested positive for Escherichia coli contamination. This study concluded that a large proportion of schools had contaminated drinking water. The presence of these bacteria in high levels, especially the coliform group, poses a risk on school children that use this water and reflects the seriousness of the unsafe water distribution network.

Key words: Coliform bacteria, contamination, drinking water, Escherichia coli

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Introduction

Water quality issues are a major challenge that humanity is facing in the twenty-first century. Water pollution is widespread in most of the developing countries of the world, where natural water resources are at risk of contamination by pathogens due to increased human, agricultural and residential activity (Algryani, 2012). Transmission of bacterial, viral, parasitic and chemical contaminants to surface and groundwater resources are the source of epidemics and diseases caused by microorganisms or the presence of chemicals in them (Lechellier et al., 1980). Drinking water is one of the most important and common vectors of disease transmission of contaminated water. Water could be contaminated through various means of pollution including chemical, biological and radioactive pollution (Atef, 2004; Al-Azzawi, 1997).

Escherichia coli (E. coli) is a bacteria normally habitant in the intestines of humans and animals (Escherich and Bettelheim, 1988). Although most strains of this bacterium are harmless, several are known to produce toxins that can damage the intestinal lining and cause diarrhea (loose stools), vomiting and abdominal cramps.

E. coli is the major species in the fecal coliform group. Of the five general groups of bacteria that comprise the total coliforms, only *E. coli* is generally not found growing and reproducing in the environment. Consequently, *E. coli* is considered to be the species of coliform bacteria that is the best indicator of fecal pollution and the possible presence of pathogens.

The disease causing *E. coli* is strains of the bacterium that produce toxins, these strains are known as Shiga toxin-producing *E.coli* (STEC). The most common *STEC* strain is the *E. coli O157:H7*, that can cause severe diarrhea, nausea, vomiting, abdominal pain and fever. Infection occurs when individuals consume food or drinking water contaminated with *E. coli,* serotype *E. coli O157: H7*. Hemolytic uremic syndrome (HUS) is a rare but serious disease that can occur as a complication of an *E. coli* infection; HUS, which can sometimes lead to death, is transmitted from contaminated soil, plants and water.The disease can also cause kidney damage/failure and affect blood-clotting functions. Typically, HUS occurs more commonly in children under the age of 5 years than in other age groups.

In 1958, the World Health Organization (WHO) stated that drinking water should be free from harmful microorganisms. The WHO has formed guidelines for drinking-water quality, determining the safe quality of water that should be supplied to communities, in order to protect human well-being and health (WHO, 2017). The WHO has stipulated methods for sampling and bacteriological testing of coliforms in drinking water (WHO, 1973), the most basic of these testing methods of water supply contamination is the test for total coliform bacteria.

Total coliform counts give a general indication of the sanitary condition of water supplies. Total coliforms include bacteria that are found in the soil, in surface water and in human or animal waste. Examining the total number of live pollutants is a very important test as it gives a clear idea of the extent of water pollution by microorganisms

and the contamination of this water through the mobilization and transport process (El Gatlawy. Milad 2013). There is a lack of studies in Libya investigating the quality of water and its bacteriological pollution within communities.

The aim of this study was to conduct microbiological analyses of drinking water from schools in three regions of western Libya, to determine the safety of water utilized and consumed by school children.

Materials and methods

This study was carried out in July, 2019, sampling schools located in three cities, Al-Ajailat, Sorman and Sabratha in the western region of Libya. A total of 20 schools were sampled (10 schools in Sorman; 5 schools in Sabratha; 5 schools in Al-Ajailat) (Table 1).

From each school 2 random water samples were taken from their drinking-water taps. Each sample consisted of 500 ml of water collected in large sterile bottles. Each bottle was labeled with the school and the location. The samples were transferred directly to the laboratory of the microbiology unit of the Biotechnology Department, University of Sabratha, no longer than 3 hours after initial sampling was carried out.

Table (1). Schools sampled in the western region of Libya.

City	Name of School
Al-Ajailat	Golden Medal School / Northern School / Southern School / Ghout School / Al-Dis School / Hardworking School
Sabratha	Independence School / Osama bin Zayed School / Fatima Al-Zahra School / Driver School / Secondary Talle
Sorman	Zubair bin Awam School / Rafea Al-Ansari School / Gnawi School / Sorman Central School / Mohammed Doura School / Bin Jaber School / Victory School / Farouk School / Mousa Ben Nasr School (M) / Mousa Ben Nasr School (F)

Estimate the total number of bacteria

The total number of bacteria was estimated using the pour plate method, determining the microbial load in accordance to OECD (2003). Water sample were diluted up to 7 folds. 3 drops from the 4th, 5th and 6th serial dilutions were inoculated onto an agar plate and were incubated at 37 ° C for 24 hours. Following the incubation period, cell count was performed using 1 ml of the incubated sample and the total coliform bacteria were calculated, in respect to the serial dilution of the plate. Water samples were considered pure if the water tested contained less than 10 log (cfu/ml) (Fewtrell, 2001).
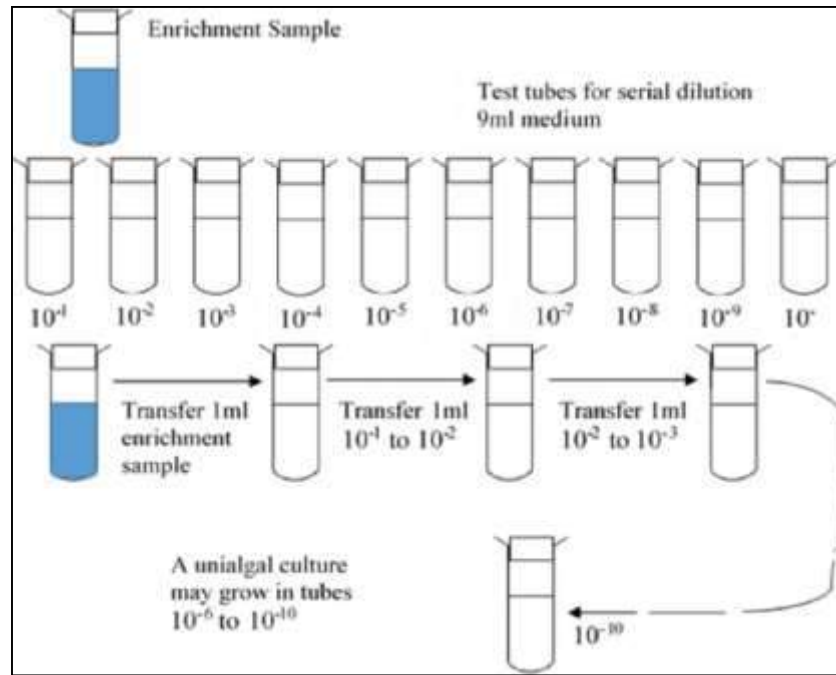
Figure 1.Figure illustrating the pour plate method used.

Identification of *Escherichia coli* clinical isolates

Each specimen was cultured on Cysteine Lactose Electrolyte Deficient (CLED) agar plates. Culture plates were incubated at 37ºC for 24 hours. After incubation, all suspected colonies were sub-cultured for further identification. All clinical isolates were identified using API 20E kits following manufacturer's instruction.

Results and Discussions

Results from the microbiological analysis of the drinking water from the 20 sampled schools in this study have shown that only 5 (25%) of the sampled schools had non-contaminated, clean water, while 15 (75%) of the sampled schools had contaminated water (Figure 2) that according to the National Center for Standardization and Metrology (2015), is not suitable for drinking. From the schools testing positive for contaminated water 3 (15%) of the schools also tested positive for *E. coli* contamination.
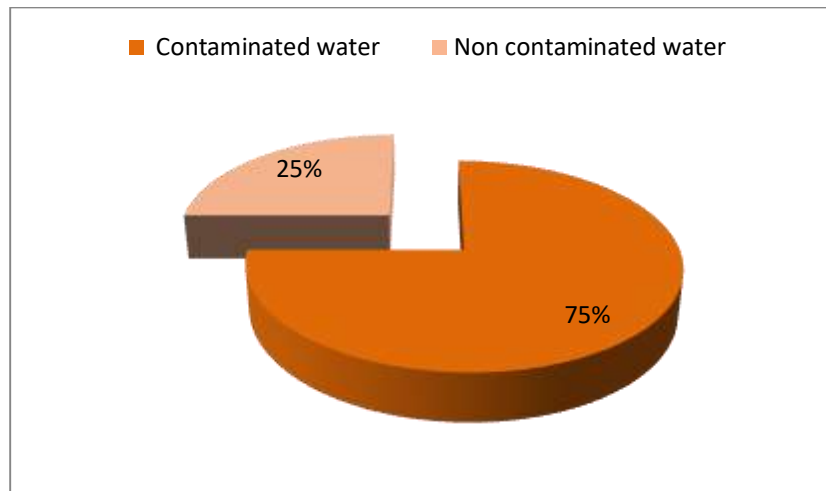
Figure 2.Pie chart illustrating the percentage of microbial contamination in the sampled drinking water.

Of the 15 (75%) schools with contaminated water, 9 (45%) were from Sorman, 2 (15%) were from Sabratha and 2 (15%) were from Al-Ajailat. Results of the positively tested contaminated water within the western region of Libya support a previous study conducted by Elmabrok, (2018), in the city of Al-Ajailat carrying out a microbiological evaluation on 65 samples of groundwater in 26 urban and rural areas; the study identified that 63.1% of the total samples tested were contaminated with coliform bacteria, while in 26.2% of the contaminated samples *E. coli* presence was detected (Elmabrok, 2018).

In this study all schools had total number of bacteria numerated from the samples ranging between 8×10^2 and 52×10^7 log (cfu/ml), apart from the following schools which had clean pure drinking water: Ghout Al-Dis School, Hardworking School, Diver School, Secondary Talle and Bin Jaber school; as displayed in (Table 2). These results would presumably be of concern to the health authority of Libya, seen as only 15% of the educational institutional facilities are abiding by the Libyan specification standard (2007) providing safe drinking water to the attending school children.

Table (2). the number of aerobic bacteria (cfu/ml) present in the sampled drinking water in schools, as well as the presence or absence of *E. coli*.

City	Name of school	Number of aerobic bacteria (cfu/ml)	*Escherichia coli*
Al-Ajailat	Northern School	35×10^5	No growth
	Southern School	26×10^7	No growth
	Golden Medal School	25×10^7	No growth
	Ghout Al - Dis School	0	No growth
	Hardworking School	0	No growth

Sabratha	Independence School	33×10^4	*Escherichia coli growth*
	Osama bin Zayed School	54×10^3	*Escherichia coli growth*
	Fatima Al - Zahra School	30×10^3	*Escherichia coli growth*
	Diver School	0	No growth
	Secondary Talle	0	No growth
Surman	Zubair bin Awam School	10×10^4	No growth
	Gnawi School	87×10^6	No growth
	Mohammed Doura School	12×10^5	No growth
	Victory School	52×10^7	No growth
	Farouk School	9×10^4	No growth
	Rafea Al Ansari School	9×10^4	No growth
	Sorman Central School	80×10^6	No growth
	Bin Jaber School	0	No growth
	Mousa Ben Nasr School (M)	8×10^2	No growth
	Mousa Ben Nasr School (F)	90×10^5	No growth

The concerning outcome of the results in this study of the drinking water supplies in schools in the western region of Libya not only conquer with similar findings produced by Elmabrok, (2018), but also findings of research on water supplies from other developing countries such as Pakistan. In2010 study conducted by Anwar et al. (2010), investigated the bacteriological quality of 520 drinking water samples in the capital city, Lahore; 197 (37.2%) of the samples tested positive for bacterial contamination. Another study conducted by Hanan et al. (2010), also analyzed the bacteriological quality of 100 samples of drinking water in Lahore using a Membrane Filtration Technique (MFT) and CHRO-Magar; the study identified that 54% of the specimens were contaminated with coliform bacteria, while 42% of the samples were shown to have *E. coli* growth. The concerning outcome of positively testing for E. coli presence in drinking water illustrates a clear picture of the possible health risks posed (Fewtrell, 2001) on the school children. It is widely understood and established how the quality of water greatly impacts the quality of life; assumable public health crises that could occur as a result of poor water quality and contamination, which could lead to it being a driving factor for child morbidity and mortality (Jasper et al., 2012). Outbreaks of drinking water contamination are not limited solely to developing countries. Although found on a very small scale, water contamination outbreaks may also occur in

developed countries. A study conducted by Park et al., (2018), on 188 students that had presented with gastroenteritis symptoms after a school camping trip; through completed questionnaires and microbiological sampling of the water and the stools of the students, the researchers identified there to have been *E. coli* contamination in the water supply. With further environmental investigation Park et al. (2018), revealed the *E. coli* outbreak and water contamination was a result of the water supply system that had a defected pipeline between the water reservoir and the chlorination device as well as inappropriate filters in the water purifier. The latter emphasizes the point that the contamination of water may not only occur as a result of the water source but also it could be as a result of the water distribution system. Thus there is great importance of having periodic sanitation and inspection, even for clean water supplies, to prevent future waterborne outbreaks (Park et al., 2018).

More research is necessary to determine the extent to which drinking water quality in non-household settings differs from the community settings to better understand how to effectively and appropriately address their challenges. This is of particular relevance to public health seen as people spend the majority of their day outside their homes, where they may be exposed to consume unsafe drinking water.

Conclusion

To conclude, this study has identified that educational institutions located within the western region of Libya pose health risks to our school children, with the majority of the schools sampled in this study testing positive for contaminated drinking water supplied by the educational facility. The presence of contamination in water, particularly the coliform group, reflects the seriousness of using unsafe water distribution networks as drinking water. This study has confirmed that certain areas/schools are not yet meeting the standard of the safe quality of water according to Libyan standards approved or approved by the National Center for Standardization and Metrology. Future research could look into a carrying out a larger sample of this bacteriological study of school drinking water in all schools in the western region of Libya to determine the true extent of water contamination within the facilities of educational institutions, as well as investigating the original source of the contamination.

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دراسة الجودة البكتريولوجية لمياه الشرب في بعض المدارس بالمنطقة الغربية من ليبيا

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الملخص:

الماء هو الأكثر استهلاكًا من قبل جسم الإنسان، لذا فإن جودة المياه هي مصدر قلق كبير للمنتجين والهيئات التنظيمية والمستهلكين، وبالتالي فإن حدوث الحد الأدنى من تلوث المياه يمثل خطرًا حقيقيًا على الصحة. لذلك هدفت هذه الدراسة إلى إجراء تحليل ميكروبيولوجي لمعرفة سلامة المياه، وذلك باختيار مياه الشرب من صنابير مياه الشرب لعشرين مدرسة تقع في ثلاث مناطق من غرب ليبيا. وأخذت 5 عينات من مياه الشرب من مدارس بمدينة العجيلات و5 عينات من مدارس بمدينة صبراتة و10 عينات مياه شرب من مدارس بمدينة صرمان. حيث تم جمع العينات تحت ظروف مضبوطة بدرجة الحرارة، وأجريت الاختبارات البيولوجية في معمل الأحياء الدقيقة بكلية التكنولوجيا الطبية، جامعة صبراتة.تم تحليل العينات فور وصولها، في موعد لا يتجاوز 3 ساعات بعد جمع العينة، لتحديد وجود البكتيريا القولونية البرازية من خلال العدد الكلي لخلايا البكتيريا باستخدام طريقة عد البكتيريا غير ذاتية التغذية. من بين 20 عينة من صنابير مياه الشرب للمدارس التي تم أخذ عينات منها، تبين أن 15 عينة 75٪ كانت إيجابية للتلوث البكتيري. تم اختبار 3 (15٪) من عينات مياه الشرب الملوثة إيجابية لتلوث بكتيريا الإشريكية القولونية. وأظهرت هذه الدراسة أن نسبة كبيرة من المدارس قد تلوثت مياه الشرب. إن وجود هذه البكتيريا بمستويات عالية، وخاصة مجموعة القولونيات، يشكل خطراً على أطفال المدارس الذين يستخدمون هذه المياه ويعكس خطورة شبكة توزيع المياه غير الآمنة.

الكلمات المفتاحية: بكتيرياالقولون، التلوث، مياه الشرب، الإشريشيةالقولونية

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