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Detect of human fecal contamination in water and soil of multiple sanitary landfills in Baghdad city

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ABSTRACT

Pollution of the local site has the potential of causing a number of issues as a result of pollution of local environment such as contamination of ground water or aquifers or soil contamination, improper dumping of rubbish, garbage, or other sorts of solid wastes and lack of facilities maintenance, poorly run landfills may become nuisances to the environment because poorly manage landfill attracts vectors such as rats and flies which can cause infectious diseases. The occurrence of such vectors can be mitigated through the use of daily cover. The aim of this study is to detect *E. coil* in ground water and soil around solid waste disposal in three landfill sites in Baghdad city. Three sites of landfill, located in south Baghdad city, Iraq, were used in this study during the period from 1st March 2013 to 1st March 2014. The sites were namely, Al-Emarry, Al-Boaatha, Erkaia and Fathel. The groundwater and soil from these three city were manually sampled using clean containers. Macro analysis was done by the necked eyes by observing odour and the color of water samples, also pH meter was used to evaluate the pH value in the soil and water samples, while micro analysis was done on specimens collected by streaking method with the use of MacConke ager and nutrient agar surface and the specimens was incubated at 37°C for 24 h. Bacteriological and biochemical tests were performed to recover *E. coil*, viable cell counts. Statistical analysis was performed by using Statistical Package of Social Sciences (SPSS), and P-value < 0.05 indicates significant differences. This study shows that the value of pH in soil sample vary from 7.1 to 7.4 in the studied area. The value recorded in Al-Boaatha site is 7.45, while the water samples from Al-Emarry site show highest value (8.4), comparing with each other. Viable cell count demonstrated that *E. coli* constitutes a higher number (2400/100 ml) in soil solution from Erkaia and Fathel site compared with other sites. According to most probable number (MPN) of total coliforms (TC), fecal coliforms (FC), *E. coli* and fecal streptococci assessment in the soil and water samples, the result revealed that *E. coli* has the highest statistical significant differences in Erkaia and Fathel site among three sites. In conclusion, water samples from the studied area were contaminated and this in-turn has social and environmental impact. Due to lack of alternatives to another source of water, many individual from the studies area still consume the water.

Keywords: *Escherichia coli*, solid waste landfill, wastewater, dump.

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INTRODUCTION

Landfill, also known as a dump (US) or a tip (UK), is a site for the disposal of waste materials by burial and is the oldest form of waste disposal. Historically, landfills have been one of the most common organized methods of waste management (alongside with incineration), and this remain so in many places around the world. The refuse is spread and compacted and then a cover of soil applied so that effects on the environment (including public health and safety) are minimized under current regulations, landfills systems are required to have liners and a leachate treatment system to prevent contamination of ground water and surface waters (Kirch, 2008). Wastes generated by the full extent of human activities range from relatively innocuous substances such as food and paper waste to toxic substances such as paint, batteries, asbestos, healthcare waste, sewage sludge derived from wastewater treatment and as an extreme example, high-level (radioactive) waste in the form of spent nuclear fuel rods. Numerous classifications of solid wastes have been proposed (Ali et al., 1999).

Animal and human remains, although not considered a 'waste product' represent a risk to the quality of local groundwater because of the proliferation of microorganisms that occurs during the process of corpse decomposition (Pacheco et al., 1991).

Coliform bacteria generally originate in the intestines of warm-blooded animals. Fecal coliforms are capable of growth in the presence of bile salts or similar surface agents, are oxidase negative, and produce acid and gas from lactose within 48 h at 44 ± 0.5°C. Coliform bacteria include genera that originate in feces (e.g. *Escherichia*) as well as genera not of fecal origin (e.g. *Enterobacter*, *Klebsiella*, *Citrobacter*). *Escherichia coli* and total coliform have been used to determine the general quality of drinking water in the world and which is an indicator of fecal contamination (Coli, 2005).

E. coli is a gram-negative, facultatively anaerobic, rod-shapedbacterium of the genus *Escherichia* that is commonly found in the lower intestine of warm-blooded organisms (endotherms) (Singleton, 1999). Most *E. coli* strains are harmless, but some serotypes can cause serious food poisoning in their hosts, and are occasionally responsible for product recalls due to food contamination (Vogt and Dippold, 2005). *E. coli* is expelled into the environment within fecal matter. The bacterium grows massively in fresh fecal matter under aerobic conditions for 3 days, but its numbers decline slowly afterwards (Russell and Jarvis, 2001). Fecal-oral transmission is the major route through which pathogenic strains of the bacterium cause disease. Cells are able to survive outside the body for a limited amount of time, which makes them potential indicator organisms to test environmental samples for fecal contamination (Thompson, 2007). A growing body of research, though, has examined environmentally persistent *E. coli* which can survive for extended periods outside of a host (Ishii and Sadowsky, 2008).

There are several historical accounts of pollution of water wells in the vicinity of cemeteries (Teale, 1981). But few studies of the microbiological impact of cemeteries on groundwater (West et al., 1998). So this study aims to detect *E. coil* in groundwater and soil around solid waste disposal in three landfill sites in Baghdad city.

MATERIALS AND METHODS

Site description

Three sites of landfill, located in south Baghdad city, Iraq, were included in this study during the period from 1st March 2013 to 1st March 2014. The sites were namely, Al-Emarry, Al-Boaatha, Erkaia and Fathel as show in Figure 1.

Sample collection

Groundwater were tests by taken from 3 locales for one year time span, the aggregate number of the examples were 30 samples for examination were taken utilizing plastic container of 30 ml volume which include [well water sample, mixed water (rain water mixed with other), and filter water]. To begin with, the examples were separated utilizing 200 nm film channel to dispose of colloids likewise two kilograms of surface soil were tested at profundity of 20 to 30 cm and after that put in a capacity sack, soil tests were gathered amid the penetrating, then Electrical Conductivity (EC) and pH were altogether measured in the field utilizing water verification compact meter (Etech, PCD650).

Micro analysis was done by laboratory analysis. The work of this study was done in central environmental laboratory - Ministry of Environment. For isolation, media for bacterial culture were prepared according to the manufacturer company; from each area sample were collected randomly in a clean, plastic container and water samples rotated at 3000 rpm using ordinary centrifuge for five minutes, then used for fecal coliforms. All water specimens were streak on MacConke ager and nutrient agar surface, and then incubated at 37°C for 24 h (Benson, 2001). The next day many bacteriological and biochemical tests performed to recovered *E. coil* such as indole, catalase, methyl red, production of gas were positive while urease, oxidase, voges-proskauertei, citrate utilization, H2S production were negative (Jaggi, 2008).

Ten grams of each soil sample were added to 95 ml of 0.1% (w/v) solution of sodium pyrophosphate. After homogenization for 30 min, this solution was decimally diluted (10^1 to 10^7) and aliquots of the resulting solutions plated on appropriate culture media. After incubation at 25 or 30 1°C, for up to 10 days, the colony forming units (CFU) were counted and the number of CFU's is related to the viable number of bacteria in the sample.

Statistical analysis

Statistical Package of Social Sciences (SPSS), Microsoft Excel 2013 was used for data analysis and P-value of < 0.05 as significant difference by Duncan's new multiple range test.

RESULTS

Regarding to values of PH in soil samples, the study which found that the value of PH ranges form from 7.1 to 7.4 in the studied area. The lowest value was recorded in Al-Emarry site (7.18) and highest value were recorded in Al-Boaatha site (7.45) and followed by Erkaia and Fathel site (7.41) as shown in Figure 2.

Values of PH in water samples which revealed that the high value were recorded in Al-Emarry site (8.4) and followed by Erkaia and Fathel site (7.5) and Al-Boaatha site (7.18) as shown in Figure 3.

According to viable cell count, the result of present study which demonstrated that *E. coli* constitute higher number (2400/100 ml) in soil solution from Erkaia and Fathel site compare with other sites as shown in Table 1. In water samples the same bacteria show elevated in the Erkaia and Fathel site as shown in Table 2.

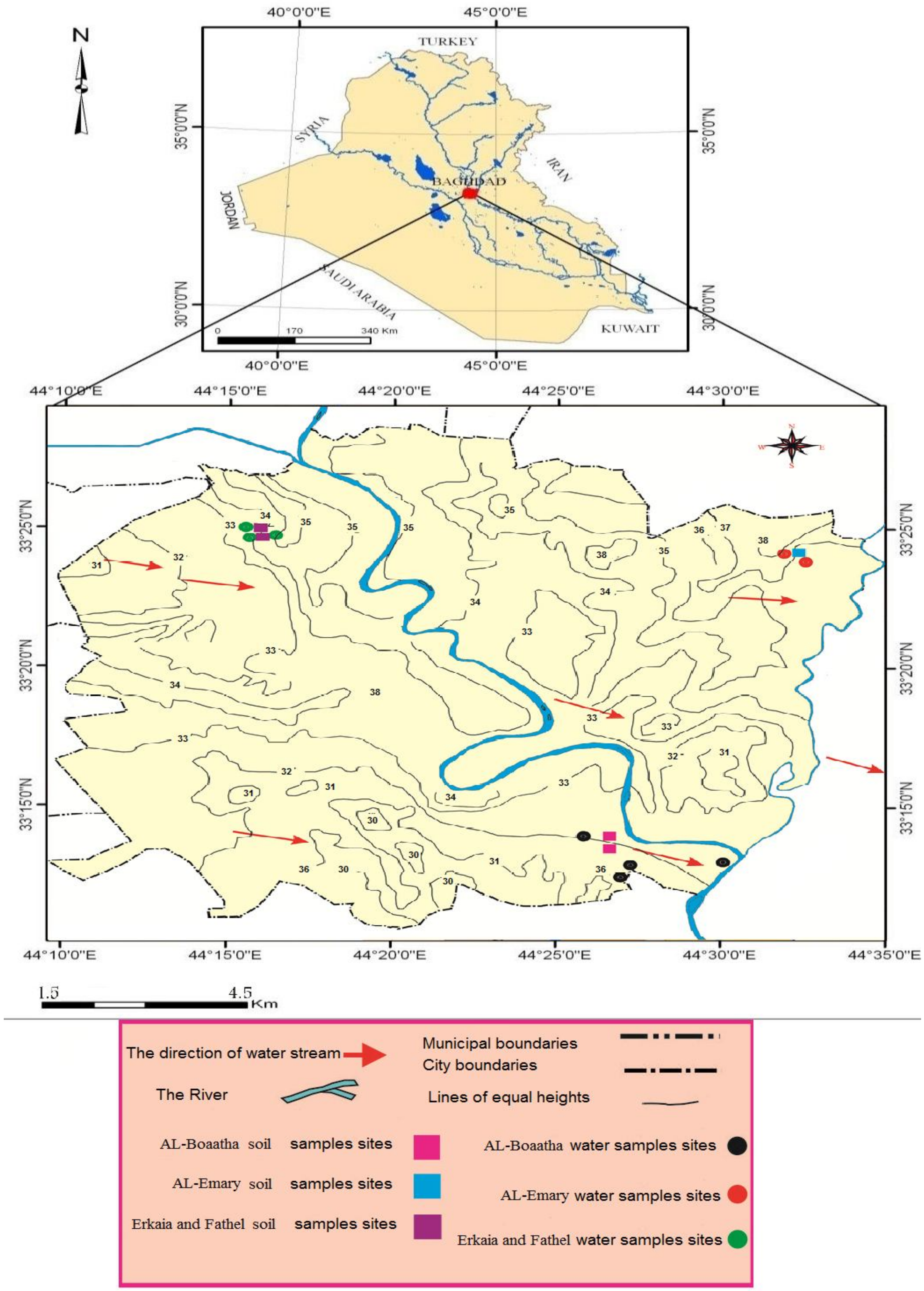

Figure 1. Geographic distribution of the ground water and soil collection sites in Iraq.

According to most probable number (MPN) of total coliforms (TC), fecal coliforms (FC), *E. coli* and fecal streptococci assessment in the soil and water samples, the result of present study revealed that statistical

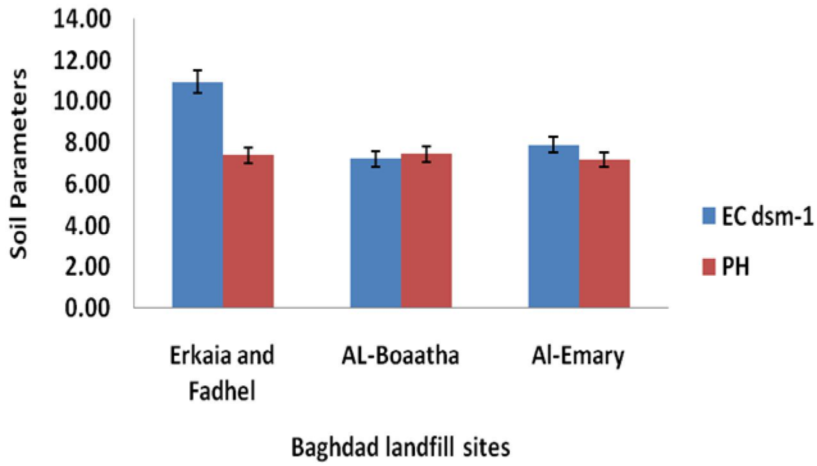

Figure 2. EC and pH values of soil samples in the studied area.

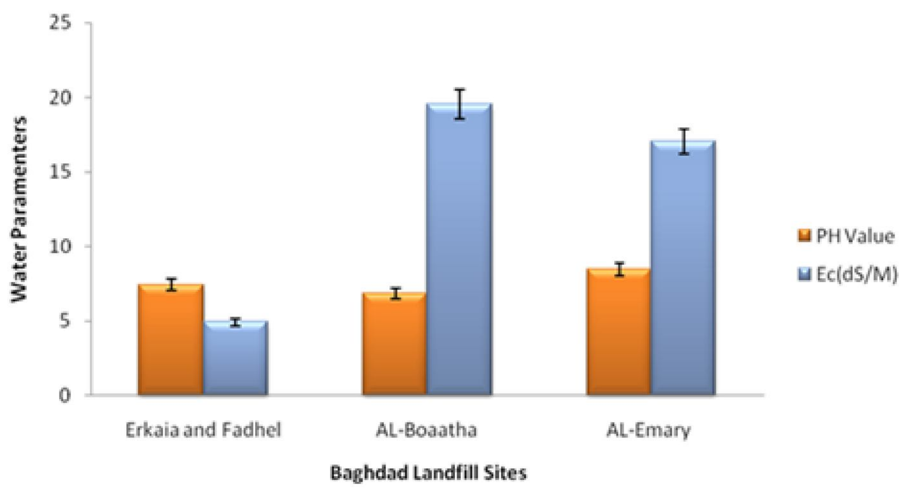

Figure 3. EC and pH values of water samples in the studied area.

significant differences among three sites and *E. coli* constitute the higher number in Erkaia and Fathel site as shown in Tables 3 and 4.

DISCUSSION AND CONCLUSION

This study is one of the first attempts to detect fecal contamination in water and soil of multiple sanitary landfills in Baghdad city. However, several studies have shown that some *E. coli* strains may persist and replicate in natural environments such as soils, sediments, and surface waters (Beversdorf et al., 2007; Ibekwe et al, 2011; Oh et al., 2012). The presence of an indicator does not show the presence of human fecal contamination. There are numerous published reports of regrowth of indicators in the environment (Desmarais et al., 2002; Anderson et al., 2005).

The result of this study show high elevated in pH values in all soil and water samples but in general within the normal value, the high percent was recorded in Al-Emarry site and this may be related with type of west, so basically most it belong to chemical industry waste while in another sites most are domestic waste. The pH level tells how acidic or basic water is. The pH level of the water can change how water looks and tastes. If the pH of water is too low or too high, it could damage pipes, cause heavy metals like lead to leak out of the pipes into the water, and eventually result in sickness. The pH of soil is a standout amongst the most imperative physicochemical parameters influencing plant development and conduct of ionic contaminants in soil, its esteem alludes to the sharpness or alkalinity level in the dirt (Manahan et al., 1994). Soil pH are typically within the scope of 4 to 8.5 in spite of the fact that, the extraordinary range found over the world is 2 to 10.5. Soil

Table 1. Soil samples analysis according to different depths in studied area.

Location name	GPS	Samples no.	EC (μmohs/cm)	pH	T.P.C/1 ml	M.P.N of T.C/100 ml	M.P.N of F.C/100 ml	M.P.N of *E. coli*/100 ml	M.P.N of F.S/100 ml	M.P.N of pseudomonas spp./100 ml
Al-Emary	N 33º24′55.29" E 44º32′29.85"	1	23255	8.6	99800	0	0	0	0	Positive
	N 33º24′25.88" E 44º32′31.86"	2	13478	8.4	201500	0	0	0	0	Positive
Al-Boaatha	N 36º74′40.68" E 44º81′52"	1	17064	6.4	87500	0	0	0	0	Positive
	N 36º74′40.95" E 44º82′82"	2	34679	6.8	246600	0	0	0	0	Positive
	N 36º74′40.95" E 44º82′82"	3	26798	6.7	104200	0	0	0	0	Positive
	N 36º74′87.6" E 44º70′70"	4	7988	8.5	446100	0	0	0	0	Positive
Erkaia and Fadhel	N 33º25′36.53" E 44º16′31.29"	1	20883	7.3	98200	3500	13500	2400	0	Positive
	N 33º24′16.70" E 44º18′21.35"	2	15793	7.8	6680	9200	3500	1300	0	Positive
	N 33º24′17.34" E 44º18′19.22"	3	6467.6	7.4	95760	1700	1700	700	0	Positive
	N 33º24′17.34" E 44º18′19.22"	4	6219.7	7.2	4320	1700	460	460	0	

T.P.C. = Total viable count, M.P.N. of TC = Most probable number of total coliform, M.P.N. of FC = Most probable number of fecal coliform, M.P.N. of *E coli* = Most probable number of *E. coli*, M.P.N. of F.S. = Most probable number of fecal streptococci.

in bone-dry areas has a tendency to have pH esteems between 7 and 9 (Harrison, 1999). Outrageous estimation of pH effectsly affect supplement accessibility. Soil pH more prominent than 8.5 demonstrates high sodium content and these dirt have a tendency to be hard and extremely impermeable (Kamble, 2006). The pH estimation of soil is exceedingly impacted by the kind of parent material from which the dirt was determined. Precipitation additionally influences soil pH, soil framed under high precipitation conditions are more acidic than those shaped under dry conditions. Deterioration of natural issue expands soil corrosiveness and use of composts containing ammonium or urea accelerate the rate at which sharpness creates. Low pH of soil upgrades the activation of replaceable cations and many follow components feebly clung to soil parts.

Regarding bacterial contamination, the results show difference in the number of bacteria from one site to another, most types belong to coliform bacteria and *E. coli* the genera that originate in feces considerate the higher number. The assay is intended to be an indicator of fecal contamination; more specifically of *E. coli* which is an indicator microorganism for other pathogens

Table 2. Water samples analysis in studied area.

Location name	GPS	Samples no.	EC (µmohs/cm)	pH	T.P.C/1 ml	M.P.N of T.C/100 ml	M.P.N of F.C/100 ml	M.P.N of *E.coli*/100m	M.P.N of F.S/100 ml	M.P.N of pseudomonas spp./100ml
Al-Emary	N 33º24′55.29" E 44º32′29.85"	1	23255	8.6	80000	160000	160000	160000	160000	Positive
	N 33º24′25.88" E 44º32´31.86"	2	13478	8.4	525000	160000	160000	160000	20	Positive
Al-Boaatha	N 36º74′40.68" E 44º81′52"	1	34679	6.8	1400	160000	24000	24000	68	Positive
	N 36º74′40.95" E 44º82′82"	2	26798	6.7	300	45000	24000	13000	2400	Positive
	N 36º74′40.95" E 44º82′82"	3	7988	8.5	500	1200	450	450	230	Positive
	N 36º74′87.6" E 44º70′70"	4	91574	7.18	733.3	68733.3	16150	12483.3	899.3	Positive
Erkaia and Fadhel	N 33º25′36.53" E 44º16´31.29"	1	20883	7.3	507800	310	310	230	507800	Positive
	N 33º24′16.70" E 44º18´21.35"	2	15793	7.8	6100	230	230	130	6100	Positive
	N 33º24′17.34" E 44º18´19.22"	3	6467.6	7.4	104400	110	110	780	104400	Positive
	N 33º24′17.34" E 44º18´19.22"	4	6219.7	7.2	8900	16000	16000	5400	8900	Positive

T.P.C.=Total viable count, M.P.N. of TC = Most probable number of total coliform, M.P.N. of FC = Most probable number of fecal coliform, M.P.N. of *E. coli* = Most probable number of *E. coli*, M.P.N. of F.S. = Most probable number of fecal streptococci.

that may be present in feces. Presence of fecal coliforms in water may not be directly harmful, and does not necessarily indicate the presence of feces (Doyle and Erickson, 2006). Also good PH and suitable environment help this bacterium to growth and multiplication. Number of *E. coli* was more than standard value (1000 cell/1 ml) except water sample no. 2 in Al-Boaatha this is considered suitable for agricultures while in other site not stabile for any activity.

According to direct interview with people in the studied area and doctors working in central health during sample collection, persons revealed direct use of river water for many uses without boiling water or by treating with chlorine especially in summer times, and suffering from different types of disease; this may be related to bacteria associated with many diseases such as respiratory infection, gastrointestinal infection and skin infection are most common. In general, children, the elderly, and immunocompromised individuals require a lower dose of a pathogenic organism in order to contract an infection. Presently there are very few studies which are able to quantify the amount of time people are likely to spend in recreational waters and how much water they are likely to ingest. In general,

Table 3. Soil analysis according to bacteriology test in studied area.

Sites	M.P.N of F.S/100 ml	M.P.N of *E. coli* /100ml	M.P.N of F.C /100 ml	M.P.N of T.C /100 ml	T.P.C/ml
Al-Emarry	A 0.00 ± 0.00	B 0.00 ± 0.00	B 0.00 ± 0.00	B 0.00 ± 0.00	C 147920 ± 71565
Al-Boaatha	A 0.00 ± 0.00	B 0.00 ± 0.00	B 0.00 ± 0.00	B 0.00 ± 0.00	B 76537 ± 76406
Erkaia and Fathel	A 0.00 ± 0.00	A 12483.33 ± 1164.88	A 1232.0 ± 750.4	A 4025 ± 3553	A 54544 ± 46671

T.P.C.=Total viable count, M.P.N. of TC = Most probable number of total coliform, M.P.N. of FC=Most probable number of fecal coliform, M.P.N. of *E coli* = Most probable number of *E. coli*, M.P.N. of F.S.=Most probable number of fecal streptococci. * A and B are significant at ($p<0.05$) to compression columns.

Table 4. Water analysis according to bacteriology test in studied area.

Sites	M.P.N of F.S/100 ml	M.P.N of *E. coli* /100ml	M.P.N of F.C /100 ml	M.P.N of T.C /100 ml	T.P.C/ml
Al-Emarry	C 0.00 ± 0.00	C 1635 ± 405.82	C 4162.5±473.8	C 4162.5 ± 473.8	C 19055 ± 1647.77
Al-Boaatha	B 80010 ± 6009.71	B 126000 ± 5066.7	B 160000 ± 40000	B 160000 ± 40000	B 42500 ± 3112.08
Erkaia and Fathel	A 899.3333 ± 217.55	A 12483.33 ± 1164.88	A 16150 ± 2051.1	A 71733.33 ± 52000	A 733.3333 ± 131.5

T.P.C. = Total viable count, M.P.N. of TC = Most probable number of total coliform, M.P.N. of FC=Most probable number of fecal coliform, M.P.N. of *E coli* = Most probable number of *E. coli*, M.P.N. of F.S. = Most probable number of fecal streptococci
* A and B are significant at ($p < 0.05$) to compression columns.

children swim more often, stay in the water longer, submerge their heads more often, and swallow more water.

The current monitoring guidelines are based on epidemiologic studies at sites impacted by point sources of sewage contamination which have been found to have increased risk for transmission of infectious diseases, including gastroenteritis, and acute febrile respiratory, skin, eye, and ear illnesses for bathers compared to non-bathers (Haile et al., 1999; Prieto et al., 2001; Wade et al., 2003; Sinigallianoa et al., 2010).

Contamination problem is very important and found in each country and associated with different sources may be human or animal, pets, especially dogs, and can contribute to fecal contamination of surface waters, Birds can be a significant source of fecal coliform bacteria. Swans, geese, seagulls, and other waterfowl can all elevate bacterial counts, especially in wetlands, lakes, ponds, and rivers. As well as in the soil, some older industrial cities, particularly in the Northeast and Midwest of the United States, use a combined sewer system to handle waste. A combined sewer carries both domestic sewage and storm water. During high rainfall periods, a combined sewer can become overloaded and overflow into a nearby stream or river, bypassing treatment. Large quantities of fecal coliform bacteria in water are not harmful according to some authorities, but may indicate a higher risk of pathogens being present in the water (Fresno, 2009). Some waterborne pathogenic diseases that may coincide with fecal coliform contamination include ear infections, dysentery, typhoid fever, viral and bacterial gastroenteritis, and hepatitis A.

Untreated organic matter that contains fecal coliform can be harmful to the environment. Aerobic decomposition of this material can reduce dissolved oxygen levels if discharged into rivers or waterways. This may reduce the oxygen level enough to kill fish and other aquatic life. Reduction of fecal coliform in wastewater may require the use of chlorine and other disinfectant chemicals. Such materials may kill the fecal coliform and disease bacteria. They also kill bacteria essential to the proper balance of the aquatic environment, endangering the survival of species dependent on those bacteria. So higher levels of fecal coliform require higher levels of chlorine, threatening those aquatic organisms.

Numerous studies have been done in this subject area to assess human bacterial contaminate in and around sanitary landfills, in a study done by Gomez et al. (2011) in Medellín, Colombia who collected the sample from soil and leachate contain high levels of contaminants and the natural soil is highly disturbed with solid anthropogenic materials to study bacterial diversity at different depths. Another study done by Threedeach et al., (2012) showed that a bacterial susceptibility test to 31 antibiotics was conducted on the 80 isolated *Escherichia coli* from the leachates of the landfills in two different operations: semi-aerobic (SL) and anaerobic (AL) landfills and indicate that the difference in available oxygen in landfills could affect *E. coli* susceptibility to antibiotics in leachates.

In conclusion, most water samples from the studied area were contaminated and this in-turn have social and environmental impact. Due to lack of alternatives to another source of water, many individual from the studies area still consume the water.

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