LEACHATE CHARACTERIZATION AND ITS IMPACT ON GROUNDWATER QUALITY NEAR MUNICIPAL SOLID WASTE LANDFILL SITE OF DUBAGGA, LUCKNOW

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ABSTRACT

Improper disposal of waste and absence of scientific management led to disgorge of leachate. Leachate generating from organic and inorganic chemical present in municipal solid waste(MSW)can contaminate the groundwater, posing great health risk to humans. The present study evaluated the physico-chemical parameters and heavy metals of leachate and quality of nearby groundwater collected from Hand-pumps and Tube-wells. The groundwater samples were examined for physico-chemical, microbiological parameters and heavy metals.It is observed that the physico-chemical parameters leachate sample has high contamination of oraganics, salts and heavy metal. The groundwater results shows that Mg^{2+}, F^{-} and Cr^{6+} exceeds permissible limit in groundwater give proof that quality of groundwater notably affected by percolation of leachate. The presence of TC in groundwater samples indicates possible contamination. Scientific management strategies should be adopted to prevent the future contamination of groundwater by leachate.

KEYWORDS: Dubagga, groundwater quality, leachate, solid waste, landfill.

1. INTRODUCTION

Open dumps are the most common and the oldest recognized method for discarding solid waste and despite the fact that thousands have been shut in recent years, many still are being utilized. They are generally formed in low lying land without giving any consideration to public safety. The waste is frequently heaped as high as machines allows. Open dumps have a tendency to make a disturbance by being unattractive, breeding insects, making a health risk, contaminating the water sources and polluting the air.

Management of Municipal Solid Wastes (MSW) is the least concerned areas of urban development in India. Major MSW landfill sites in India are without lining and system of leachate collection. Waste generally disposed in uncontrolled manner in open dumps is common practice in developing countries. Waste upon degradation oozes liquid which is highly contaminated in nature called landfill leachate or from rain water that passes through the waste within the facility.Landfill leachate contains high concentration of anions, cations, heavy metals and pathogens.The landfill leachate composition generally depends upon the nature of waste, decomposition of waste materials cause due to chemical and biochemical processes, waste moisture content, characteristics of soil and rainfall.In developing nations like India, landfills are not provided with liners and also not equipped with leachate collection mechanism and treatment facilities which result in percolation of leachate into the groundwater with the assistance of rainfall and contaminate the groundwater.

Groundwater is subsurface water that present in cracks and space of underground soil and rocks and moves through aquifers under pressure greater than atmospheric pressure. Aquifers are geological formations having large interconnected cracks and pores that make them permeable.The suitability of groundwater as a source of

water for consumption of human and animal, irrigation and for other purpose depend upon its chemical composition.

This study aims to investigate the extent of groundwater contamination due to percolation of leachate from municipal landfill site at Dubagga. Leachate sample is collected from Dubagga open dumping site and groundwater samples collected from Hand-pumps and Tube-wells analyzed for various physico-chemical parameters and heavy metals. Groundwater samples additional analyzed for microbiological parameters.

1.1 STUDY AREA

Lucknow is capital of the province of Uttar Pradesh in India, with a zone of 2528 sq. km and a populace of around 4.58 million (Census of India, 2011). The monsoon season is from July to September when the city gets a average precipitation of 896.2 millimeters from the south-west monsoon winds, and sometimes frontal precipitation will happen in January. Lucknow city creates around 1600 tons of MSW every day, out of which the organics portion is a noteworthy contributor (47-55%). Open dumping in discouraged or low-lying territories without liners and without a leachate collection facility is the typical practice. The lucknow Municipal Corporation (LMC) as of now works a few unsecured landfill sites for the transfer of gathered solid wastes. The LMC has tried to manage the collection of waste through a private association, while squander processing and disposal have unregulated. In Lucknow there are around 23 new and old municipal strong waste dumping destinations, among which Dubagga is main one.

Dubagga landfill lies at 26.47" North and 80.55" East. It is located at 160 meter distance of the Chandoia Village in north near Musabag and western direction of Lucknow city (Figure1) is low lying area and close to the fish market and KadimiKabristan, receives about 1000 Metric tons municipal solid waste daily. The Dubagga landfill started in the year 2007 and still in use. The area of landfill spread over approximately 61420.08 m^2 and the landfill height varies from 4 m to 5 m.

Fig 1 Dubagga landfill site

2. EXPERIMENTAL ANALYSIS

2.1. SAMPLING OF LEACHATE AND GROUNDWATER

Since leachate collection mechanism or leachate streams for collection of leachate is absent, pits were excavated to a depth of 1 to 1.5 m in the landfill. After a day's time the oozed out leachate are collected in a laboratory cleansed plastic cans. The collected samples of leachate were shifted to the laboratory, stored at 4°C and analyzed within 48 hours.

5 groundwater sample locations were chosen nearby the Dubagga municipal landfill site shown in Table 1. 5 Liter bottles were used to collect groundwater samples. But before collection, all the bottles were rinsed with nonionic soap and washed with de-ionized water as part of the quality control measures. After each collected sample container bottle was labeled according to sampling location and all the samples were transported to the laboratory and preserved at 4ºC in refrigerator for further physico-chemical, heavy metal and biological analyses according to APHA,2005.

Table 1Groundwater samples site locations.

	Sampling locations	Type	Depth	Distance	Location
GW 1	M.C. Saxena College mod	Hand-pump	15 m	50 m	26º53'51" N 80º52'13" E
GW 2	farm	Tube-well	32 m	80 m	26º53'49" N 80º52'22"E
GW 3	mandir	Hand-pump	12 m	400 m	26º54'10" N 80º52'22" E
GW 4	farm	Tube-well	34 m	100 m	26º53'40" N 80º52'16" E
GW 5	S S& COMPANY site office	Tubewell	38 m	500 m	26º53'58"N 80º52'10" E

The results of the physico-chemical parameter and level of trace metal concentration of groundwater are compared with the limits prescribed by Bureau of Indian Standard (BIS) 2012. All parameters and methods prescribed in Table 2.

Table 2 List of parameters analyzed and methodology followed

Parameters	**methodology**
pH, Electrical conductivity as (EC), Total dissolved solids as (TDS)	pH meter
Total hardness as (TH), Calcium as (Ca^{2+}), Magnesium as (Mg^{2+}),	EDTA titrimetric method
Chloride as (Cl^-)	Argentometric method
Sulphate as (SO_4^-)	Nephlometric method
Nitrate as (NO_3^-), Ammonium as (NH_4^+)	Ammonia selective Electrode method
Fluoride as (F^-)	Fluoride Meter
Sodium as (Na^+)	Flame photometric method
Coliforms	MPN method
Biological Oxygen demand as (BOD_5)	Winkler's modified method
Chemical Oxygen demand as (COD)	Dichromate reflux method
Heavy Metals	Acid digestion method (AAS)

3) RESULTS AND DISCUSSION

3.1 LEACHATE

Leachate is generated due to waste decomposition and rainfall. Contaminant quantity and quality in the leachate depend on waste types and composition. Leachate quality in Dubagga landfill site is showing in Table 3.

The value of pH of collected leachate sample comes out to be 6.9. the concentration TDS observed as 6875 mg/l. EC value found as 8678 µ mho/cm shows the presence of dissolve inorganic materials in the samples. The BOD_5 value is observed as 2486.59 mg/l and COD as 3657 mg/l indicates high organic strength of waste. The sodium concentration found to be 125 mg/l. chloride concentration in leachate sample is 1953 mg/l. The sulfate value is 1643 mg/l. nitrate concentration is 933 mg/l and ammonium concentration is found to be 176 mg/l. The cadmium concentration observed below detection limit. Concentration of chromium ion is found to be 0.24 mg/l due to the various wastes dumped in the landfill sites. There is no separate dumping sites for hazardous and industrial waste generate from the useless batteries, radio, televisions, mobiles, computer parts and other electronics appliances that unused iron scraps are dumped in the the landfills.

Table 3 Physico-chemical characteristics of the leachate

Parameters	Concentrations
pH	6.9
TDS	6875
EC	8678
BOD_5	2486.59
COD	3657
Na^+	125
Cl^-	1953
SO_4^{2-}	1643
NO_3^-	933
NH_4^+	176
Cd	BDL
Cr	0.24

*All units are in mg/l except pH and EC (unit of EC is µ mho/cm).

3.2 GROUNDWATER

3.2.1. Physico-Chemical Characteristics and Heavy metals

The collected ground water was analyzed for its physico-chemical characteristics. The samples were also tested for the presence of heavy metal ions Cadmium and Chromium Hexavalent. The physico-chemical parameters of groundwater samples collected from different sources shown in Table 5

Table 5 Physico-chemical parameters of Groundwater samples.

samples	pH	EC	TDS	TH	TA	Ca^{2+}	Mg^{2+}	Na^{+}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}
GW 1	7.5	521	339	286	226	47	27	35	30	23	43	1.2
GW 2	7.3	492	318	231	200	35	20	26	21	5	8	0.8
GW 3	7.6	721	624	245	213	65	52	49	35	14	24	0.7
GW 4	7.2	735	525	312	247	21	41	12	26	2.4	4	0.65
GW 5	7.5	540	348	215	196	28	15	18	15	2.2	5	0.6

The analysis shows that pH is in neutral range in all groundwater samples i.e. 7.2 to 7.6. The value of EC in samples comes in range of 492 to 735 µS/l. It represents the measures of number of ions present in water. The TDS of the samples are varying from 339 to 624. The Total hardness (TH) values groundwater samples are found in between 212 to 317 mg/l which found higher than desirable limit but lesser than the permissible limit. Total alkalinity (TA) as $CaCO_3$ in groundwater ranges from 215 to 312 mg/l. TH went from 212 to 317 mg/l. Total Hardness of groundwater predominantly dispersed in the considered territory. All samples are comes in very hard category of water as all samples are greater than 180 mg/l. Ca^{2+} values in groundwater varies from 21 to 65 mg/l. The concentration of Mg^{2+} particles changed from 15 to 52 mg/l. Sample of GW3 exceed Mg^{2+} permissible limit of 50 mg/l. Na^{+} in samples differed from 12 to 49 mg/l. The hazard posture because of high concentration of Na^{+} to people that they may experience the ill effects of cardiovascular, renal and circulatory ailment. Cl^{-} particle abundance in water is demonstrates the file of contamination and considered with respect to groundwater sullying. Cl^{-} in the groundwater found in range of 15 mg/l to 35 mg/l. The contamination hotspots for Cl^{-} may be because of the residential effluents, manures, and leachates. The nitrate fixation was additionally inside as far as possible (45 mg/L) in all the testing areas yet higher most importantly in area 1 (GW1) and range between 23 to 2.2 mg/l. The real source for nitrate in groundwater incorporate local sewage, spillover from agrarian fields, and leachate from landfill destinations higher concentration of NO_3^{-} in water causes an illness called "Methaemoglobinaemia" otherwise called "Blue-child Syndrome". This sickness especially influences babies that are up to a half year old. The SO_4^{2-} concentration in samples is within permissible values of BIS and WHO guidelines for all the gathered examples range between 43 to 4 mg/l. The concentration of F^{-} in the gathered water tests ran from 0.6 to 1.2 mg/l. F^{-} concentration up to 1 mg/l is necessary for development of teeth but more than it may causes dental fluorosis and more than 1.5 mg/l causes skeleton fluorosis. Cadmium concentration in all groundwater samples is below detection limit. But the concentration Chromium Hexavalent ion is exceed the permissible limit in groundwater sample in 2 location GW1 and GW2 as 0.15 and 0.12 mg/l respectively as the permissible of chromium hexavalent is 0.05 mg/l.

3.2.2 Microbiological contamination

Table 6 Microbiological analysis of water

Samples	Combinations of positive	Total coliform (MPN index/ 100ml)
GW1	3-1-0	11
GW2	2-0-1	7
GW3	1-0-1	4
GW4	0-0-0	<0
GW5	0-0-0	<0

Table 6 exhibits the present of coliform in 3 samples, demonstrating the sullying of groundwater maybe due to leachate permeation in groundwater. The GW1 test demonstrate the greatest number of total coliform 11 while at the same time GW2 and GW3 samples indicates 7 and 4 separately. The coliform microorganisms can increment when leachate enters in an oxygenated system.

3.2.3 Correlation analysis

As per Table 7 the groundwater samples correlation coefficient was highly positive between EC and TDS, TA and Mg; TDS and Mg; TH and TA; Ca and Mg; NO3 and F and Cr. Correlation coefficient was significantly positive between EC and Mg and Cl; TDS and Cl, TA; TH and Mg, Cl; TA and Mg, Cl; Ca and Mg, Cl, NO3-, SO42- and Cr; Mg and Cl, Na; Na and Cl, NO3- and Cr; Cl and NO3-, SO42-;Cr^{6+} and Cl^{-} and SO_4^{2}.Significant negative correlation was observed between EC and F; TDS and F- ; Mg and F-.

	Ph	EC	TDS	TH	TA	Ca^{2+}	Mg^{2+}	Na^{+}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	Cr^{6+}
pH	1												
EC	-0.079	1											
TDS	0.152	0.952	1										
TH	-0.457	0.480	0.302	1									
TA	-0.451	0.615	0.431	0.985	1								
Ca^{2+}	0.779	0.145	0.418	-0.181	-0.189	1							
Mg^{2+}	0.129	0.891	0.952	0.464	0.553	0.523	1						
Na^{+}	0.761	0.094	0.372	-0.195	-0.212	0.997	0.488	1					
Cl^{-}	0.325	0.546	0.672	0.483	0.487	0.757	0.851	0.744	1				
NO_3^{-}	0.574	-0.131	0.014	0.256	0.159	0.720	0.245	0.730	0.701	1			
SO_4^{2-}	0.574	-0.162	-0.027	0.258	0.158	0.683	0.199	0.692	0.661	0.997	1		
F^{-}	0.195	-0.461	-0.408	0.335	0.183	0.330	-0.135	0.363	0.383	0.858	0.871	1	
Cr^{6+}	0.393	-0.112	0.070	0.220	0.121	0.769	0.334	0.794	0.769	0.908	0.881	0.800	1

Table 7 Correlation coefficient among physico-chemical and heavy metal characteristics of groundwater samples

4. CONCLUSION

The leachate collected from the Dubagga municipal open dumping ground shows high values for the physico-chemical parameters. Chromium were present at low level in leachate and Cadmium is below detection limit in leachate sample. The impact of leachate permeation is obvious on the encompassing groundwater. The groundwater results shows that Mg^{2+}, F^{-} and Cr^{6+} exceeds permissible limit in groundwater give proof that quality of groundwater notably affected by percolation of leachate. The presence of TC in groundwater samples indicates possible contamination.

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