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ORIGINAL ARTICLE

Characterization of Leachate from Municipal Solid Waste Rampur Dumpyard, Telangana State

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ABSTRACT
The present study discusses the characteristics of leachate generated from municipal solid waste dump site of Rampur, Telangana State (India). Leachate samples were collected from the dumpyard and analyzed for various physicochemical parameters to assess its pollution potential. This study aims to analyze the impact of municipal solid waste dumpyard leachate impact on surrounding environment. The dumpsite of Rampur is non- engineered without lining. The dumpsite has not having bottom liner, leachate collection and treatment system. Therefore, the leachate generated finds its paths into the surrounding surface canals and surface water. It has been found that dumpsite leachate contains high concentrations of organic, inorganic constituents and it's beyond the permissible limits. The present study indicated that the age of the landfill and it has a significant effect on dumpsite leachate composition. Based on the characterization of landfill leachate it belongs to intermediate landfill category and the land fill age were below 10 years. Except for pH, in all other studied parameters like EC, TDS, Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, NO_3^-, BOD and COD majority of the samples were found above the permissible limits and MoEF (2000) discharge limits (1). Indiscriminate open dumping, without proper solid waste management (SWM) practices impact on surrounding environment. It should stop and require contamination prevention in serious manner.
Keywords- *Solid waste, Dumpyard, Leachate, Contamination, Pollutants*

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INTRODUCTION

Solid waste generation is a continually growing problem at all over the world. The increasing of generation of solid waste is the result of growing population and the adoption of the modern lifestyle. Improper disposal of municipal solid waste pollutes all the vital components of the living environment (2). The problem is more acute in developing countries than in developed countries, as their economic growth level as well as urbanization is more rapid and unregulated (3). Currently, the main problem facing solid waste treatment is no proper segregation into degradable and non-degradable before dispose (4). The amount of waste generated per capita per day was dependent on variables. Municipal Solid Waste Management is a challenging problem for developing cities (5). The present study was taken to find out the problems of MSW of dumped in the Rampur area. This study also comprises the direct impact of leachate due to open dumping.

Management of Municipal Solid Waste Laws:

The MSW laws were prior to 1974 at different level (regional and national) were there to punish the offender for making any nuisance in public places and pollution of any water bodies. In 300-400 B.C. in Chanakya provisions were there to punish offenders for making nuisance, these were ineffective and not strictly enforced in that time. The Environment Protection Act, 1986 was also silent in solid waste management and the Govt. of India is effective in implement mostly after developed countries declaration. Several laws particularly to Solid Waste Management since 1974 are as enumerated(6,7).

Table:1 Various Environmental Acts of Government of India.

Year	Act/ Rules
1974	Water (prevention and control of pollution) act amended in 1978 and 1988.
1981	Air (prevention and control of pollution) act amended in 1987.
1986	Environment Protection Act (umbrella act) even was silent in MSW management.
1989	Hazardous waste management and handling rule.
1990	Govt. of India and Supreme Court initiated on the necessity of solid waste management.
1998	Bio-medical waste (management and handling) rules amended in 2000.
1999	Recycled plastic manufactured and usage rules.
1999	Solid waste management in Class-1 cities in India-guidelines by Supreme Court.
2000	Municipal waste (management and handling rules).

MATERIAL AND METHODS

Study area:

Warangal is the second-largest city in Telangana state after Hyderabad capital. Warangal city has a population of more than 7.5 lakhs, it has been dumping its municipal solid waste at Rampur village for many years. The Rampur is a Village is in Warangal Urban District of Telangana. The solid waste is collected and transported from Greater Warangal Municipal Corporation to the dump yard.

Table 2: Physical characterization of MSW in Dumpyard

Waste characteristics	Percentage %
Biodegradable	51.14%
Recyclable	19.59%
Combustible	13.74%
Inert waste	15.53%
Total	100%

Figure 1: Study area map of solid waste dumpyard and sampling sites (L1, L2, & L3)

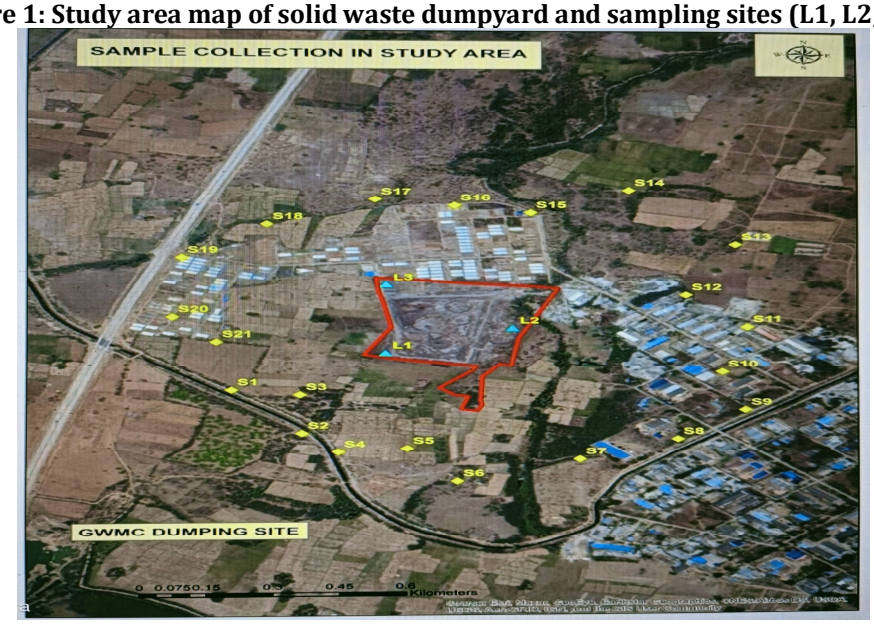


Table 3: Leachate sampling sites

Sl.no	Sampling Site	Longitude	Latitude
1	L1	79° 27' 7.216" E	17° 57' 5.727" N
2	L2	79° 27' 16.596" E	17° 57' 9.391" N
3	L3	79° 27' 7.265" E	17° 57' 15.908" N

Landfill Age:

The duration of time for solid waste dumping determines waste decomposition in landfills. The leachate forms in different layers and it becomes toxic with increasing duration (8). Leachate of recent landfills

contains high COD and BOD with a gradual reduction in the lower layers (8). Carbon-containing compounds decompose faster than inorganic compounds with age(9).

Table:4 Leachate types and age (10)

Leachate type	New	Intermediate	Old
Landfill age	Less than 5 years	5-10 years	Above 10 years
pH	Less than 6.5	7	Above 7.5
BOD/COD g/L	Above 0.3	0.1-0.3	Less than 0.1
COD g/L	Above 20	13-15	Less than 2

Leachate Physico -chemical analysis

The Samples were analyzed for the following physico-chemical parameters pH, EC, Total dissolved solids (TDS), Sodium (Na^-), Chlorides (Cl-), Calcium (Ca2+), Magnesium (Mg2+), Potassium (K^+)) and Nitrates (NO3 -) , BOD and COD were carried out in accordance with standard analytical methods of APHA [29]. The laboratory analytical results were subjected to data evaluation by using of standard statistical methods.

RESULTS

Leachate Physico -chemical analysis: The primary issue produced by municipal solid waste is landfill leachate, which is isolated by precipitation, surface runoff, and groundwater infiltration seeping through a landfill. The term "leachate" refers to the liquid waste produced from various physicochemical and biological processes that will occur within the "landfill" (11). Even after the landfill site was already closed for 30-50 years, this landfill continues to cause problems. From the literature, it was observed that landfills can be classified into 3 major groups based on age. If the landfills age 5 or less it is young, 5-10 years it is intermediate, more than 10 years it is old (12, 13). Leachate samples collected in pre-monsoon and post-monsoon from the site in three locations (L1, L2 and, L3). Analyzed it for physicochemical parameters. Every analysis triplicate was properly maintained to avoid human error, three samples of leachate were obtained data represented in respective tables (5 and 6 table) from different sites of the dumpsite.

Table 5: Physico-chemical characteristics of pre-monsoon leachate samples in 2018

Parameters	L1	L2	L3	Min	Max	Average
pH	7.29	7.19	7.46	7.19	7.46	7.313333
EC	8924	9351	8594	8594	9351	8956.333
TDS	5263	6395	6179	5263	6395	5945.667
Ca^{2+}	723	802	734	723	802	753
Mg^{2+}	639	614	646	614	646	633
Na^+	346	291	274	274	346	303.6667
K^+	612	593	642	593	642	615.6667
NO_3^-	BDL	BDL	BDL	0	0	0
Cl^-	625	529	561	529	625	571.6667
BOD	1693	1396	1997	1396	1997	1695.333
COD	8468	6980	6658	6658	8468	7368.667

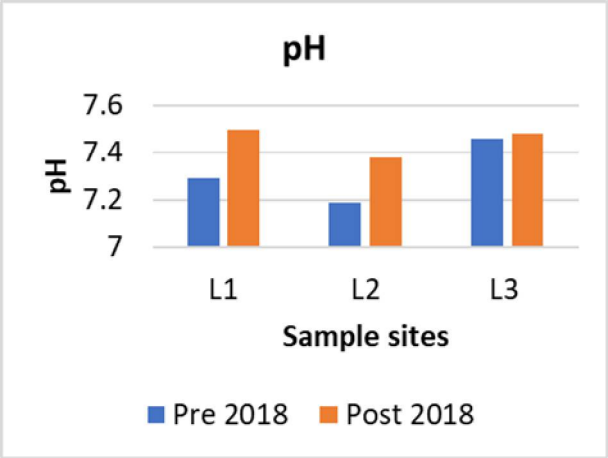
Except for EC (µS/cm), all readings were expressed in mg/l. ; BDL-Below detectable level.

Table 6: Physico-chemical characteristics of post-monsoon leachate samples in 2018

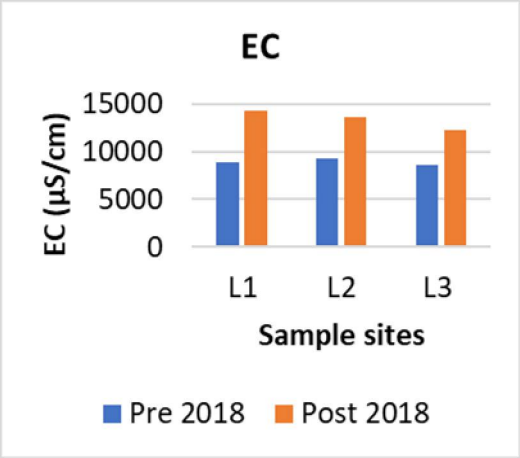
Parameters	L1	L2	L3	Min	Max	Average
pH	7.5	7.38	7.48	7.38	7.5	7.453333
EC	14271	13592	12364	12364	14271	13409
TDS	8798	9245	9561	8798	9561	9201.333
Ca^{2+}	612	649	574	574	649	611.6667
Mg^{2+}	597	564	559	559	597	573.3333
Na^+	231	198	183	183	231	204
K^+	390	412	428	390	428	410
NO_3^-	BDL	BDL	BDL	0	0	0
Cl^-	330	346	359	330	359	345
BOD	1643	1956	1697	1643	1956	1765.333
COD	8216	9784	8485	8216	9784	8828.333

Except for EC (µS/cm), all readings were expressed in mg/l. BDL-Below detectable level.

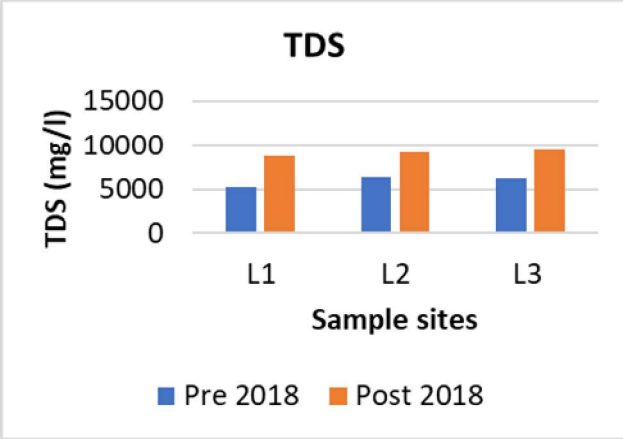
The represented data showed tables (5 and 6) pre monsoon as pre and post-monsoon as post and leachate sampling sites showed as L1, L2, and L3 for the study period (Graphs **1** to **10**).



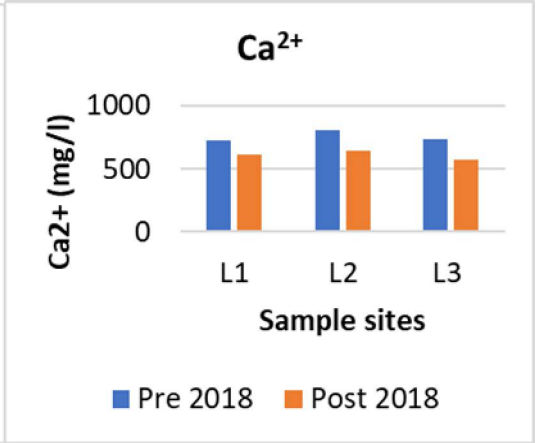
Graph 1: Variations of pH in 2018



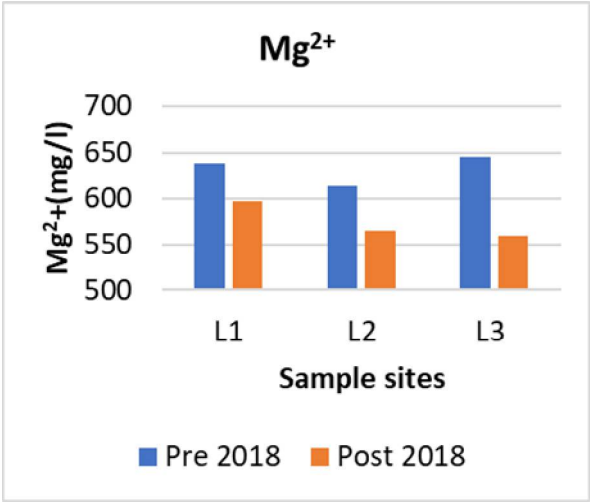
Graph 2: Variations of EC in 2018



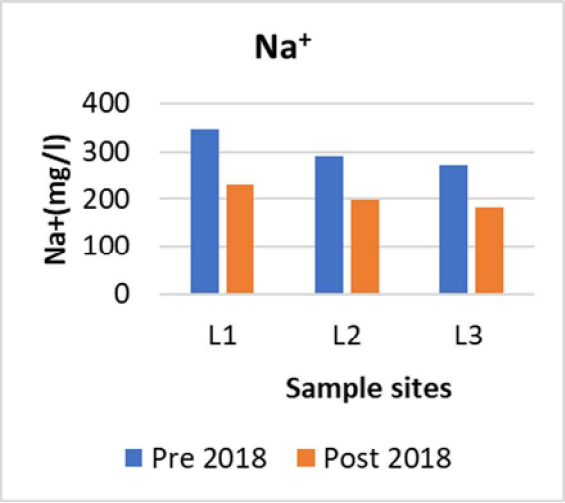
Graph 3: Variations of TDS in 2018



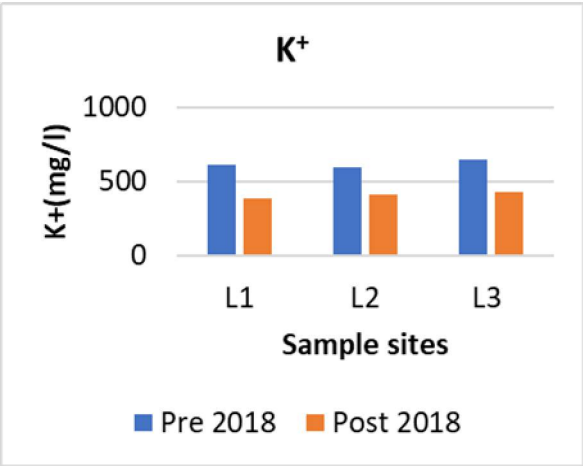
Graph 4: Variations of Ca^{2+} in 2018



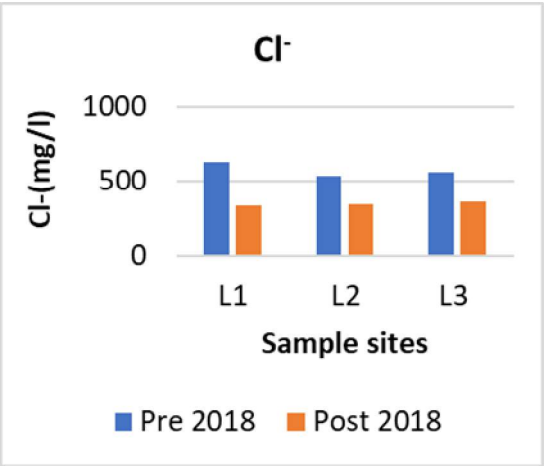
Graph 5: Variations of Mg^{2+} in 2018



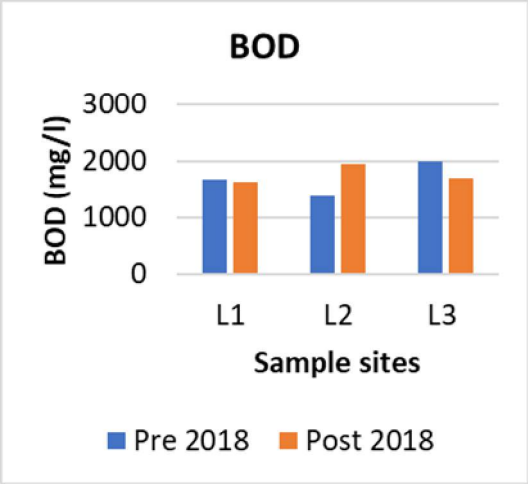
Graph 6: Variations of Na^{+} in 2018



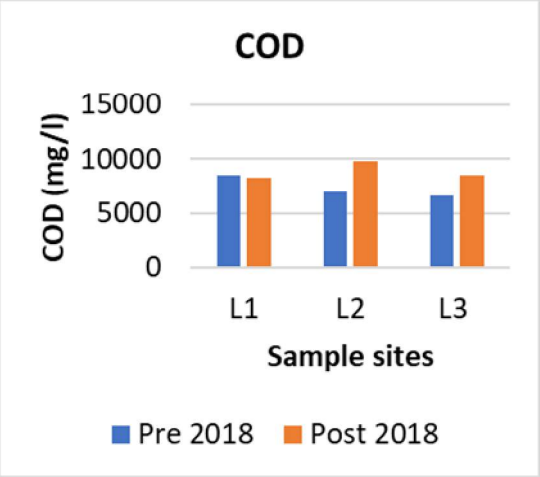
Graph 7: Variations of K^+ in 2018



Graph 8: Variations of Cl^- in 2018



Graph 9: Variations of BOD in 2018



Graph 10: Variations of COD in 2018

pH: The pH graph1 represents pre and post-monsoon 2018 L1, L2, and L3 leachate sample sites. The L3 sample site showed the highest pH value 7.46 and the lowest was in the L2 site (7.19) in pre-monsoon. From the graph 1 highest pH value showed in the L1 sample site (7.5) and the least value of 7.38 was shown in the L2 sample site in post-monsoon.

EC: The variations represented in graph 2 and the pre-monsoon leachate sample site L3 showed the least value, that is 8956µS/cm, and the highest value 9531µS/cm was in the L2 sample site. In the post-monsoon season, the graph showed at the L1 site value was 14271 µS/cm and the least value was 12364µS/cm.

Total Dissolved Solids: The variations of TDS in 2018 are represented in Graph 3. It was observed that the L3 sample site in "post-monsoon" showed the high TDS value 9561mg/l and the least value was in the L1 sample site, that is 8798 mg/l. In the graph pre-monsoon, sample sites were showed the lowest 8798 mg/l in the L1 sample site and highest in L2 sample site TDS as 9561 mg/l. The average TDS values in table 4-5 ranged from 5945 mg/l to 9561 mg/l. The observed levels were much higher than the allowed limits (2100mg/l).

Calcium: The variations of calcium in 2018 are represented in Graph 4. In the pre-monsoon 2018 leachate sample site L1 was showed the least Calcium value 723 mg/l and leachate sample site L2 showed 802 mg/l and from the graph, it was showed the least value 574 mg/l in the L3 sample site and highest value 649 mg/l in the L2 sample site in post-monsoon 2018.

Magnesium: From Graph 5 it was observed in pre-monsoon 2018 leachate sample site L3 showed the least Magnesium value 614 mg/l and leachate sample site L1 showed the highest value 646 mg/l. From the table , it was showed the least value 559 mg/l in the L3 sample site and the highest Magnesium value 597 mg/l in the L1 sample site of post-monsoon 2018.

Sodium: variations of leachate sample sites in 2018 are represented in Graph 6. In pre-monsoon 2018 leachate sample site L3 showed the least Sodium value 274 mg/l and leachate sample site L1 showed the

highest 346 mg/l. From the graph, it was showed post-monsoon 2018 sodium least value 183 mg/l in L3 sample site and highest value 231 mg/l was in L1 sample site.

Potassium: From Graph 7, it was observed that the pre-monsoon 2018 leachate sample site L2 showed the least Potassium value 593 mg/l and the least value 390 mg/l showed the L1 site in post-monsoon 2018.Sodium takes the sixth rank among the elements which are abundantly present in soil and water. Na is present in lesser concentrations than Calcium and Magnesium in freshwater. Potassium is a naturally occurring element with a lower concentration than Calcium, Magnesium, and Sodium. (19).

Nitrates: From the table 5 and 6 it was observed that the minimum and maximum values of NO_3^- were recorded BDL in all the seasons.

Chloride: Variations of leachate sample sites in 2018 are represented in Graph 8. In pre-monsoon 2018 leachate sample site L2 showed the least Chloride value 529 mg/l and leachate sample site L1 showed the highest 625 mg/l and from the graph, it showed the least value (330 mg/l) in the L1 sample site and high value in L3 sample site (359 mg/l) in post-monsoon 2018.

Biological Oxygen Demand: BOD variations of leachate sample sites in 2018 represented in the Graph 4.65. In pre-monsoon 2018 leachate sample site L2 shown least BOD value 1396 mg/l and leachate sample site L3 shown highest 1997 mg/l and from the graph it shown least value (1643 mg/l) in L1 sample site and high value in L2 sample site (1956 mg/l) in post monsoon 2018.All of the recorded values were much higher above the permissible limits (30mg/l), according to the tables. The reason for this is that the organic component in solid waste dissolves over time, seep to the ground with rains, and pollutes the groundwater. Conducted similar studies and reported that the solubilization process produces organic acids, ammonia and carbon dioxide which increases BOD leads to a reduction in pH levels (21).

Chemical Oxygen Demand: From the graph 10, it was observed that COD values of leachate sample site in pre-monsoon 2018 sample site L3 showed the least value 6658 mg/l and leachate sample site L1 showed the highest value 8468 mg/l. From the graph, it showed the least value 8216 mg/l in the L1 sample site and a high value of 9784 mg/l was shown in the L2 sample site of post-monsoon 2018.

DISCUSSION

The samples were slightly alkaline at the time, and the reason for this trend can be attributed to the dump yard's age (there will be comparatively less salt dissolution from solid waste). Because the age of the dump yard affects the pH of the leachate, the younger the age, the more acidic the leachate will be. As grow older, the concentration of free volatile acids decreases due to anaerobic decomposition, resulting in partial ionisation of fatty acids, which leads to increased pH values (14,15). The electrical conductivity of sample is measured in EC. The increased EC values indicate that the salts in the samples were enriched. The pH of the water and the EC will have a direct relationship. The higher the pH, the greater the solubility of salts, resulting in higher EC values. EC is also affected by temperature, salt concentration, and salt type (16). The presence of a huge number of salts in the solid waste could be one of the reasons for the high value observed. (17) Studied leachate characterization and assessment of groundwater pollution near municipal solid waste landfills by taking 4 distinct samples and recording the maximum value as 7070 mg/l, which is similar to our current discussion. Calcium high in leachate can attribute presence of of fly as in municipal solid waste. Na is present in lesser concentrations than Calcium and Magnesium in freshwater. Potassium is a naturally occurring element with a lower concentration than Calcium, Magnesium, and Sodium. (19). Concentrations of Calcium and Magnesium depends on biological activity in dumpsite initially these two cations concentrations will be high as time passes depletion of the values take place leads to an increase in pH, which further leads to poor solubility in the leachate, which encourages precipitation (15).Although the average calcium and magnesium concentrations were 732 mg/l and 172 mg/l, respectively, these were both within intermediate landfill age range (Calcium: 500-2000 mg/l and Magnesium: 500-1000 mg/l) (17). Construction waste was included in the municipal solid waste, which caused in the presence of “Calcium” and “Magnesium” in the leachate (18). All of the Chloride values were recorded much higher above the permissible limits (30mg/l), according to the tables. The reason for this is that the organic component in solid waste dissolves over time, seep to the ground with rains, and pollutes the groundwater. NO_3^- were recorded BDL in all the seasons. The Process of microbial decomposition of organic carbon which is present in the solid waste, influences different processes of nitrogen, which leads to decrease-increase in nitrogen concentration with time (20). According to the literature, new landfill BOD levels varied from 2000 to 30000 mg/l, but old, stabilised landfill records range from 100 to 200 mg/l (22). Different authors found higher levels of leachate in their leachate samples, similar to our current study (23,24,25,26). Contrary to our present study (28) reported that COD values which was 160 mg/l which was just above the permissible value.

CONCLUSION

Leachate samples from dumpyard were collected and analyzed for different physico- chemical parameters to assess its pollution potential. It was found and concluded that leachate samples contain high concentration of constituents (organic and inorganic) beyond the permissible limits. The measured dumpyard leachate samples need an appropriate treatment to reduce the pollutants level prior to discharge. The dump yard age has a significant effect on leachate composition when observed the constituents in leachate. So, management and Indiscriminate dumping of municipal solid waste and without proper solid waste management practices should be stopped or some remedial measures were required to prevent contamination. The dump yard is non-engineered low-lying site. It should be converted as engineered site and should be provided with impermeable liner and drainage system at the base of the dumpyard. So that the leachate will not allow to percolate into sub layers of soil. It will easy to collect leachate sample at the base and treatment purpose.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of the manuscript.

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