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Ecological Study on Characterization Of Leachate at Ibb Landfill Using Physicochemical and Biological Analysis

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Abstract

Yemen is one of the developing countries suffering from water pollution. Landfill is one of the sources of water pollution. A study of composition of landfill leachate was conducted at Ibb landfill, located at Al-Sahool area, north of Ibb City, Yemen. The leachate was sampled at five different landfill locations during dry season, due to the excessive generation of leachate during this season. The physico-chemical characteristic of leachate, such as pH, temperature, EC, TDS, DO were measured in-situ. Also, biological parameters such as COD and BOD_5, major anions and nitrogenous compound such as Cl, SO_4, NO_2, NO_3, NH_3-N, major cations (Na, Mg, Ca, K, Fe) and heavy metals (Pb, Zn, Ni, Cr, Cd, Cu) were analysed in the laboratory. The results showed that, the leachate from Ibb landfill is in methanogenic phase. The first leachate site at Al-Sahool area was characterized by the highest values of most physico-chemical parameters. However, the quantitative results of most studied parameters were generally decreased towards downstream sites (1-5). The BOD_5/COD value of 0.1 to 0.7 obtained for leachate suggested the partially stabilization. The concentrations of heavy metals were found in relatively high levels (except Cu). Therefore, a leachate collection pond should be built to collect and treat the leachate to prevent further contamination as well as build more sanitary landfill facilities in Al-Sahool area to prevent further ecological contamination and keep public health safer.

Keywords: *Ibb landfill*, *pollution leachate*, *heavy metals*

Streszczenie

Badania właściwości odcieku ze składowiska IBB za pomocą analiz biologicznych oraz fizykochemicznych

Jemen jest jednym z krajów, które borykają się z zanieczyszczeniem wód. Składowiska odpadów są jednym ze źródeł zanieczyszczeń wód. Celem pracy jest badanie właściwości oraz charakterystyka odcieku ze składowiska zlokalizowanego w mieście Al-sahool, w północnej części województwa IBB w Republice Jemenu. Próbki przeznaczone do badań pobrano z pięciu różnych lokalizacji na ww. składowisku. Próbki odcieku zebrano podczas pory suchej, ze względu na nadmierną ilość wytwarzania odcieków w tym sezonie. Właściwości fizykochemiczne takie jak pH, temperatura, przewodnictwo elektryczne właściwe (PE), suma substancji rozpuszczonych (SSR), rozpuszczony tlen (RT) zbadano na miejscu. Parametry biologiczne takie jak chemiczne zapotrzebowanie tlenu (ChZT), biologiczne zapotrzebowanie na tlen (BZT), główne aniony takie jak chlorek (Cl), siarczan (SO_4) oraz azotowe związki takie jak azotyny (NO_2), azotany (NO_3), amoniak (NH3-N), główne kationy (Na, Mg, Ca, K, Fe) oraz metale ciężkie (Pb, Zn, Ni, Cr, Cd, Cu) analizowano w wojewódzkim laboratorium Wody i Służby Sanitarnej, IBB. Wyniki przeprowadzonych badań wykazały, iż badane odcieki są w metagonicznej fazie. Odcieki z pierwszej lokalizacji charakteryzują się najwyższymi wartościami głównych parametrów fizykochemicznych. Natomiast wyniki ilościowe większości badanych parametrów na ogół miały tendencję spadkową w kierunku lokalizacji (1-5). Wartości (BZT)/ (ChZT) od 0,1 do 0,7 otrzymano dla odcieku częściowo stabilizowanego. Koncentracja metali ciężkich była na wysokim poziomie (oprócz Cu). Wyniki badań rekomendują, że budowa basenu do gromadzenia ścieków, budowa sanitarnego składowiska jest bardzo potrzebna aby ochronić przed zanieczyszczeniami ekologicznymi.

Słowa kluczowe: *Ibb składowisko, zanieczyszczenia odciekami*, *metale ciężkie*

1. Introduction

Pollution occurs when a product added to our natural environment adversely affects nature's ability to dispose it. There are many types of pollution such as air pollution, soil pollution, water pollution, nuclear pollution and oil pollution. A pollutant is something which adversely interferes with health, comfort, property or environment of the people. Generally, most pollutants are introduced in the environment as sewage, waste, accidental discharge and as compounds used to protect plants and animals [1].Open dumps are the oldest and the most common way of disposing of solid wastes, and although in recent years thousands have been closed, many are still being used. In many cases, they are located wherever land is available, without regard to safety, health hazard and aesthetic degradation. The waste is often piled as high as equipment allows. In some instances, the refuse was ignited and allowed to burn. In others, the refuse was periodically leveled and compacted. As a general rule, open dumps tend to create a nuisance by being unsightly, breeding pests, creating a health hazard, polluting the air and sometimes polluting groundwater and surface water. Landfill is an engineered waste disposal site facility with specific pollution control technologies designed to minimize potential impacts. Landfills are usually either placed above ground or contained within quarries and pits Landfills are sources of groundwater and soil pollution due to the production of leachate and its migration through refuse [2]. Municipal solid waste did not pose a significant problem until human established settlements near landfill. Prior to that, the types and quantities of waste were readily degraded or consumed by animals or naturally degraded without causing significant impact to the environment [3]. Leachate pollution is the result of a mass transfer process. Waste entering landfill undergoes biological, chemical and physical transformations which are controlled, among other influencing factors, by water input fluxes. In the landfill three physical phases are present: the solid phase (waste), the liquid phase (leachate), and the gas phase. The liquid phase is enriched by solubilized or suspended organic matter and inorganic ions from the solid phase. In the gas phase mainly carbon (prevalently in the form of CO_2 and CH_4) is present.

2. Materials and methods

2.1. Study area and topography

Ibb city is located between Taiz and Dhmar governorates (Figure 1). It is about 193km from Sana'a, the capital of Yemen, and the area is about 5383 km^2. Ibb city is located at latitude 13°58′48″ and longitude 44°10′48″.

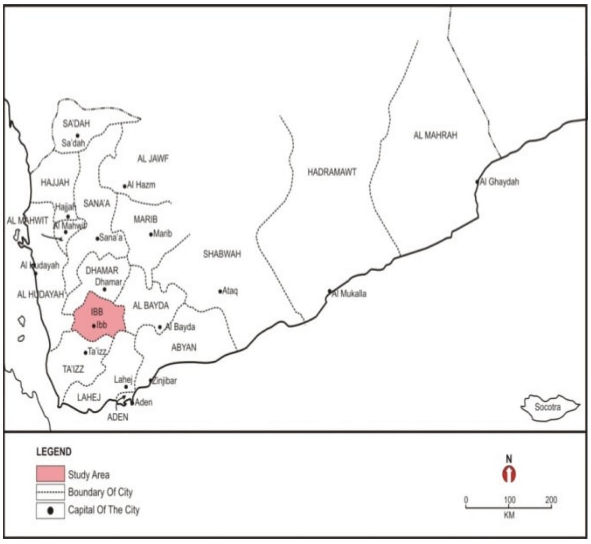

Fig.1. Location of Ibb city

Ibb city is located in the southern highlands of Yemen and is situated between two watersheds of the so-called southern and western highlands. In addition to the considerable tectonic displacements, the relief of Ibb city is highly controlled by lithologic characteristics of the different layers. The topographic map of Ibb city is given in Figure 2. The varying resistances against weathering and erosion, which depend upon the mineralogical composition of such layers, have given an accentuated relief. The relief changes abruptly from the high plateaus with steep slopes to the deep valleys with wide deposits. The amount of vertical displacement varies from one horst to another and in many cases it is more than 3km [4].

Fig. 2. Topographical map of Ibb city

Ibb landfill is an open dump is located in Al Sahool area with an area of 0.8 km^2. It is a fertile agricultural area, and there are plantations surrounding the site, such as quality corn and coffee plantations to the south of the site. Five different sites of leachate collection points (Figure 3) were selected in and around Ibb landfill. Glass bottles were used to collect leachate samples for chemical analyses, whereas, samples preserved for BOD_5 and COD tests were collected in polyethylene bottles covered with aluminum foils. A few drops of concentrated nitric acid were added to all the leachate samples collected for heavy metals analysis to preserve the samples. The samples were then transported in a cool box and stored under suitable temperature until analysis.

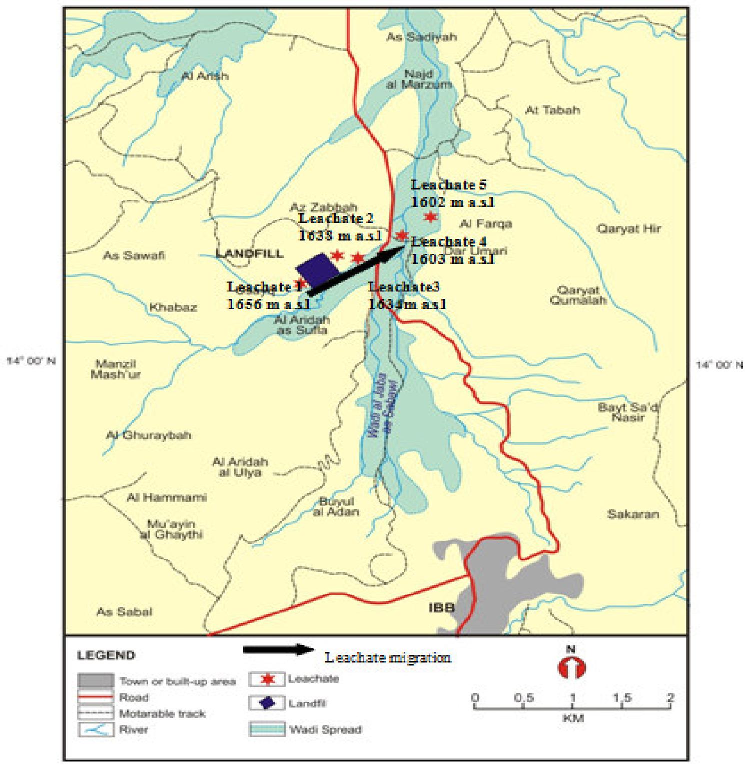

Fig. 3. locations of Ibb landfill and leachate (L1, L2, L3, L4 and L5) sites

2.2. In-situ measurements

In-situ parameters that are measured include pH, temperature by using pH meter model 3071, UK. Dissolved Oxygen (DO) was measured by using DO meter model 9071, UK. Electrical conductivity (EC) is measured by using EC HACH meter model LF91 in microsiemen per cm (µS/cm), whereas, total dissolved solid (TDS) is measured by using the factor 0.65 multiplied by the EC reading [5]. The reading is performed in triplicate and the average is recorded.

2.3. Laboratory measurements

Biochemical Oxygen Demand (BOD) is a test conducted at 20 ºC (68 ºF) within a controlled environment. The test measures the amount of oxygen consumed by bacteria oxidizing organic matter in a water sample. BOD Trak HACH was used for determining the BOD_5.The chemical oxygen demand is measured by the Portable Data logging Spectrophotometer HACH DR/4000. 2 ml from water was transferred into the sample cell which contains the chemical material for COD analysis. 2 ml from distilled water was placed into another sample cell. Both sample cells

were placed in COD reactor for two hours at 150ºC. Then the cells left at room temperature until be cooled. The reading was performed in triplicate and the average is recorded. Fluoride (F^-) was measured by using Portable Data logging Spectrophotometer HACH DR/4000 Method 8029 (SPADNS Method). Chloride was measured by the Mercuric Nitrate Titrimetric Method. 25ml of water samples was placed in Erlenmeyer flask, and then Diphenylcarbazone regent was added to the sample. The solution was blue-green, when the Mercuric Nitrate was added as a titrant, the solution was turned from blue-green to purple, and making the end point of the titrant [5].

$$Cl = \frac{M \cdot M.W_t \cdot 1000 \cdot \text{Number of ml of Hg } (NO_3)_2}{V} \qquad (2.3.1)$$

where,

M = 0.1

Wt = atomic weight of Cl which equal 35.5

V = volume of water sample

Sulphate was measured by the Portable Datalogging Spectrophotometer HACH DR/4000 using SulfaVer 4 Method (Method 8051). Nitrate was measured by the Portable Datalogging Spectrophotometer HACH DR/4000 using Cadmium Reduction Method (Method 8039). The method for Nitrite measurement was Diazotization Method (Method 8507) using Portable Datalogging Spectrophotometer HACH DR/4000. Ammonia was measured by the Portable Datalogging Spectrophotometer HACH DR/4000 using Nessler Method (Method 8038). For Iron measurement by the Portable Datalogging Spectrophotometer HACH R/4000 the method was FerroVer Method (Method 8008). Calcium was measured by the (EDTA) titrimetric methods which involves the use of solutions of ethylene diamintitra acetic acid. 25ml of water sample was placed in a conical flask, and then 2ml of buffer solution was added to the sample. Man Ver 2 Calcium indicator was also added to the sample. The solution was wine red, when EDTA was added as a titrant, the solution was turned from wine red to blue, making the end point of the titrant. The equation below gives the calculation of calcium [5].

$$Calcium = \frac{M \cdot W_t \cdot 1000 \cdot 40 \cdot \text{Number of ml of EDTA}}{V} \qquad (2.3.2)$$

where,

M = 0.05

Wt = atomic weight of Ca which equal 40

V = volume of water sample

Magnesium was measured by calculation as the difference between the total of hardness and the calcium hardness as follows:

$$Total\ Hardness\ (as\ CaCO_3) = 2.497\ [Ca^{2+}, mg/L] + 4.118\ [Mg^{2+}, mg/L]$$

Then:

$4.118\,[Mg^{2+}, mg/L = Total\ Hardness\ (as\ CaCO_3) - 2.497\,[Ca^{2+}, mg/L]$ [5].

Flame photometer (PFP 7) is a low temperature, single channel emission flame photometer and has been designed for the routine determination of sodium (Na), potassium (K) and calcium (Ca). It is a direct reading digital instrument.

The laboratory of Ibb Water and Sanitation Local Corporation (IWSLC) is used for analyzing of leachate samples. Also, the department of chemistry was used for preparing and analyzing of heavy metals by using Atomic Absorption Spectrophotometer (AAS).

2.4. Statically analysis

The analyses were subjected to statistical analysis. The quantative results were expressed as means ± S.D. Differences between means were tested using one-way analysis of variance (ANOVA) followed by the student-Newman- keuls t-test.

3. Results and discussion

3.1. In-situ parameters

The in-situ parameters results which including pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), and dissolved oxygen (DO) are given in Figure 4, 5 and 6. For pH values, there was not significant difference between all leachate studied sites. The highest mean value of pH is obtained at site two, whereas the lowest mean value of pH is obtained at site three as given in Figure 3. There is a general consensus that the lower pH cluster represents the acid producing phase and the upper cluster represents the methanogenic phase [6]. According to [7], the pH value >7 is normally encountered at landfill 10 years after operation. Since the pH value tolerated by methanogenic bacteria is usually in the range of 6-8, the leachate is characterized by almost neutral pH values at the methanogenic stage [8].This indicates that the leachate samples are at the stages of methanogenic phase. The results from this study are within the standard acceptable levels 6.5-8.4 which required for treated wastewater discharge determined by Yemen’s Ministry of Water and Environment [9].

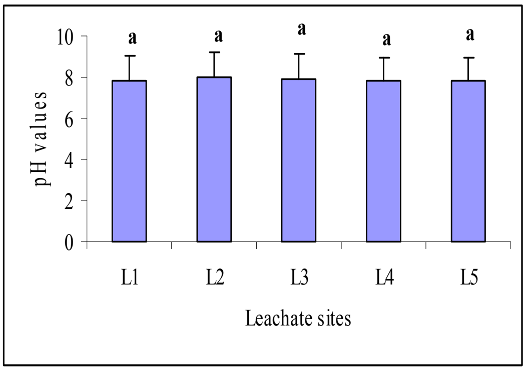

Fig. 4. Mean values of pH in the leachate sites. Leachates with same letters do not differ significantly

The results of Electrical Conductivity (EC) and total dissolved solids (TDS) are presented in Figure 5. Statically, there were a significant differences ($p<0.01$) between all leachate studied sites. Higher mean values of EC and TDS are obtained at site two; whereas the lower mean values are obtained at site four. These results are higher than those of [10] regarding EC (4970 µS/cm) and TDS (3231 mg/l) at the same area. [11] Mentioned that, the EC is a valuable indicator of the amount of material dissolved in water whereas, [12] mentioned that, the high values of EC can be attributed to the high levels of the various anions. According to [13], between 500 and 1000 mg/l TDS in irrigation water can affect sensitive plants. At 1000 to 2000 mg/l TDS levels can affect many crops and careful management practices should be followed. [11] Mentioned that, the EC is a valuable indicator of the amount of material dissolved in water whereas [12] mentioned that, the high values of EC can be attributed to the high levels of the various anions. These values are not within the standard range of 0.7 to 4 µS/cm for EC and are not within the standard range of 450-2000 set by [9] and [14] which required for irrigation purpose. In general, the EC and TDS results in the present study indicate the large content of soluble ions particularly inorganic.

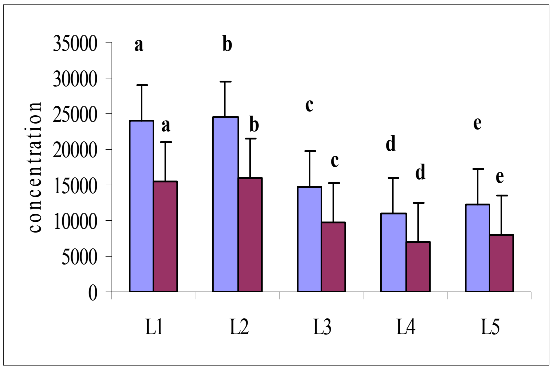

Fig. 5. Mean values of EC and TDS in the leachate sites. Leachates with different letters differ significantly

For dissolved oxygen (DO), there was a statically difference between the studied leachate sites ($p<0.01$). Also, there was not statically difference appear between site one, two, four and five. The anaerobic microbial activities within this landfill could be the preferable reason caused by the depletion of DO. This assumption has been asserted by results obtained by [15] in [16] who confirmed that in landfill leachate, highly reducing conditions and low DO concentrations are typically found because of anaerobic microbial activity. It can be said that, the variations in concentrations of the above in-situ parameters can be attributed to the age of the landfill, types of waste, precipitation, the composition of leachate.

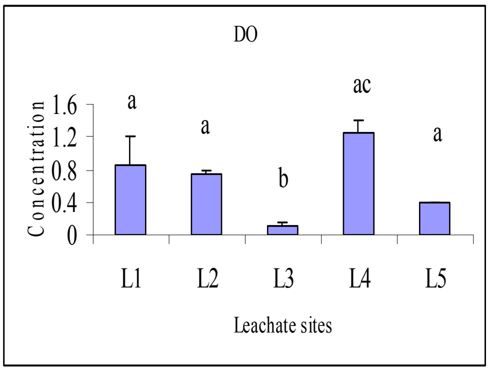

Fig. 6. Mean values of DO in the leachate sites. Leachates with same letters do not differ significantly, while Leachates with different letters differ significantly.

The leachate maturity indicator includes BOD_5 and COD show statically significant difference ($P<0.01$) between all leachate sites as given in Figure 6. The first leachate site has recorded the greatest content of BOD_5, whereas the lowest content is measured in the five site. On the other hand, the greatest COD content value is measured in the second site, whereas the lowest content value is measured in the fourth site. These results are higher than results (2030 mg/l for BOD_5 and 1986 mg/l for COD), that obtained by [10]. With the age of the landfills, the processes of the biological degradation of organic substances slow down and the susceptibility of leachates to biological degradation declines. In fact, leachates from old deposition sites are characterized by smaller BOD_5 and COD values of the order of several hundred to several thousand mg/l [17]. The BOD_5 and COD values are in general within the normal range of municipal landfill leachate which are reported by [18 & 19]. The high values of these indicators suggested the stability of microbial activity at the presence of high BOD_5 and COD indicates the high organic strength.

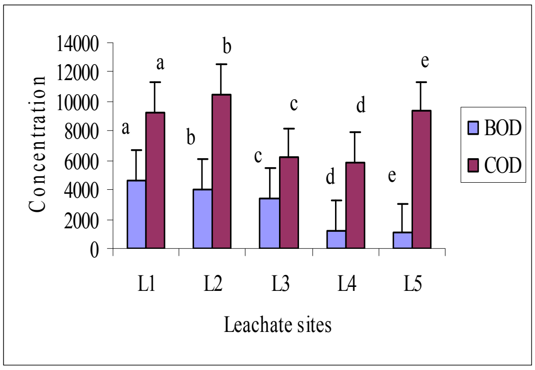

Fig. 7. Mean values of BOD_5 and COD in the leachate sites. Leachates with different letters differ significantly

In general, BOD_5 and COD contents for the leachate exceeded the standard limit of 150 mg/l and 500 mg/l respectively for the treated wastewater discharge determined by Yemen's Ministry of Water and Environment [9]. The BOD_5 /COD ratios show statically significant difference ($P<0.01$) between all leachate sites. The BOD_5 /COD ratios range between 0.1 mg/l to 0.6 mg/l which were calculated for leachate correspond to stable of the leachate. The ratio BOD_5 to COD indicates the degree of biodegradability of the leachate and provides indications regarding the age of a landfill and about biochemical alterations within the landfill [20]. [21] in [16] categorize the stability of landfill according to the leachate BOD_5 /COD ratio as shown in Table 1. The BOD_5/COD ratio decreases as the age of the landfills increases [8].

Table 1. BOD_5 /COD ratio as key parameter for landfill leachate, Source: [21]

BOD_5 /COD ratio	Rank
> 0.50	Young, unstable
0.10 – 0.50	Partially stable
< 0.10	Old, stable

It can be said that, leachate in Ibb landfill is located in the second category which is partially stable. In the initial stage of the landfill BOD_5 /COD ratio is high and decreased with the increasing of the landfill.

3.2. Major anions and nitrogenous compounds

Major anions and nitrogenous compounds include chloride (Cl^-), sulfate (SO_4^{-2}), nitrites (NO_2^-), nitrates (NO_3^-), and ammonia-N (NH_3-N). The concentrations of Cl were statically significant difference between all studied sites. The first leachate site showed the highest concentration (4955 mg/l), while the fourth site showed the lowest concentration (3163 mg/l). [10] Studied leachate characteristics of Ibb landfill. He found Cl concentration of 3727 mg/l. It can be said that, this result in a good agreement with the results of the present study. [22], found a typical concentration range from 100 to 2000 mg/l from municipal landfill leachate in a study based on 83 landfills. Cl is a conservative contaminant and is not affected either by the biochemical processes taking place in the landfill body or by the natural decontamination reactions in which the leachates are involved during their penetration in the vadose zone. Therefore the chlorides constitute a serious threat for the aquifer of the area [12].

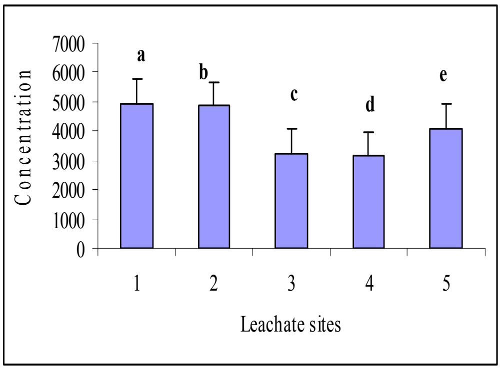

Fig. 8. Mean values of chloride (Cl^-) in the leachate sites. Leachates with different letters differ significantly

There was a statically difference in the concentration of SO_4 between the studied leachate sites ($p<0.01$). Also, there was not statically difference appear between site four and three. The highest concentration is measured in the site two, while the lowest concentration is measured in the forth site. These results are higher than those of [10] regarding SO_4 (294.67 mg/l) at the same area.

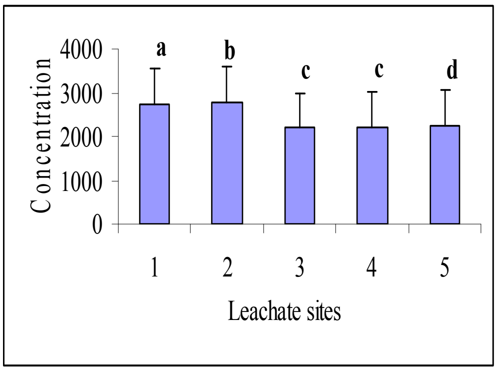

Fig. 9. Mean values of SO_4 in the leachate sites. Leachates with different letters differ significantly, while Leachates with same letters do not differ significantly.

Statically, there was not significantly difference between site four and five in the results obtained for NO_2. On the other hand, there were significantly differences between the other leachate sites as shown in Figure 10. The results of NO_3 showed not significant difference between site one, two and four. Also, results of NO_3 showed significant difference between the other sites as given in Figure 10. The result of leachate from the first site was characterized by high levels of nitrogenous compounds concentrations in terms of ammonia-N as shown in figure 11. The results of ammonia-N (1199.59 mg/l) that obtained by [10] are lower than the results of the present study. The ammonia range was considered to be in high concentration due to the anaerobic conditions that prevailed in the landfill which in return contributed to nitrate reduction towards ammonia gas phase [12].

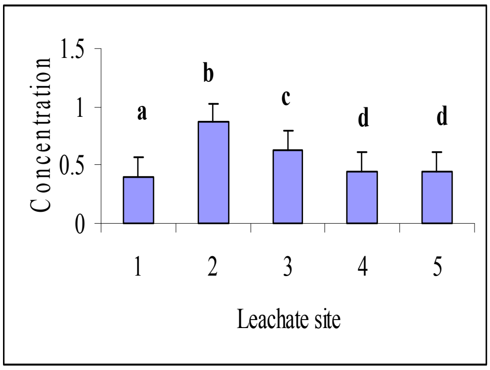

Fig. 10. Mean values of NO_2 in the leachate sites Leachates with different letters differ significantly, while Leachates with same letters do not differ significantly.

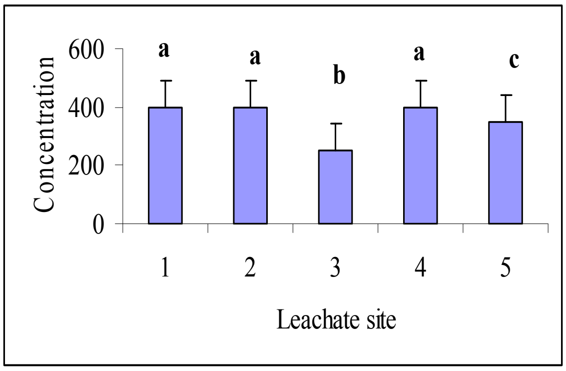

Fig. 11. Mean values of NO_3 in the leachate sites. Leachates with different letters differ significantly, while Leachates with same letters do not differ significantly.

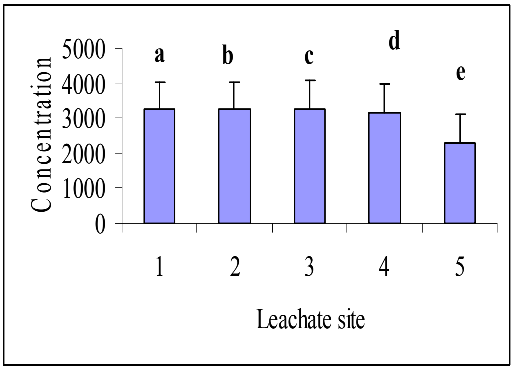

Fig. 12. Mean values of ammonia-N in the leachate sites. Leachates with different letters differ significantly.

[22] in his study found 600 mg/l of ammonia concentration, whereas [8] found 2000 mg/l of ammonia concentration. [23] in [16] reported that, leachate from landfills are often rich in ammonia-N due to the hydrolysis and fermentation whereas the decrease in concentration was mainly attributed to the leachate washout. These high concentrations are very toxic to the microorganisms that are responsible for the anaerobic processes. This may indicates the occurrence of extensive anaerobic bacterial activities because of proper landfill operation and efficient leachate collection system. This assumption was supported by the fact that in water ammonium ion (NH_4) is transformed into ammonia (NH_3) through the following reaction:

$NH_4 \rightarrow NH_3 + H^+$, or

$NH_4OH \rightarrow NH_3 + H_2O$. [24]

The unconverted ions of ammonia (NH_3^+) as well as ammonium (NH_4^+) are oxidized in anoxic conditions to nitrite by denitrifying bacterial activities. On the other hand, nitrite is oxidized into nitrate which can be quickly assimilated by plants or otherwise reduced again to nitrite and NH_3^+ [24].

3.3 Major cations

The major cations include Fe, Na, K, Ca, and Mg. Among all cations analyzed, Fe showed the lowest concentration in studied leachate sites, whereas Na showed the highest concentration of these cations. The concentrations of Fe for leachate showed significantly differences and exhibited range values between 3.424 and 13.340 mg/l. The low level of Fe in the leachate sites compared to the high level (45.87 mg/l) that obtained by [10] indicate the good sorting of iron components before dumped the waste in the landfill. The dark brown color of the leachate is mainly attributed to the oxidation of ferrous to ferric form and the formation of ferric hydroxide colloids and complexes with fulvic/ humic substance [11].

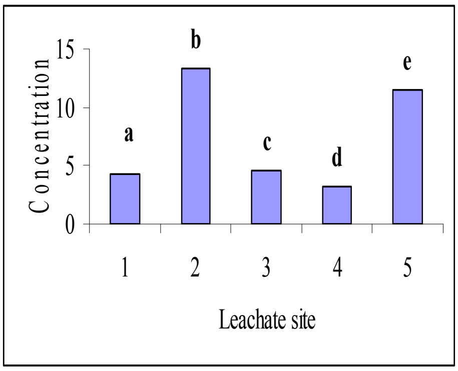

Fig. 13. Mean values of Fe in the leachate sites Leachates with different letters differ significantly

The mean values of Na were significantly difference between leachate sites. Also, there was not significantly difference between site one, four and five. On the other hand, the mean values of K were significantly difference between leachate sites. Also, there was not significantly difference between site one-five and three –four.

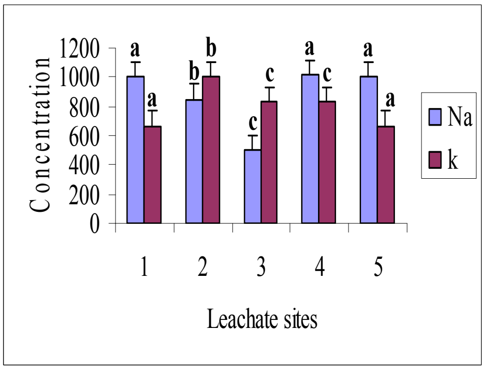

Fig. 14. Mean values of Na and K in the leachate sites. Leachates with different letters differ significantly, while Leachates with same letters do not differ significantly.

The distribution of Ca showed significantly difference values between all leachate studied sites as given in Figure 15. These results are lower than those of [10] regarding Ca (1400 mg/l) at the same area. On the other hand, the concentrations of Mg are varied between all sites. The result that obtained by [10] regarding Mg (212 mg/l) is in a good agreement with the results of the present study. [25] Mentioned that, calcium is naturally present in water. It may dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. Calcium is a determinant of water hardness, because it can be found in water as Ca^{2+} ions. Calcium is present in various construction materials, such as cement, brick lime and concrete. It is present in batteries, and is applied in plaster as calcium sulphate. Calcium may negatively influence toxicity of other compounds. Elements such as copper, lead and zinc are much more toxic in soft water. Multivalent cations, particularly Ca^{2+} and Mg^{2+} are often present at a significant concentration in natural waters. These ions are easily precipitated and in particular react with soap to make it difficult to remove scum. Ca^{2+} and Mg^{2+} are the important parameters for total hardness. The excess of Ca^{2+} causes concretions in the body such as kidney or bladder stones and irritation in urinary passages [11]. It can be said that, the variations in concentrations of the above major cations can be attributed to the age of the landfill, types of waste, precipitation, the composition of leachate.

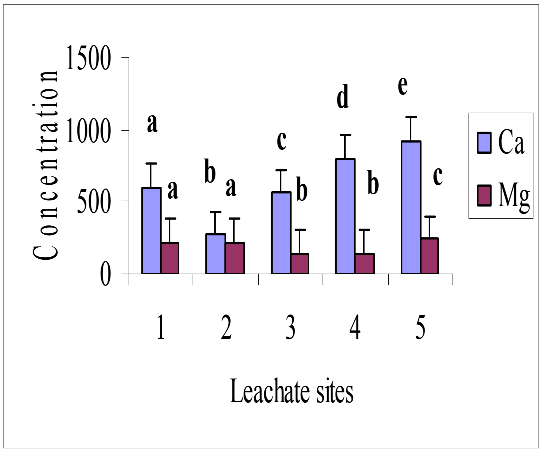

Fig. 15. Mean values of Ca and Mg in the leachate sites. Leachates with different letters differ significantly, while Leachates with same letters do not differ significantly.

3.4. Heavy metals

The heavy metals examined in this study were lead (Pb), zinc (Zn), nickel (Ni), chromium (Cr), cadmium (Cd), and copper (Cu) as shown in Figure 16, 17 and 18. Among all the trace elements analyzed, Cr showed the highest content followed by Ni, whereas Cu showed the lowest content followed by Cd content. From statically analysis, the concentrations of Cu and Cd appeared significantly differences between studied sites. On the other hand, the maximum concentrations of all trace elements are found at the first leachate site. Generally, the concentrations of the metals (except Zn and Cu) were relatively high compared with those obtained by [10]. The presence of Pb in the leachate samples indicates the disposal of Pb batteries, chemicals for photograph processing, Pb-based paints and pipes at the landfill site; whereas the presence of Zn in the leachate shows that the landfill receives waste from batteries and fluorescent lamps. Cr, Cu and Ni were also present in the leachate samples. A variety of waste is dumped at Ibb landfill site, which likely indicate the origin of Zn, Pb, Cr, Cu and Ni in leachate. [3] mentioned that, Heavy metals, especially Cd, Cu, Pb, Sn, and Zn, are dispersed into the environment in leachate from landfills, which pollute soils and groundwater. It can be said that, the concentration of most heavy metals in leachate at the present study is found in high concentrations so that this leachate will constitute a groundwater pollution problem at landfill.

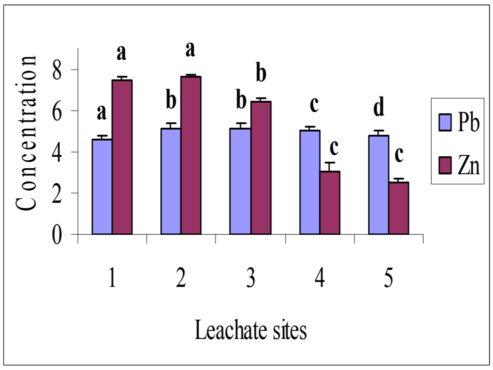

Fig. 16. Mean values of Pb and Zn in the leachate sites. Leachates s with different letters differ significantly, while Leachates with same letters do not differ significantly.

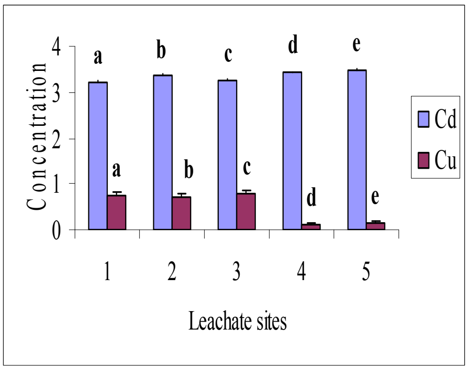

Fig. 17 Mean values of Cd and Cu in the leachate sites. Leachates with different letters differ significantly.

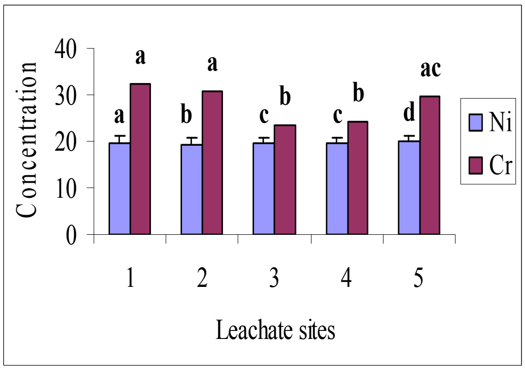

Fig. 18. Mean values of Ni and Cr in the leachate sites. Leachates with different letters differ significantly, while Leachates with same letters do not differ significantly.

4. Conclusion

From the study which carried out at Ibb landfill area, it can be concluded as follow: the landfill is found to be in its methanogenic phase, due to low acid content in the leachate. During the methanogenic stage the pH appeared to be neutral to alkaline. Based on parameters such as BOD_5, COD and BOD_5/COD, the age of landfill corresponding to stabilization stage that has a significant affect on leachate charactertics and composition. Thus the BOD_5/COD value of 0.1-0.7 obtained for leachates suggested the partially stabilization of the landfill. The leachate from the first site, which is located upstream of the landfill, is characterized by the highest values of most physico-chemical parameters. According to the topography of Ibb landfill (which is located on a hilly area with an elevation 1660m a.s.l), it is clear that migration of leachate is towards to the northeast (downstream sites) due to this site is the lowest elevation (1602m a.s.l) at this area. This leachate will pollute the surround groundwater, surface water and soil. It can be said that, the variations in concentrations of the physico-chemical parameters can be attributed to the age of the landfill, types of waste, precipitation, the composition of leachate. Beside that, it can be said, there is a good sorting in the waste before dumped it directly to the landfill.

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