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Research Article

Quantitative Assessment of Heavy Metals and bacterial Contamination in Soil: A Comprehensive Study on Estimation Methods and Environmental Impli

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ABSTRACT

This study aimed to Quantitative Assessment of Heavy Metals and bacterial Contamination in Soil. Fifteen soil samples have been taken at a depth of the first 30 cm of soil for each of the land-use types using a stainless-steel spatula from each of the source area (Ramadi City). For the land-use activity of the residential lands, six samples whereas for land-use activity of industrial lands was for gathers nine samples. These selected soil samples were now ready to study by the XRF for its scientific analyze for the trace elements. The Enrichment Factor (EF) was used to assess the level of contamination in the soils. One gram of each soil sample got weighed and diluted in nine milliliters of distal water. Every subsequent decimal notation until the ninth dilution was re-diluted by a dilution factor of 1:10. At every dilution step, MacConkey agar was seeded. After incubation for three days at temperatures 37 ´C, the bacterial colonies generated were sub-cultured on nutrient agar medium thereafter, and were diagnostically retrieved. Vitek was used for identification of bacteria. The current study indicates that pH measurement for the soil in the neighborhood ranges between 7.5 to 9.3, for residential soils, while industrial regions are in the mildly acidic to moderately alkaline range of 5.4–8.2. The high levels of pollution are reflected in the considerable enrichment factor values for trace metals including lead, nickel, and zinc. In contrast, elements like manganese showed low levels of contamination due to deficiency or little enrichment, whereas metals like copper, and chromium showed moderate levels of pollution in the research region's industrial area. The results of bacterial isolation indicated that among the soils of Iraq, the most common species isolated was Enterobacter spp., which accounted for 34% of the total. Second on the list was Pseudomonas aeruginosa with a 25% share, followed by Proteus spp. with 18%, Aeromonas spp. with around 13%, Burkholderia spp. with about 2.65%, and finally E. coli with 5%.

In conclusion, according to the enrichment factor, Pb was found to be much more abundant in soil samples from industrial areas, whereas Nickel was found to be significantly more abundant in residential areas due to the buildup of household waste and oil combustion. The research also found that the most common G -ve bacteria were Enterobacter spp. and Pseudomonas spp.

Keywords: Bacteria, Soil, heavy metals, contamination

INTRODUCTION

Li (1) defines this as ‘environmental pollution’, that is, any change in an area or element, be it physical, chemical or biological, caused by substances that previously did not exist in the area or have never existed before, or whose concentrations in soils, air or

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water, in any case, exceed the natural contents. As a result of these changes, Ecology and productivity are affected. Pollution of soil and water is one of the fastest growing environmental problems. There are various causes of environmental pollution. Chemical fertilisers and pesticides used in farming, factory emissions and garbage, municipal and industrial garbage are the primary sources of pollution of soil and water (2). Pollution is an age-old problem that is getting worse and worse. The reason for its growth is poor preparation for industrialization. Industrialized countries might give the impression that pollution is not a big issue (3).

It had been considered that soil is a resting place for human faeces (4,5). It is a complex, alive, changing and dynamic ecosystem, which can be contaminated by human disturbance (6). Heavy metals are the most dangerous contributors because they do not biodegrade in the environment (6). Industry, tyres, municipal solid waste, and brake and engine wear, corrosion, oil leaks, and settlement of dust and airborne particles are some of possible sources of the heavy metals reaching urban soils (7). Atmospheric precipitation from combustion of fuel, wood, petrol, diesel, animal manure, sewerage, industrial lubricants, domestic waste oils, as well as other organic wastes are major causes for the pollution of soil with trace elements (8). Paper, incomplete combustion products, coal fly ash, as well as wood ash are common industrial and urban waste products; lime, fertilisers and pesticides are agricultural inputs; and generators are domestic uses producing air pollution. The city soil is one of the components of the city ecology (9,10). Lead (Pb) is on the top of essential List to be removed from the ground (11), as leading is the most widely used of numerous heavy metals entering the environment (7). Three major products lead is used in are batteries, pet of heavy metals in the soil and sediment is by atmospheric deposition, biological absorption, physic-chemical adsorption, as well as accumulation (12). Due to their important pollutants of the environment that has been present since ages (13). Heavy metals including lead (Pb), copper (Cu), nickel (Ni), chromium (Cr), iron (Fe), manganese (Mn), and cadmium (Cd) are the products of automobiles parts, lubricants, and industrial and incinerator emissions (14). Their concentrations in the environment are unstable and varying due to industrial output, urbanisation, lubricants, and emissions from industries and incinerators (15). A study of these important soil targeted heavy metals is gaining popularity for their geographical distribution in soil and relationships with the factors such as land use, parent material, as well as other human activities (8). These metals may gather them in vegetation and fauna to be passed to people through the food chain (16).

Specifically, soil microbes are a critical component of nutrient-cycling processes, without which Earth would not be habitable (17). Soils contain a great variety of microbes, but – in terms of quantity and variety – no life-form is as abundant or diverse as bacterial populations in the soil (18). The transformation of soil nutrients and organic matter and most of the soil activities are being carried out by bacteria and other soil microbes (19).

A major factor altering their activity is the soil physicochemical processes and ecological interactions. Agricultural soils have been long applied with beneficial bacteria that can enhance plant health and function, and microorganisms also orchestrate biogeochemical cycles. It is interactions between plant and microbe in the rhizosphere, the narrow zone of soil surrounding the roots of plants, that governs plant health and soil fertility. Plant growth promoting rhizobacteria (PGPR), by colonising roots and releasing compounds that enhance plant growth, could promote plant development. Plant growth promotion rhizobacteria (PGPR) rhizobacteria (rhizo- for root; -bacteria for bacteria) promote plant function and are also called PHPR and NPR (20).

The interaction between plants and microbes in the rhizosphere is a key biological hotspot in soils. Bacteria from soil have the largest collection of antibiotic-resistant genes. With few exceptions, most research has revealed that once viruses became less virulent, they could evolve resistance genes from naturally occurring bacteria through horizontal gene transfer in fast timescales (21-23). These days, people are more interested in where the genes for antibiotic resistance in bacteria come from and how resistance can enter healthcare settings from the environment (24-26).

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Selection for resistance is present all the time amongst soil microbes and elsewhere in nature, but it's the sheer volume of antibiotics used and the resulting washout into the environment that immediately places a radically new and overwhelming value on selection pressures (27).

This study aimed to Quantitative Assessment of Heavy Metals and bacterial Contamination in Soil.

METERIALS AND METHODS

GEOLOGICAL STUDY AREA

The provincial capital of Anbar, Ramadi, is situated on the borders of Jordan, Syria, and Saudi Arabia in the arid areas of Iraq. Fig. 1 displays Ramadi City's geographic location. Ramadi City, home to around 270,000 people, is a fairly urbanized region with a large number of small industries.

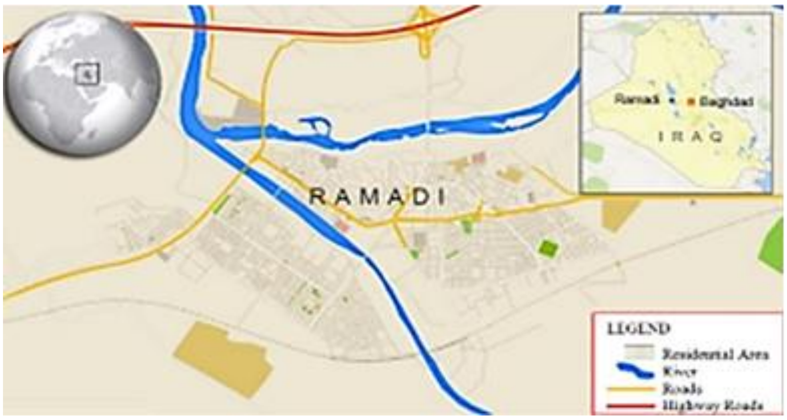

Fig. 1. Geographical location of Ramadi city

SAMPLING

Fifteen soil samples have been taken at a depth of the first 30 cm of soil for each of the land-use types using a stainless-steel spatula from each of the source area (Ramadi City). For the land-use activity of the residential lands, six samples whereas for land-use activity of industrial lands was for gathers nine samples. The debris was broken with a porcelain pestle and mortar, and left for air drying in the laboratory circulation oven in 30 °C, homogenised, and sieved with 2 mm polyethylene sieve to remove great debris, stones or pebbles to make them fit for further analysis (17). After that, the samples placed in sterile and self-sealing plastic bags for further analysis.

pH TEST

The pH of soil sample was found out the acidic of sediments by pellet. which the soil sample is mix with 250 ml distilled water it converts into the suspension solution. After it 100 ml of suspended it, solution is taken and then 50 ml of pellet is added in pH meter and the pH solution will be change the color the find out the color and the pH of the solution is determined and compared to conventional pH values.

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HEAVY METALS TESTS

These soil samples were now ready to study by the XRF for its scientific analyze for the trace elements. This method will detect the chemical element composition of samples after it being powdered which to be assess by the XRF. An XRF analyzed was created using Fifteen samples, powdered and compressed in compacts by a SPECTRO XPOS for the selected soil samples.

CONTAMINATION INDEX

The Enrichment Factor (EF) was used to assess the level of contamination in the soils (21).

BACTERIAL COLONY ISOLATION

One gram of each soil sample got weighed and diluted in nine milliliters of distal water. Every subsequent decimal notation until the ninth dilution was re-diluted by a dilution factor of 1:10. At every dilution step, MacConkey agar was seeded. After incubation for three days at temperatures 37 ´C, the bacterial colonies generated were sub-cultured on nutrient agar medium thereafter, and were diagnostically retrieved.

BACTERIAL IDENTIFICATION

A VITEK 2 (small system device), which consists of 47 biochemical assays, is used in order to identify pure bacterial isolates. Cards of streptococci group D, enterococci, and Staphylococcus aureus were utilised. Bacterial identification: Gram-negative bacteria were utilising a comprehensive procedure called batched report Gram-negative card, which is used in order to perform a standardised identification of the most clinically important fermenting and non-fermenting Gram-negative bacilli or cocci.

RESULTS AND DISCUSSION

EFFECT OF pH

The mineral’s flow in the soil is regulated by a complex combination of physical, chemical and biological entities (25). Based on observations, two principal aspects of an element interact with the heavy metals in the soil. These two parameters appear to be the susceptibility of the element moving from one state into the other, following the changes in the pH. The research indicates that even though the pH measurement for the soil in the neighborhood ranges between 7.5 to 9.3, most of the residential soils are in neutral semi-alkaline and alkaline states. Semi-alkaline and alkaline bases can, in part, be attributed to the human origins and explained by abundant carbonate and ash (26, 27). A portion of the explanation comes from the extraneous materials that are tossed into the soil, such as bricks and building materials which can drive up the pH. However, industrial and human activity can also alter the organic components that are in the soil which could affect the results of the soil in industry. The evidence shows that the majority of the soil samples in the industrial regions are in the mildly acidic to moderately alkaline range of 5.4–8.2.

ENRICHMENT FACTOR (EF)

Indicators of environmental pollution may be effectively captured by the enrichment factor (EF). According to EF calculations, each number is compared to a certain background level. Either the average composition of regions or the globe, or the local site, where ancient soils formed under similar conditions without human intervention, might be used to determine this background level. The current research used the crustal mean compliance from (28) to determine the background contents of the heavy

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elements studied, even though there were no heavy metal background values in the study region. This was based on (29). Table 1 displays the findings for the industrial and residential areas in terms of the enrichment factor.

Table 1. Heavy metal enrichment factors in the research region

	Samples	Pb	Mn	Cr	Cu	Zn	Ni
Residential Land samples	**S1**	1.28	0.9	1.99	0.82	1.68	11.34
	S2	2.7	1.1	2.8	0.78	2.1	10.48
	S3	7.1	0.89	2.1	0.97	1.96	10.77
	S4	5.3	0.98	3.6	0.83	2.3	12.83
	S5	1.9	1.07	3.2	0.99	2.15	11.73
	S6	3.6	1.1	4.3	1.05	1.87	11.43
Industria samples	**S7**	25.2	0.38	3.7	1.59	8.2	4.97
	S8	22.8	0.46	2.1	3.6	3.71	8.52
	S9	18.9	0.41	4.9	2.1	4.55	7.38
	S10	6.5	0.92	5.4	7.1	7.9	9.56
	S11	8.1	0.63	3.6	3.9	12.3	10.4
	S12	17.3	0.79	3.9	4.8	13.09	5.79
	S13	7.7	0.53	4.7	5.2	5.7	9.4
	S14	6.5	0.81	5.2	6.1	7.36	8.67
	S15	8.1	1.07	5.0	4.5	4.29	10.1

The high levels of pollution are reflected in the considerable enrichment factor values for trace metals including nickel, lead, and zinc. In contrast, elements like manganese showed low levels of contamination due to deficiency or little enrichment, whereas metals like copper, and chromium showed moderate levels of pollution in the research region's industrial area. Based on the enrichment factor values of soil samples, the heavy elements in the residential area, such nickel and arsenic, were very contaminated. Chromium, Lead, and zinc were moderately polluted, while manganese, and copper were lowly polluted. Compared to the residential sector, the industrial region had considerably higher enrichment factor values for several heavy metals, such zinc and lead. The industrial sector has much lower concentrations of several elements compared to the residential area, for example, nickel and arsenic. Human activities, including the production of industrial waste and sewage sludge, are largely to blame in both areas. The following is an order of the enrichment factor mean levels of heavy metals in the soil of industrial areas: Pb> Ni> Zn> Cu> Cr>Mn. The following is the order of the mean values of the Enrichment Factor for heavy metals in the soil of residential areas: From left to right, Ni, Pb, Cr, Zn, Mn and Cu flow in that order.

BACTERIAL ISOLATION

Table 2, Figure 1 displays the findings of the bacterial isolate identification using the VITEK 2 compact system. The results indicated that among the soils of Iraq, the most common species isolated was Enterobacter spp., which accounted for 34% of the total. Second on the list was Pseudomonas aeruginosa with a 25% share, followed by Proteus spp. with 18%, Aeromonas spp. with around 13%, Burkholderia spp. with about 2.65%, and finally E. coli with 5%.

Table 2. Bacterial isolation in this study

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Bacteria	Percentage
Enterobacter spp	38%
Pseudomonas aeruginosa	21%
Proteus spp.	16%
Aeromonas spp.	11%
Burkholderia spp.	8%
E. coli	6%

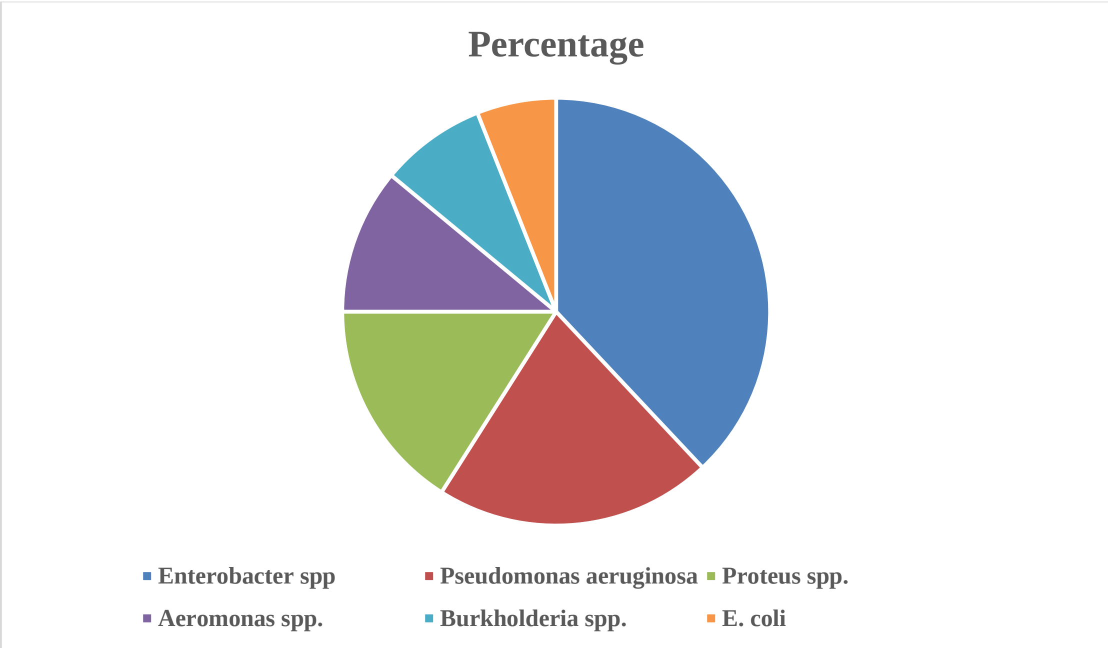

Fig. 1. Bacterial isolates

Soil naturally hosts a broad spectrum of bacterial species, many of which are already happy to be in those particular soil environments. Sister soils laced with petroleum and its derivatives, however, might be a hospitable habitat by sustaining high levels of bacteria that promote the decay and culling and purification of the soil (30–32). A group of microbes which may promote plant growth are the bacteria in PGPR of genera (33). Bacteria found in contaminated soil are: Pseudomonas, Bacillus lentus, M. amount, Bacillus alvei, E. aerogene, B. pumillus making a percentage of 56%, 30%, 21%, 20%, and 15% respectively (33). Different types of bacteria taken from soil are Aeromonas spp., Salmonicida spp., Burkholderia spp., and Pseudomonas spp. These types of bacteria are known to be opportunistic pathogens for human, animals and others (21). However, some disagreement with (23) is when they mentioned that their percentage of Enterobacter spp., and Pseudomonas spp. percent is contradicted to (22). Some of the 384 genera that were isolated from the ten-soil sample in Indonesia are Pseudomonas spp., which accounts to 81.8%, and other 18.2% is as follows: Micrococcus (6.2%), E coli (6.0%), Pasteurella (3.1%), and Staphylococcus (2.9%). Isolates in all soils were mainly from the genus Pseudomonas (79), followed by Stenotrophomonas (13) and Bacillus (13) in addition to Sphingobacterium (9) and Corynebacterium (8). Overall, 151 isolates were recovered from all six soils samples from organic and conventional wheat field (23).

CONCLUSION

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According to the enrichment factor, Pb was found to be much more abundant in soil samples from industrial areas, whereas Nickel was found to be significantly more abundant in residential areas due to the buildup of household waste and oil combustion. The research also found that the most common G -ve bacteria were *Enterobacter spp.* and *Pseudomonas spp*. Antagonism between microorganisms is essential for their survival and, in some instances, may even be ecologically beneficial to the environment; this is because the diversity of soil bacteria varies from country to country due to factors such as dietary differences, chemical composition, the make-up of the rhizobiome, and environmental changes.

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