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Response of Ammonia-Oxidizing Bacteria and Nitrite-Oxidizing Bacteria to Cadmium at an Elevated Concentration

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ABSTRACT

The study was undertaken to investigate the effect of cadmium on different nitrifying bacteria. The response of heavy metal salt on Ammonia-oxidizing bacteria(AOB) and Nitrite-oxidizing bacteria(NOB)isolated from soil samples were investigated by supplementing cadmium (Cd)at four loading rates(100, 200, 500, 1000 µg/ml) in mineral salt broth with Ammonia Oxidizing Bacteria (AOB) and Nitrite-oxidizing bacteria(NOB)isolates. The cultures were incubated for 7 days. Growth of AOB and NOB were measured by withdrawing samples from the medium every 24 hours and absorbance of the turbidity measured at 600 nanometre using spectrophotometer. All bacteria showed high tendency to decrease optical density while increasing metal concentration in the medium. Tolerance for the metal ions was dependent on concentration, time and the isolate tested. Analysis of variance shows that there is a significant difference ($P < 0.05$) in the nitrifying bacteria response rates to heavy metal salts (Cadmium (Cd)) at four loading rates (100, 200, 500, 1000 µg/ml)) between the treated and the untreated. All the Ammonia oxidizing bacterial (AOB) and Nitrite-oxidizing bacteria (NOB)showed a high level of sensitivity for the metals tested, and exhibited low growth at all metal salt concentrations tested.

Keywords: Heavy metal; Cadmium; Sensitivity; Nitrification

Introduction

Environmental contamination caused by heavy metals (HM) and their oxide has received increased attention worldwide. Heavy metal is any metallic element that has a relatively high density and is toxic or poisonous at low concentrations. Heavy metals are elements with atomic number higher than 20,an atomic mass greater than 40 g and a specific weight of more than 5 g/cm3 . These elements often find their way into soil through en¬vironmental contaminants including the atmospheric pollutants in industrial regions (emissions from the rapidly expanding industrial areas), unlimited use of agricultural fertilizers, mine tailings, disposal of high metal wastes, leaded gasoline and paints, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, atmospheric deposition, municipal and industrial sewage systems in a nonreturnable fashion. Activities such as the use of agrochemicals and long-term application of urban sewage sludge, industrial waste disposal, waste incineration, and vehicle exhausts are the main sources of HM in agricultural soils . Heavy metals in the soil include mercury (Hg), lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), uranium (U), selenium (Se), silver (Ag), gold (Au) , copper (Cu) and nickel (Ni).

Heavy metals such as zinc, magnesium, copper, chromium, or nickel may have a nutritional benefit to the organism as cofactors, while other metals, such as lead, cadmium, mercury, arsenic, and gold, are not yet identified beneficial to the organism. Regardless of the nutritional benefit, all metals lead to toxic effects when accumulated in high concentrations in the cell [1]. The toxicity of the metals is dependent upon the concentration, but also the chemical structure, time of exposure, and the source of the metal contamination.Toxic metals apply their toxicity in the displacement of essential metals from their normal binding sites of biological molecules, inhibition of enzymatic functioning and disruption of nucleic acid structure, oxidation stress, genotoxicity and interfering with signalling pathways. Ecologically, the accumulation of heavy metals in soils is extremely hazardous because soil is a major link in the natural cycling of chemical elements; it is also a primary component of the trophic chain The danger of heavy metals is intensified by their almost indefinite persistence in the environment due to their absolute nature which cannot be degraded (Gupta et al., 2016). Metals are non-biodegradable but can be transformed through sorption, methylation, complexation and changes in valence state.

Cadmium is located at the end of the second row of transition elements with atomic number 48, atomic weight 112.4, density 8.65 g cm−3, melting point 320.9°C, and boiling point 765°C. Cadmium is a metal of the 20th century. Cadmium (Cd) is highly toxic heavy metal in biological . Cadmium is the seventh most toxic heavy metal as per Agency for Toxic Substances and Disease Registry (ATSDR) ranking . It is a by-product of zinc production, Soils and rocks, including coal and mineral fertilizers contain some amount of cadmium. Anthropogenic release of Cd due to industrialization predominantly via non-ferrous ore processing, combustion of fossil fuels and manufacturing of Cd-containing products pollute both terrestrial and aquatic ecosystems, it can easily enter into the food chain . The world production of Cd has increased alarmingly by > 1000 fold from the beginning of the twentieth century to about 20,000 t per years. It is estimated that average human ingests 30 µg Cd per day through their normal foodstuff

Source of Cadmium

Cadmium is released into the environment through natural activities such as volcanic eruptions, weathering, river transport and some human activities such as mining, smelting, tobacco smoking, incineration of municipal waste, and manufacture of fertilizers which humans or

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animals may get exposed to at work or in the environment.. Cadmium is a highly toxic nonessential heavy metal that is well recognized for its adverse influence on the enzymatic systems of cells, oxidative stress and for inducing nutritional deficiency in plants [2].

Uses/ applications of Cadmium

Cadmium metal was first used in World War I as a substitute for tin and in paint industries as a pigment. In today's scenario, it is also being used in rechargeable batteries, for special alloys production and also present in tobacco smoke [3]. About three-fourths of cadmium is used in alkaline batteries as an electrode component, the remaining part is used in coatings, pigments and platings and as a plastic stabilizer .Cadmium has many applications, e.g. in batteries, pigments, plastics and metal coatings and is widely used in electroplating

Cadmium Toxicity

Intracellular Cd induces oxidative stress resulting severe damages to several organs such as liver, lungs, kidneys, testes, pancreas, bones and placenta. Moreover, Cd is considered as a potential carcinogen by the International Agency for Research on Cancer (IARC). Cd is one of the most toxic pollutants and needs special attention to control it particularly in agricultural fields. The elevated concentration of Cd in the soil affects soil fertility, disordered physiology and metabolism of the plant that showed a limitation in plant growth, symbiosis crop production andAlso, it has deleterious effects on photosynthetic process, mineral elements uptake and transport resulting massive agricultural loss . Alleviation of Cd as well as other heavy metals' toxicity mainly from agricultural fields is necessary[4].

Recent research on the metabolic pathways of heterotrophic ammonia oxidation has been conducted using and a few other bacterial species. Some studies have suggested that the biochemical mechanisms of heterotrophic nitrification differ among strains . The two main genera of microbes involved in nitrification have been identified in many studies and are the aerobic, gram negative, chemoautotrophic [5]. They thrive in the temperature range of 25-30° C, and require a neutral pH.

Nitrogen is an essential element for plants.Nitrifying bacteria play important role in soil fertility, make available nitrate nitrogen to plants (common soil nutrient element required in large quantity by plants), aid in waste treatment plant, biogeochemical cycling of nitrogen compounds and purification of the air. Nitrifying bacteria in polluted soil initiate a syntrophic pathway that provides intermediates for heterotrophic bacterial activity and thus are excellent candidates for remediation [6].

Materials and Methods

Sample collection

Surface soil samples at depth of 0-15 cm were collected at random from Akwa Ibom State University in Akwa Ibom State, and soil sample from University of Nigeria, Nsukka. And from solid waste disposal site in Uyo, Akwa Ibom State [7]. The soil was collected using sterile auger borer and into sterile polyethylene bag, merged to form a composite soil sample and transferred to the laboratory for analysis.

Preparation of samples for analyses

Precisely, 5 g of the sieved soil sample was suspended in 45 ml of sterile phosphate buffer containing 139 mg of K2HPO4 and 27 mg KH2PO4 per litre (pH 7.0) and shake at 100 rpm for 2 hrs in order to liberate the organisms into the liquid medium.

Preparation of media

Media preparation was carried out using Winogradsky broth medium for serial dilution of soil samples and Winogradsky solid medium for the inoculation of serially diluted soil suspension.

Preparation of Winogradsky broth

Winogradsky broth medium phase 1 (used for the isolation of nitrifying bacteria responsible for oxidizing ammonium to nitrite) was prepared with the following composition (g/l) in sterile distilled water: (NH4)2SO4, 2.0 ; K2HPO4, 1 ; MgSO4. .7H2O, 0.5; NaCl, 2.0 ; FeSO4 .7H2O, 0.4 ; CaCO3, 0.01. Winogradsky broth medium phase 11(used for the isolation of nitrifying bacteria responsible for oxidizing nitrite to nitrate) was prepared with the following composition (g/l) in sterile distilled water: KNO2, 0.1; Na2CO3, 1; NaCl 0.5; FeSO4 .7H2O, 0.4.Each of ten test tubes filled with 9 ml of the Winogradsky broth media 1 and 11, respectively, autoclaved at 121 0C at 15 psi for 15 minutes and allowed to cool. The test tubes was used to carry out ten-fold serial dilutions of the soil suspension.

Preparation of Winogradsky agar media

Winogradsky agar media for nitrification phases I and 11 will be prepared by adding 15.0 g agar to 1000 ml of fresh broth and sterilized at 121 0C at 15 psi for 15 minutes and allowed to cool to about 45 0C before dispersing into sterile Petri dishes.

Isolation of nitrifying bacteria from soil sample

All the plates was aseptically inoculated with 0.1 ml of the appropriate dilution of the soil suspension using spread plate technique. All the inoculated Petri dishes will be incubated aerobically at room temperature (28 +20C) for 1week and examined for growth[8,9].

Ammonium oxidation test for determination of nitrite

Five millilitres of Winogradsky mineral basal medium was prepared. The tubes was sterilized by autoclaving at 1210C at 15 psi for 15 minutes and allowed to cool. One loopful of each ammonium oxidizing bacteria isolate was added into each tube and incubated aerobically for 5 days at room temperature. At the end of the incubation period, the presence of nitrite was tested using Griess Ilosvay reagent. The reagent was added and observed for the development of purplish red/pink colouration within 5 minutes.

Nitrite oxidation test

Five millilitres of Winogradsky mineral basal medium was sterilized by autoclaving at 1210C at 15 psi for 15 minutes and allow to cool. One loopful of each nitrite oxidizing bacteria isolate was added into each tube and incubated aerobically for 5 days at room temperature. At the end of the incubation period, the presence of nitrite was tested using Griess Ilosvay reagent, the content of each test tube was observed for the development of purplish red colouration within 5 minutes. No development of purplish red/pink colour is positive for nitrite oxidizing bacteria.

Comfirmatory test for nitrite oxidizing bacteria

Five ml of Winogradsky mineral basal medium was sterilized by autoclaving at 1210C at 15 psi for 15 minutes and allowed to cool. One loopful of each nitrite oxidizing bacteria isolate was added into each tube and incubated aerobically for 5 days at room temperature. At the end of the incubation period, the presence of nitrate was confirmed by:

Brown ring test for determination of nitrate ion

A squirtful of FeSO4 was added to the tube and mixed; the test tube was placed at an angle of about 45 degrees and concentrated sulphuric acid was slowly added so that the sulphuric acid moves below the tube. The formation of a brown ring indicates the presence of nitrate.

Determination of nitrate using Phenol disulphonic acid

Phenol disulphonic acid was prepared by dissolving 25 g of phenol in 150 ml of conc. H2SO4.Thirty five ml of fuming H2SO4 was added and the solution heated at 100°C for 2 hours on water bath.

About 0.5 ml of Phenol disulphonic acid reagent was added to 5 ml of the nitrite oxidizing bacteria broth in a test tube. Nitrate reacts with phenol disulphonic acid to give a yellow colour (Jagessar & Sooknundun, 2011).

Inoculum preparation and standardization

Inocula were prepared by inoculating isolates onto prepared nutrient agar plates and incubating at 30˚C for 24 h. After incubation, colonies were suspended in test tubes containing sterile normal saline solution. The tubes were vortex for 2 min, and then transferred into a sterile test tube. The cells suspension was adjusted to a 0.5 McFarland standard (Optical density of 0.14 at 600nm) using sterile normal saline, to get the final inocula.

Mineral salts medium of the following composition (g/l): (NH4)2SO4, 1.0 ; KH2PO4, 1.0 g; K2HPO4, 1.0 g; MgSO4, 0.2 ; CaCl2, 0.02 ; FeCl3.6H2O; 0.004for ammonium oxidizing bacteria and mineral salts medium of the following composition (g/l): NaNO2, 1.0 ; KH2PO4, 1.0 ; K2HPO4, 1.0 ; MgSO4, 0.2 ; CaCl2, 0.02 ; FeCl3.6H2O; 0.004for nitrite oxidizing bacteria. Sterilized by autoclaving at 1210C at 15 psi for 15 minutes and allowed to cool.

Heavy metal salts used

Salts of Cupper (Cu), Nickel (Ni), Cadmium (Cd), and Lead (Pb) will be used as CuSO4.5H2O, NiSO4.6H2O, CdCl2.H2O and Pb(CH2COO)2)2. (OH) 2, respectively.

Primary Screening of heavy metal resistant nitrifying bacteria

An amount (0.1 ml) of the standard inoculum was plated into mineral salts agar medium supplement with metal salt concentrations of 100 mg/L. The plates was incubated at room temperature for 3 - 5 days Nitrifying bacterial isolates will be selected for tolerance study.

Experimental Set up

Analytical grades of metal salts was used to prepare stock solutions. The mineral salt medium for ammonia oxidizing and nitrite oxidizing bacteria was amended with the appropriate aliquot of the stock solution of the metal salt concentrations of 100 mg/L,200 mg/L, 500 mg/L and 1000 mg/L.

Effect of heavy metal on the growth of nitrifying isolates

Changes in population of the nitrifying isolates were monitored following their exposure to heavy metals.About 1 ml of the standard inoculum was introduced into each flask containing 100 ml of the amended mineral salt medium (MSM). The cultures were incubated aerobically at room temperature (28 ± 2˚C) for 7 days. The growth was measured by withdrawing samples from the medium every 24 hours and absorbance of the turbidity measured at 600 nanometre using spectrophotometer[10].

Tolerance of Ammonia-Oxidizing Bacterial Isolates to Cadmium

The result presented in Figure 1 shows the level of cadmium effect on the ammonia- oxidizing bacteria isolates at different day intervals. All the isolates showed high sensitivity to all the concentration (100, 200, 500 and 1000 mg/l) of cadmium. Growth was highest in the absence of cadmium (0 mg/l) at 120 hours. However, increasing metal salt concentration to 1000 mg/l caused a decline in growth by more than 97 % at 168 hours of cultivation.The growth of A1 isolate ranged from 0.08 ± 0.006 to 0.09 ± 0.007within 120 hours at 0 mg/l concentration. At 100 and 1000 mg/l concentration of cadmium, A1 growth ranged from0.08 ± 0.010 to 0.08 ± 0.001and 0.06 ± 0.006 to 0.05 ± 0.001, respectively. The growth of isolate A2 ranged from 0.08 ± 0.013 to 0.09 ± 0.001, 0.08 ± 0.010 to 0.08 ± 0.001 and 0.06 ± 0.004 to 0.06 ± 0.004 at 0, 100 and 1000 mg/l concentration. Isolates A3 exhibited related trends in cadmium tolerance as their growth was affected even at 100 mg/l. Bacterial growth significantly reduced ($p \leq 0.05$) as the concentration increased. Isolate A4 growth range from 0.08 ± 0.008 to 0.08 ± 0.001 within 72 hours, increased to 0.09 ± 0.001 after 168 hours at 0 concentration. At 100 mg/l concentration A4 growth ranged from 0.07 ± 0.015 to 0.09 ± 0.008 within 72 hours, increased to 0.10 ± 0.001within 120 hrs and decreased to 0.08 ± 0.001 after 168 hours at 100 mg/l concentration.The growth of A4 ranged from 0.08 ± 0.001 to 0.06 ± 0.002 within 72 hours and reduced to 0.03 ± 0.002 after 168 hours.

Figure 1: Schematic generic diagram of CW-EA system

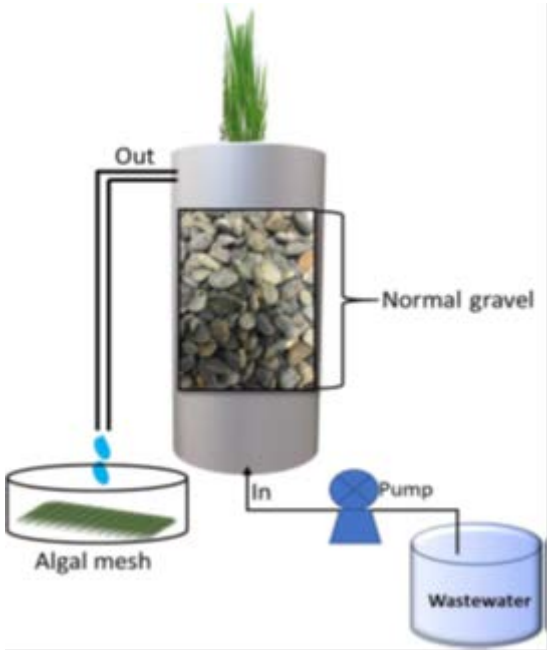


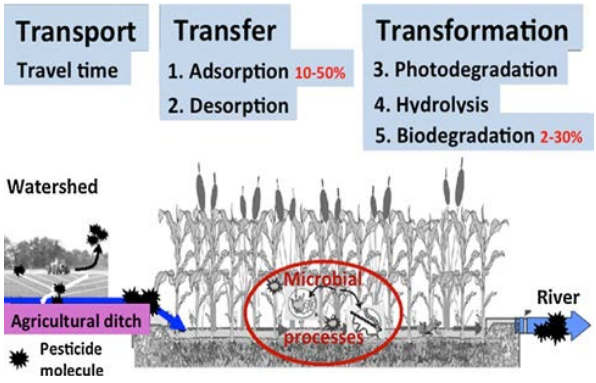
Figure 2: Processes involved in pesticide retention in a shallow surface flow constructed wetland

For isolates A6, A7, A8 and A9 accordingly, growth ranged values were; 0.08 ± 0.003 to 0.12 ± 0.001; 0.08 ± 0.008 to 0.09 ± 0.002; 0.08 ± 0.005 to 0.12 ± 0.003; 0.07 ± 0.014 to 0.11 ± 0.003 and 0.08 ± 0.005 to 0.10 ± 0.000.Growth of A10 ranged from 0.09 ± 0.002 to 0.13 ± 0.002 within 72 hours, increased to 0.15 ± 0.001within 120 hours and increased to 0.22 ± 0.02 after 168 hours at 0 concentration. Isolate A10 growth ranged from 0.08 ± 0.001 to 0.16 ± 0.004 within 72 hours, decreased to 0.08 ± 0.001within 120 hours and increased to 0.08 ± 0.006 after 168 hours at 100 mg/l concentration. A10 growth ranged from 0.08 ± 0.005 to 0.10 ± 0.020 within 72 hours; decreased to 0.05 ± 0.000 after 168 hours at 1000 mg/l concentration. Tolerance of the ammonia-oxidizing

bacterial isolates to cadmium was in the order; A6 < A8 < A3 < A5 < A9 < A7 < A1 < A2 < A4 < 10. Isolates A2, A4 and A10 exhibited the great ability to tolerate the metal salts than A6, A8, A3, A5, A9, A7 and A1.

Tolerance of Nitrite-Oxidizing Bacterial (NOB) Isolates to Cadmium

The result presented in Figure 2 shows the level of tolerance for the different metal salt concentrations by the ammonia oxidizing bacteria isolates (N1 to N10).



Growth of N1, N2, N3 and N4 ranged from 0.08 ± 0.001 to 0.10 ± 0.001,0.07 ± 0.002 to 0.11 ± 0.016,0.08 ± 0.004 to 0.13 ± 0.003 and0.08 ± 0.003 to 0.13 ± 0.005 within 120 hours of experiment. Growth was highest in the absence of cadmium (0 mg/l) at 120 hours. However, increasing metal salt concentration upto 1000 mg/l caused a decline in growth by more than 92 % at 168 hours of cultivation.Growth of N5 ranged from 0.08 ± 0.004 to 0.10 ± 0.003 within 72 hours, increased to 0.11 ± 0.015 within 120 hours and decreased to 0.10 ± 0.010 after 168 hours at 0 concentration. N5 growth ranged from0.07 ± 0.021 to 0.09 ± 0.001 within 72 hours, increased to 0.10 ± 0.011 within 120 hours and decreased to 0.09 ± 0.003 after 168 hours at 100 mg/l concentration. The growth of N5 ranged from 0.05 ± 0.016 to 0.05 ± 0.001 within 72 hours; 0.05 ± 0.004 within 120 hrs and decreased to 0.05 ± 0.001 after 168 hours at 1000 mg/l concentration.

N6 exhibited minimal growth at 1000 mg/l compared to the control (0 mg/l). The growth of N7 ranged from 0.08 ± 0.001 to 0.12 ± 0.001 within 72 hours, increased to 0.13 ± 0.006 within 120 hrs and increased to 0.15 ± 0.010 after 168 hours at 0 concentration. N7 growth ranged from0.07 ± 0.002 to 0.08 ± 0.002 within 72 hours, increased to 0.10 ± 0.013 within 120 hours and decreased to 0.09 ± 0.015 after 168 hours at 100 mg/l concentration.The growth of N7 range from 0.05 ± 0.005 to 0.05 ± 0.006 within 72 hours; decreased to 0.05 ± 0.001within 120 hrs and decreased to 0.04 ± 0.003 after 168 hours at 1000 mg/l concentration.

For N8 and N9 accordingly, growth ranged values were; 0.08 ± 0.008 to 0.10 ± 0.004 and 0.07 ± 0.011 to 0.10 ± 0.002. Growth of N10 ranged from 0.04 ± 0.009 to 0.12 ± 0.028, 0.07 ± 0.001 to 0.12 ± 0.011 and 0.05 ± 0.002 to 0.05 ± 0.064 at 0, 100 and 1000 mg/l concentration, respectively. Thus, for all nitrite-oxidizing bacterial isolates, the least and peak values for growth were recorded at 1000 mg/l and 0 mg/l respectively between 120 and 168 hours of cultivation and the tolerance of the isolates to cadmiumwas in the order; N1< N2 < N9 <N6 < N8 <N4 <N3< N10 <N5 < N7. Isolates, N10, N5, and N7 exhibited the great ability to tolerate the cadmium than N1, N2, N4, N6, N8, N9 and N3.

Discussion

The growth ofthe Ammonia-oxidizing and nitrite-oxidizingbacteria increased successively throughout the period of five days and decrease at 7 days exposure time at 0(Control), 100 mg/L, 200 mg/L, 500 mg/L and 1000 mg/L concentration of metal salt. The highest growth was observed, for all the isolates, in the medium with no metal ion amendment, which served as the control, followed by 100 mg/L, 200 mg/L, 500 mg/L and 1000 mg/L respectively. Increasedin the growth of ammonia oxidizing organism was observed throughout the period of five daysand decrease at 7 days exposure time at 0(Control), 100 mg/L, 200 mg/L.

There is a significant difference (P<0.05) in the nitrifying bacteria response rates to heavy metal salts (Cadmium (Cd)) at four loading rates (100, 200, 500, 1000 µg/ml)) between the treated and the untreated.

Sensitivity of the isolates to salts of Cadmium (Cd) were in the decreasing order of A6 > A8 > A3 > A5 > A9 > A7 > A1 > A2 > A4 > A10. All the isolates showed the high sensitivity to high concentration of 500 and 1000mg/L salts of Cadmium (Cd). A1, A2, A4 and A10 exhibited the greatest ability to tolerate the metal salts than A6, A8, A3, A5, A9, A7, A2, A1, A4 and A10.

The sensitivity of the isolates to salts of Cadmium (Cd) where in the decreasing order N1> N2 > N9 > N6 > N8 > N4 > N3 > N10> N5> N7. All the isolates showed the high sensitivity to high concentration of 500 and 1000mg/L salts of Cadmium (Cd). N10, N3, N5 and N7 exhibited the greatest ability to tolerate the metal salts than N1, N2, N4, N6, N8 and N9.

The obtained results showed that the addition of pollutants in environment, eco-physiological microorganisms had different types of response. Adding Cd in low concentration and high concentrations had a strong inhibitory effect. Most nitrifying bacteria were susceptible to heavy metals; some bacteria were resistant to the pollution, maintaining themselves even in the presence of elevated concentrations of Cadmium. Ammonia-oxidizing bacteria were more sensitive than Nitrite-oxidizing bacteria.

The harmful effect of metals was obvious, in all eco-physiological studied groups

studied values recorded in samples with high concentrations of Cd were lower

than in samples with low concentrations and maximum values were recorded in the control

sample, without added metals. The maximum value was calculated for the control sample without the addition of metals and the minimum values in samples 1000 mg/L Cd.

Metal toxicity depends upon: The absorbed dose, route of exposure and the duration of the exposure that is acute or chronic.

Heavy metals used in greater amounts, result in metabolic disorders, suppress the growth of most plants and microorganisms . Markedly different responses of AOB communities to metal pollution stress have been observed.Both metal-sensitive and metal-tolerant AOB populations have been observed in agricultural soils amended with metals also found that there was no significant difference in the abundance of AOB among different concentrations of Hg. Response of an organism to a toxicant dependent on the genetic constitution of the organism and the gene operon mediating enzyme biosynthesis. Studies have confirmed that the target of toxicant activity on bacterial systems include cell wall, cytoplasmic membrane, enzyme mediated activities and genetic machinery .Heavy metals used in greater amounts, result in metabolic disorders, suppress the growth of most microorganisms

Negative correlation of microbial viability to extended exposure to Pb is reported.Different studies have particularly emphasized the response of nitrifying bacteria to heavy metals such as Zn, Cu and Hg . Some of these studies reported a sensitive response of the AOB community to Heavy metals

study Crude oil degradation and plasmid profile of nitrifying bacteria isolated from oil impacted mangrove sediment in the Niger Delta and found that nitrifying bacteria were able to carry out degradation of crude oil.Demonstrate that nitrifying bacteria (Nitrobacter) predominance in waste environments is sensitive to various toxicants and it predominance in waste environment. Ferry reported that soil metal contamination did not decrease the abundance of AOB while the research of found that bacterial functional diversity was significantly decreased with increasing soil pollution. Hypothesize that high organic matter contents of soil can bind metals and decrease their toxicity. Investigated that there were no significant differences in the effect of metals on AOB abundance which suggested that metal concentration was not the main factor affecting the abundance of ammonia-oxidizing bacteria.

Microorganisms are very sensitive; they react quickly to any kind of changes (natural and anthropogenic) in the environment, and quickly adapt themselves to new conditions . Microorganisms take heavy metals into the cell in significant amounts. This phenomenon leads to the intracellular accumulation of metal cations of the environment and is defined as bioaccumulation. Some bacterial plasmids contain specific genes for resistance to toxic heavy metal ions . Pacwa- and ability to solubilize phosphate (biofertilizers) . Some microorganisms can adjust their metabolic activity or community structure to adapt to the harmful shock loadings. Microorganisms play important role in stress environment and the derived ecosystem functions .Microorganisms can mobilize or immobilize metals by biosorption, sequestration, production of chelating agents, chemoorganotrophic and autotrophic leaching, methylation and redox transformations. These mechanisms stem from prior exposure of microorganisms to metals which enable them to develop the resistance and tolerance useful for biological treatment . Microbe-metal interaction in soil/waste disposal is of interest to environmentalists in order to use adapted microorganisms as a source of biomass for bioremediation of heavy metals.

Industrial operations such as electroplating, steel manufacturing, leather tanning, wood preservation, ceramics, glass manufacturing, chemical processing and fertilizer applications release alarmingly higher amounts of heavy metals into the natural environment .Pollution by heavy metal is a threat to the environment and it remediation is a major challenges to environmental research. Heavy metal pollution is a serious global environmental problem as it adversely affects biotic and abiotic components of the ecosystem and alters the composition and activity of soil microbial communities The non-biodegradability of heavy metals makes it hard to remove them from contaminated biological tissues and soil and this is a major concern for global health because of their lethal nature.

Conclusion

Pollution by heavy metal is a threat to the environment environmental research. Heavy metal pollution is a serious global environmental problem as it adversely affects biotic and abiotic components of the ecosystem and alters the composition and activity of soil microbial communities. Therefore, there should be regulations on the disposal of Heavy metals especially Cadmium on soil.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Harrington R, McInnes R.Integrated Constructed Wetlands (ICW) for livestock wastewater management. Bioresour Technol. 2009; 100(22):5498-5505.
2. Tournebize J, Chaumont C, Mander Ü.Implications for constructed wetlands to mitigate nitrate and pesticide pollution in agricultural drained watersheds. Ecological Engineering. 2017; 103: 415-425.
3. Berberidou C, Kitsiou V, Lambropoulou DA, Antoniadis. Evaluation of an alternative method for wastewater treatment containing pesticides using solar photocatalytic oxidation and constructed wetlands. JEnvironManage2017; 195:133-139.
4. Saeed T, Haque I,Khan T .Organic matter and nutrients removal in hybrid constructed wetlands: Influence of saturation.Chemical Engineering Journal. 2019; 371:154-165.
5. Doherty L, Zhao Y, Zhao X, Wang W. Nutrient and organics removal from swine slurry with simultaneous electricity generation in an alum sludge-based constructed wetland incorporating microbial fuel cell technology. Chemical Engineering Journal. 2015; 266:74-81.
6. Lyu T, Zhang L, Xu X, Arias CA, Brix, H et al. Removal of the pesticide tebuconazole in constructed wetlands: Design comparison, influencing factors and modelling. Environmental Pollution, 2018 233, 71-80.
7. Lv T, Zhang Y, Zhang L, Carvalho PN, Arias CA et al. Removal of the pesticides imazalil and tebuconazole in saturated constructed wetland mesocosms. Water research. 2016; 91: 126-136.
8. Gikas GD, Pérez-Villanueva M, Tsioras M, Alexoudis C, Pérez-Rojas G,et al.Low-cost approaches for the removal of terbuthylazine from agricultural wastewater: constructed wetlands and biopurification system. Chemical Engineering Journal. 2018; 335: 647-656.
9. Gupta S, Srivastava P,Yadav AK . Simultaneous removal of organic matters and nutrients from high-strength wastewater in constructed wetlands followed by entrapped algal systems. Environmental Science and Pollution Research.2020; 27(1): 1112-1117.
10. Tan X, Yang Y, Liu Y, Li X,Fan X, et al. Enhanced simultaneous organics and nutrients removal in tidal flow constructed wetland using activated alumina as substrate treating domestic wastewater. Bioresource technology.2019; 280:441-446.
11. Benny C, Chakraborty S (Continuous removals of phenol, organics, thiocyanate and nitrogen in horizontal subsurface flow constructed wetland. Journal of Water Process Engineering. 2020; 33:101099.