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ORIGINAL ARTICLE **OPEN ACCESS**

Effect of Metal Concentration on Soil Properties and Soil Enzyme Activities of Industrial Soil Metoda Zone in Rajkot

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ABSTRACT
In order to study the impact of metals released by industries on soil properties and soil enzymes, many soil samples were collected from agricultural fields and industrial zone contaminated by industries of Metoda village in Rajkot region. The results revealed that the industrial zone were contaminated by metals compared with agricultural fields. Under the metal contamination, the activities of the soil enzymes (urease, protease,hydrogenase and cellulase) in industrial zone were disturbed than those in the agricultural fields. In addition, the results showed that few enzymes were negatively correlated with DTPA-extractable metals. Soil microorganisms and enzyme activities involving soil organic carbon and nitrogen decomposition and stabilization were decreased due to the toxic metal concentration.
Keywords: *Soil properties, Soil enzymes, Metal contamination, Agricultural field.*

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INTRODUCTION

We aware in a biosphere in which natural resources are limited. Water, soil, minerals, reactionary energy and products from timber, Champaign, abysses as well as from husbandry and beast are all a part of our life support system. When the human population showed slow growth and technology was in its immaturity, the environs could fluently absorb human and industrial waste. With increase in human population and great advancement in technology in the recent history, the waste materials have multiplied in amount as well as in kind, and this has resulted in impurity of environment[1].

By contaminating the environs, man has wiped out numerous species of wildlife and has pushed several other species in the danger of extermination. This adverse phenomenon also damages our living conditions and cultural assets. These environmental changes are impacting not only air, water and land resources but also natural diversity and human health.

Soil supports lifeof plants, animals and microorganisms. Hence, soil pollution affects all organisms. The soil may be regarded as a nonrenewable resources because the process of soil formation is so slow. This makes the problem soil pollution more acute.

Soil productivity includes both the quantity and quality of produce. So substances which reduce productivity of the soil are regarded soil pollutants. Numerous materials negatively affect the physical, chemical and natural properties of the soil and reduce its productivity. Elements present in the industrial waste extent the soil directly with water or indirectly through air. These include iron, lead, manganese, copper, mercury, zinc, cadmium, chromium etc.

Availability of Heavy metals in soil and aquatic ecosystem is comparatively to a fairly lower proportion in atmosphere as particulate or vapors. Heavy metal toxicity in organisms varies with their species, specific metal concentration, chemical form and soil composition, as many heavy metals are considered to be essential for plant growth. Some of these heavy metals like Cu, Zn either serve as cofactor and activators of enzyme responses, e.g., in forming enzyme-substrate metal complex or exert a catalytic property similar as prosthetic group in metaloproteins (Mildvan,). These essential trace metal nutrients take part in redox responses, electron transfer and structural functions in nucleic acid metabolism. Some of the heavy metals similar as Cd and Hg are explosively toxic to metal-sensitive enzymes, performing in growth inhibition and death of organisms.

The objectives of this paper are to bandy the threat of heavy metal contaminated side, to provide a brief view about soil physico-chemical properties and soil enzyme exertion to gate some ideas about the performance of several microorganisms to uptake heavy metals and to describe about the fate of heavy metals in soil, especially on lead (Pb), iron (Fe), copper (Cu), chromium (Cr) and manganese (Mn).

MATERIALS AND METHOD

Study region

Gujarat has made a name for itself in Metal Industries and the top listed supplier company is located in Rajkot. Metodais a fast developing industrial zone of Rajkot region. Expected samples were collected and analyzed as per designed experiment plan.

Latitude: 22.24533, Longitude: 70.68002, N $22^0 14'43.1847''$, E $70^0 40'48.0714''$

Sample collection

In the starting of monsoon season, soil samples were collected. Almost 20 to 30 cm soil depth was selected from contaminated (industrial) and non-contaminated (agricultural) soil. Ten different soil samples were chosen to reflect different degrees of metal concentration than mixed well and transferred to the polythene bag to avoid dehydration.

As per our planed, we were interested to collect bulk soil. From soil, plant was taken and vigorously shaken by hand for 8 to 10 minutes. [2]

Soil physic chemical properties

After collection, soil samples were air-dried at room temperature, homogenized and passed through 2 mm sieve before all the analysis.

Soil pH was measured using pH meter in the supernatant suspension of 1:2.5 soils to water ratio [3, 4]. EC meter was used to measureElectrical conductivity [3]. Gravimetric method was followed for soil moisture[5].Keen -Rack zowski box method was method to measure Maximum water holding capacity of soils [6]. Organic carbon of the soils was determined by wet digestion methodWalkley and Black [7]. Olsen's method [8], Kjeldahl method [9], Flame Photometer [10] and Atomic Absorption Spectrophotometer (AAS) by DTPA method [4, 11] were used to quantify different metals.

Soil enzyme activities

An equalized, safe and productive soil exists when its natural, biochemical, physical and chemical characters, all identified to each other, contribute to sustain all conditioning being in it. Among these properties the activities of soil enzymes play a fundamental role in soil fertility and productivity.

Enzyme activities were determined from soil samples in triplicate [12]. The cellulaseenzyme activity was stated on a soil dry weight as mg glucose released $g^{-1}h^{-1}$.Urease is an enzyme which responsible for the hydrolysis of urea. [13]. The urease activity was measured using urea as substrate, and the substrate mixture was incubated at 37 ºC for 3 h. The product was determined by a colorimetric method, and urease activity was expressed on a soil dry weight as ug N/100g soil h^{-1}. Esters and anhydrides of phosphoric acid were hydrolyzed by phosphates enzymes.[14]. Proteases play a significant role for N mineralization [15]. Protease activity was provedby Ladd and Butler method [16] with tyrosine concentration and measured at 680 nm by colorimetrically.Mostly biological activity in soils was determined by measuring the dehydrogenase enzyme [17]. Dehydrogenase assays based on the reduction of triphenyltetrazolium chloride (TTC) to the creaming red-colored formazan (TPF), have been used to determine soil microbial activity, which can be observed byspectrophotometrically at 485 nm. (TPF g^{-1}soil h^{-1}).

Data analysis

Experimental results were statistically analyzed using SPSS 11.0. Results were stated as mean ± SD (standard deviation). The significance of the difference in the attention of the essence among different slice times or spots was assessed with Independent Samples t- Test. A $p<0.05$ was considered statistically significant.

RESULT AND DISCUSSION

Heavy metals and physic- chemical properties

As perBłonska[18], enzyme activities mostly increase with soil pH.As per table 1, pH was near to normal[19]. cation exchange capacity and ware prone to exchange on the particle surface and form an organic wrapped layer with heavy metals, which could absorb and complex with heavy metals, thereby fixing heavy metals [20].As per table 1, CEC was slightly higher than control (Agri soil). Mass of water was strongly effects on soil microbial activity and community microbs[21], and subsequently on soil enzymatic activities. In the case of our study, soil moisture was normal level to control. Bulk density was used to express soil specific-chemical and natural confines on a volumetric base for soil quality assessment. Bulk density slightly decreased compare to control. Electrical conductivity (EC) of soil was measured the ability of soil water to carry electrical current. Electrical conductivity was the process of electrolysis which took place principally through water-filled pores. The concentration of ions were determined the EC of soils. In soil science, EC mainly used for a measurement of soil salinity. It also used to estimate soil's other properties, such as soil moisture, soil depth etc. As per table 1, Metoda soil had very high number of EC. We had to consciousness that any compound, which was alters the number or activity of microorganisms, could on the other hand effect on soil biochemical properties, and ultimately also on soil fertility and plant growth.

Total Nitrogen was found in form of organic and inorganic. Ammonium and nitrate were available forms for plants. The majority of Total Nitrogen was bounded in soil organic matter. Soils microorganisms decomposed organic matter and stored liberate energy in chemical bonds to oil their activity and to harvest nitrogen to build their biomass. Soil biota bear nitrogen for the conflation of their own proteins and other nitrogen containing organic motes. As per table 2, N content was very very high in industrial soil. The phosphorous content in soils was much higher than its normal range. This possible might be due to ferocious operationof P- containing chemicals by the diligence. The mean value of available content in soils was extremely higher range. The available Potassium content of the soil was very high compare to normal garden application of K-containing chemicals by the industries. The highest amount of available Potassium content was observed in Metoda soils. The available sulphur content in soils was extremely higher range (table 2). For normal Soil 20-30 ppm is sufficient level.

Micro nutrients and Heavy metals by DTPA method:

The amount of micro-nutrients and heavy metals was determined directly on Atomic Absorption Spectrophotometer (AAS). The results revealed that all micronutrients were higher than sufficient level. Due to industrials waste it might be increased. The contents of the different heavy metals do not vary according to the distance of soil sites. All soil sites were affected by heavy metals. Although the concentrations of Cu and Pb in the soils studied matched with the study [22] carried out with the soils from east Calcutta but the values for Cd and Zn were found to be different.

As characterized by a similar range of pH values and by Mohammed A. et al.[23],TC and CEC had showed strong positive correlations with all heavy metals. The significant positive correlation of Cd, Cr, Pb, Co, Zn and Ni indicates that the elements are derived from similar materials, particularly industrial waste materials[23].

Soil enzyme activities

The production of extracellular enzymes by microorganisms is regulated by different mechanisms. Most of the research investigating the regulation of enzymes activity has been measured in laboratory. The conditions of the trial may or may not be representative for complex microbial communities plant in soil. We investigated the response of soil microbial communities to different availabilities of metals with higher concentration. Urease is produced by soil microorganisms and released into the soil for its action. Nayak et al.[24]stated that almost 80% urease activity was extracellular and completed by soil colloids. Bowles et al. [25] showed that urease activity decreased with increasing application of NH3- based N fertilizers. It was hypothecated that the addition of the end product of the enzymatic response (NH4) suppressed urease conflation. From Table 3, it will be found that urease activities have a negative relationship with soil total Nitrogen. Therefore, urease and total Nitrogen appear in a different quadrant. Saha et al., [26]revealed that urease activity was decreased in the alkali condition and our results also supported him. Ambroz [27] showed that activity of protease was depended on proteins of soil. May be it was related with soil pH, temperature and other physic- chemical properties. About 40% of the total soil nitrogen was proteinaceous material, including proteins, glycoproteins, peptides and amino acids [28].Our result showed that protease activity slightly decreased due to disturbed soil. Maximum protease activity was found at basic pH near about 8[16].Protease activity was mostly reliant on the type of the added nitrogen source. As per results obtained by Allison and Vitousek[29], this might be due to the fact that the rate of hydrolysis was substrate specific. Comparing Studies of properties of protease synthesized by the same microbial species was found that the proteases were able to hydrolyse a range of different proteins, but that the rate of hydrolysis was protease and substrate specific [30].Cellulases were playing an important role as a group of enzymes in global recovering of the most abundant polymer and cellulose in environment. It was produced by several microorganisms like as bacteria and fungi [31].Our result showed that cellulase activity slightly decreased due to disturbed soil. As per Liu and Toyohara [32], low cellulose exertion in soil could be honored to a low position of cellulase supplied by microorganisms.G. Immanuel et al. [31]had concluded that Cellulase activity depended upon a complex relationship involving a different types of factors like pH value, temperature, presence of inducers, medium additives, aeration, growth time, and so forth.Many authors [33,34,35] suggested that the use of dehydrogenase activity as an indicator of overall microbial activity. So we can be assumed that the quality of the soil corresponds to the soil microbial activity. Thus, one can guess a relationship between the activity of dehydrogenases and the physicochemical assets of soils, which fix their quality, such as pH, moisture, CEC etc. our result showed that dehydrogenase activity was slightly decreased due to disturbed soil. The low dehydrogenase activity identified by the DhA-wb assay in the examined strongly acidic soils looks to be defensible in view of the likely dominance of microbes in these soils. Rous et al. [36] revealed that instrongly acidified soils microbes had good relationship. Tarafdar, [37] suggested that more than 72% of bacterial colonies and actinomycetes fungi in various Indian soils were capable of using TTC as an electron acceptor.

Table 1. Physical properties of soil

Site	sample 1	sample 2	sample 3	sample 4
Physical properties	**Metoda Site A**	**Metoda Site B**	**Agri Site A**	**Agri Site B**
p^H	7.09±005	7.1±005	6.9±005	6.92±005
C.E.C (meq/100g)	68.41±1.89	67.15±1.78	65.56±1.45	66.71±1.79
soil moisture (%)	6.68±0.52	6.88±0.58	6.13±0.85	6.06±0.66
bulk dencity (g/cm3)	1.27±005	1.29±005	1.37±005	1.38±005
Electrical conductivity (dS/m)	1.98±045	2.18±046	0.37±045	0.41±045

Table 2. Chemical properties of soil

Site	sample 1	sample 2	sample 3	sample 4
Chemical properties	**Metoda Site A**	**Metoda Site B**	**Agri Site A**	**Agri Site B**
Nitrogen (kg/ha)	576.42±5.62	498.9±5.85	110.1±5.92	147.09±6.01
Phosphorous (kg/ha)	459.08±4.95	402.83±4.09	140.78±3.02	102.11±3.41
Potassium (kg/ha)	297.67±5.82	289.03±5.96	177.4±4.34	191.23±3.27
Sulphur (ppm)	584.69±5.69	579.04±5.88	32.15±1.09	42.98±1.82
Chromium (ppm)	0.41±005	0.38±005	0.2±005	0.26±005
Cobalt (ppm)	1.13±005	1.56±005	1.85±005	1.09±005
Manganese (ppm)	26.01±1.01	25.87±1.12	12.25±05	16.42±05
Zinc (ppm)	6.88±07	7.03±06	3.83±005	4.06±005
Cadmium (ppm)	0.23±005	0.27±005	0.02±001	0.03±001
Lead (ppm)	30.01±1.16	24.6±1.21	0.2±001	0.18±001
Copper (ppm)	6.92±055	6.38±056	1.01±008	3.49±012
Iron (ppm)	17.12±0.85	19.66±0.89	4.26±05	4.4±05

Table 3. Enzyme activities of soil

Site	sample 1	sample 2	sample 3	sample 4
Enzymes	**Metoda Site A**	**Metoda Site B**	**Agri Site A**	**Agri Site B**
Urease (ug N/100g/h)	1.04±005	1.21±005	0.89±005	0.78±005
Protease (ug/g/h)	0.26±003	0.29±003	0.49±004	0.56±005
Cellulase (mg glucose/g/h)	45.84±7.21	48.46±7.1	51.67±6.13	56.94±6.36
Dehydrogenase (mgTPF/g/h)	9.01±1.51	9.24±1.5	30.94±2.02	35.22±2.31

CONCLUSION

From above discussion we noted that, increasing metal concentration is harmful to soil physico chemical properties and living organism. Higher concentration of metals are being toxic to all the organism because they will be easily absorbed by food plants, potentially causing a health risk. Microbial activity plays an important role in maintain soil quality. The microbiological processes occurs in the soil are at the top of many ecological functions. Therefore, development of a universal method that will make it possible to maintain soil quality and it is a very important task in the field of soil science.Disturbed soil enzyme activities are the sign of soil deterioration. It means bioremediation is a demand of soil.

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