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Research article

ENVIRONMENTAL FACTORS AND THEIR IMPACT ON SOIL CHARACTERS

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ABSTRACT: Soil is a dynamic environment. Living organisms constantly degrade the materials present in soil to provide themselves with nutrients for growth. Soil is the mixture of minerals, organic matter, gases, liquids and a myriad of organisms that can support plant life. It is a natural body that exists as part of the pedosphere and it performs four important functions. It is a medium for plant growth. It is a means of water storage, supply and purification. Soil is a modifier of the atmosphere and it is a habitat for organisms that take part in decomposition and creation of a habitat for other organisms. Some of the factors that affect soil microorganisms are nutrient supply, aeration, moisture content, pH, fertilizer, cultivation, seasonal climatic changes etc. Soil contains various groups of microorganisms like bacteria, actinomycetes, fungi, algae and protozoa. Bacteria, the smallest microbes found to be dominant in soil. The population of bacteria in soil depends on the physical, chemical and biological conditions of soil. Having known these facts, this study is aimed to find out the role of environmental factors on soil characters. Five different sites were selected for collection of the soil samples. Collected soil samples were subjected to physical, chemical & biological analysis and physicochemical properties by standard methods. The results revealed that the nature of the soil in terms of physical, chemical and biological character vary based on the environment from where it was collected indicating that the environment has its impact on soil quality.
Key words: Soil, physical nature, chemical nature and biological properties.

INTRODUCTION

Soil is one of the three major natural resources, alongside air and water. It is one of the marvelous products of nature and without which there would be no life. On earth soil is made up of three main components. They are minerals that come from rocks below or nearby, organic matter which is the remains of plants and animals that use the soil, and the living organisms that reside in the soil [1]. Mbagwu in 1992 observed that soils differ in their response to organic waste amendments and it is important to investigate more closely the influence of these organic and inorganic wastes on a range of soil physicochemical properties [2]. Soils would not exist without the complex and heterogeneous activities of microorganisms. Microorganisms constitute around 0.5% (w/w) of the soil mass yet they have a major impact on the soil properties and processes. 60- 80% of total soil metabolism is due to its microflora. The biological diversity of microorganism is mainly due to the diversity not only in their morphology but also in their role [3]. Soil organisms are important in cycling of C, N and other nutrients, enhancing soil structure, decomposing organic materials, maintaining soil quality and health. Adapting to the environment the microbes live in, they tend to involve into various metabolic pathways that produces many bioactive metabolites [1].

Aim

Hence, an attempt was made in this study to analyze the physical, chemical and biological characters of soil samples collected from five different environments.

MATERIALS AND METHODS

Five different soil samples were collected from different locations i.e hospital waste dumped area, petrol bunk, Trichy distilleries effluent collection area, laboratory waste dumped area and garden. Collection of the soil sample was done by standard methods [4]. The collected soil samples were subjected for physical, physiochemical, chemical and biological analysis by standard methods [5].

RESULTS

Physical nature

A total of four different sites were selected at Tiruchirappalli city and one from Kumbakonam for collection of soil samples. All sites were exposed to different kinds of environmental pollution. A site at which the soil sample was collected is Kauvery Medical Center, Tiruchirappalli that was dumped with hospital wastes. Another site was at Petrol Bunk, Kumbakonam exposed to Petroleum products. Soil sample collected from Trichy Distilleries effluent collection area is rich in effluent containing dirt, organic waste and chemicals. The fourth site at which the soil sample was collected is Laboratory waste dumped area which was rich in organic wastes. Garden, a fertile land is the next site which is rich in humus. The collected soil samples were coded as JKM, JPB, JTD, JLB and JCG. Physical nature of the sample was of sandy, semisolid or clayey. Colour of the sample varied from dark brown to reddish brown and the smell was earthy or with effluent or sewage smell or unpleasant (Table 1).

Table-1: Physical nature of soil samples collected

S.No	Site	Sample code	Nature of the environment	Soil characteristics
1	Kauvery Medical center, Tiruchirappalli.	JKM	Exposed to various organic wastes and environmental stress	Clay, dark brown, wet & earthy.
2	Petrol Bunk, Kumbakonam.	JPB	Exposed to sediments of various petroleum products	Clay, dark brown, wet & earthy.
3	Trichy Distilleries,Tiruchirappalli.	JTD	Exposed to dirt, organic waste and chemicals	Semisolid, dark brown, wet liquid & unpleasant.
4	Biotechnology laboratory waste dumped area	JLB	Exposed to various organic wastes and environmental stress	Clay, dark brown, wet & earthy.
5	Biotechnology garden	JCG	Fertile cultivation land rich in humus	Sandy, reddish brown, free powdered, earthy.

Bulk density of soil samples varied from 1.06 to 1.33gm/cm^3 and specific gravity ranges between 1.02 to 1.66 (Table 2). Physicochemical properties like pH, electrical conductivity, salinity and alkalinity of the selected soil samples were studied under specific conditions. pH analysis showed that the selected soil samples were of neutral in pH. Electrical conductivity ranges from 103 - 275. Salinity of all the 5 samples was very less and alkalinity was almost similar in all the samples (Table 3). Chloride content varied from 500 ppm to 894 ppm. JKM was rich in chloride content (893.84ppm) followed by JTD (656.19ppm). The remaining 3 samples showed almost similar level of chloride. JTD found to have higher level of total phosphorus (53.07ppm) compared to other 4 samples (Table 4). Sodium, potassium and calcium when quantified revealed the presence of these ions in all the samples. JKM had rich content of sodium (161 ppm). Potassium was present maximum in JPB (780 ppm). JPB and JLB were rich in calcium (782 and 780 ppm) (Table 5).

Table-2: Bulk density and specific gravity of the soil samples

S.No	Sample code	Bulk density g/cm3	Specific gravity
1	JKM	1.33	1.33
2	JPB	1.06	1.02
3	JTD	1.29	1.29
4	JLB	1.07	1.66
5	JCG	1.07	1.22

Table-3: Physicochemical properties of soil samples

S.No.	Sample code	pH	EC (s)	Salinity (ppt)	Alkalinity (ppm)
1	JKM	7.03	275	0.15	45
2	JPB	7.02	275	0.15	45
3	JTD	7.06	108	0.06	40
4	JLB	7.07	105	0.05	45
5	JCG	7.04	103	0.08	40

Table-4: Chloride content and total phosphorus in the soil samples

S.No.	Sample code	Chloride content (ppm)	Total Phosphorus content (ppm)
1	JKM	893.84	52.08
2	JPB	436.28	26.14
3	JTD	656.19	53.07
4	JLB	507.22	33.56
5	JCG	427.63	22.04

Table-5: Elements of the soil samples

S.No.	Sample code	Quantity of elements in ppm		
		Sodium	Potassium	Calcium
1	JKM	161	546	400
2	JPB	138	780	782
3	JTD	92	546	300
4	JLB	115	429	780
5	JCG	151	430	372

When the samples were looked for the presence of different living organisms like bacteria, fungi, algae, protozoa, nematodes and worms, it was observed that bacteria, fungi, algae and worms were seen in all 5 samples. Protozoa and nematodes were absent in JTD and JCG soil samples (Table 6).

Table-6: Biological nature of the soil samples

S.No.	Sample code	Nature of living organisms (+/-)					
		Bacteria	Fungi	Algae	Protozoa	Nematodes	Worm egg
1	JKM	+	+	+	+	+	+
2	JPB	+	+	+	+	+	+
3	JTD	+	+	+	-	-	+
4	JLB	+	+	+	+	+	+
5	JCG	+	+	+	-	-	+

"+" – presence of organism, "-" – absence of organism

DISCUSSION

Soil samples were collected from the sites that were exposed to different kinds of environmental pollutants because these sites may have rich microflora which in turn helps in modification of soil quality. Soil is a rich source of diverse group of microbes and their characters are influenced by physical, physicochemical and chemical nature of the soil. Soil microorganisms are responsible for the breakdown of organic matter including hydrocarbons, conversion of inorganic components from one form to another and the production of humus [6]. Soil microorganisms play an important role in maintaining soil quality [7].

This study results revealed that the samples taken from Kauvery Medical Center, Petrol Bunk, Laboratory waste dumped area are clayey, dark brown, wet & earthy (Table 1). The reason may be the presence of clay particles, organic matter, biological or non biological material, moisture and actinomycetes. Loganathan in 2007 also reported that the soil collected from hospital waste was clayey in nature, dark brown in colour, wet and earthy and the author accounted that the presence of moisture and a large quantity of organic wastes could be the reason for it [8].

The soil collected from hospital waste, petrol bunk and laboratory waste were dark in colour. The reason may be the presence of moisture, clinical waste, hydrocarbons and much organic wastes. Similarly, Loganathan in 2007 also reported that the soil from hospital waste was dark brown and the author accounted the reason may be due to the presence of organic matter and iron content [8]. According to Akter in 2000 reported that a large part of hospital waste usually consists of clinical and non-clinical waste. The excessive input of unsorted hospital wastes may lead to physical and chemical characteristic changes in soil. This can distort interrelationship among biophysical and chemical nature of soil. It may also lead to loading of nitrates and heavy metals in soil and ground water [9].

The sample from Trichy Distilleries effluent is semisolid and in liquid state and dark brown with unpleasant smell and it could be due to the chemical nature of the effluent, particularly distillery effluent and the action of microbes on it and derivative of caramelized sugar termed melanoidin formed during the process of distillation. Similar to that Ansari in 2012 has also reported that the colour of distillery effluent soil was found to be dark brown and the author accounted that this colour of effluent may be due to the presence of a derivative of caramelized sugar i.e. melanoidin formed during distillation. Small lumps were observed in the sample collected from Trichy Distilleries and it could be due to the presence of distillery waste materials [7]. The same has also accounted this (8). Dark brown colour of the Trichy Distillaries waste may be due to its continuous exposure to the distillery effluents. Ansari in 2012 reported that the odour of the distillery effluent was offensive [7]. Odourous compounds from distillery waste water mainly consist of volatile fatty acids such as butyric and valeric acids that have a high odour index. This may be the reason for the unpleasant odour of the soil collected for this study from Trichy Distillaries.

Garden soil sample was sandy, reddish brown and finely powdered which may be due to its richness in organic content and weathering process it has undergone. The soil sample collected from the Department of Biotechnology, was sandy, reddish brown and finely powdered which may be due to the organic matter, minerals, water etc. This site acted as control and free of any waste. The soil collected from garden site was sandy and it may be due to its organic content and weathering process [8]. The sample taken from garden soil was reddish brown. The richness of decomposed vegetable wastes and other materials may be the reason for this. On the other hand Loganathan in 2007 reported that the colour of the garden soil was light brown and the reason may be due to the presence of decomposed organic waste [8].

The bulk density of the sample JKM was maximum (1.33 g/cm^3) when compared with other samples. The reason could be the presence of decomposed organic waste that fills the air and space and in turn retard the permeability. Bulk densities of soils generally vary between 0.8 and 1.7 g/cm^3 (10). Bulk density is inversely related to pore spaces and it has an important role on soil permeability, which in turn can affect the flow of materials like air, water, nutrients and pollutants within the soil (8). Bulk density of the sample JTD was 1.29 g/cm^3. The reason may be due to the presence of lumps which occupies more space. On the other hand Loganathan in 2007 reported that the bulk density of distillery effluent was 1.19 g/cm^3 and the reason may be due to lumps present in it [8]. In this study the laboratory waste sample showed the bulk density within the limit. The reason may be due to the enrichment of microbial population. The bulk density of laboratory waste sample was within the limit (8). The bulk density values of garden soil was reported that it was less i.e 0.91 g/cm^3, indicating the presence of high organic matter and lower clay fractions in the upper soil layer [11]. Specific gravity of the soil samples of this study ranges between 1.02 and 1.66. Specific gravity is directly related to the bulk density and it can be used in the same way to characterize the soil quality.The pH of soil is an indicator of acidic or alkaline nature. The pH of most mineral soil is between 5.5 and 7.5 [3]. Here pH of the 5 selected soil samples was neutral. Soil with a pH of around 7 has a high availability of Mg, Ca, K, N and S indicating that these soils do have these minerals. The laboratory waste sample, distillery effluent and hospital waste soil showed pH ranges from 6.72 to 7.52 [8]. The pH value of the collected municipal waste sample was found to be 6.9 [12]. Xianghua in 2004 reported that pH of hospital waste was in the range between 6.2 to 7.2 [13]. The electrical conductivity of the soil samples ranges from 103 to 275 S. Hospital waste and petrol bunk waste showed maximum range and indicating the presence of its high ionic strength and mineral content. The laboratory waste sample, distillery effluent and hospital waste soil showed EC value ranges between 105 to 302 S [8]. The relatively high values of EC (24,500 S) was showed in municipal waste sample [12]. Salinity was found to be minimum in all five samples collected, indicating the presence of very less amount of NaCl. Loganathan in 2007 also reported that laboratory waste sample, distillery effluent, hospital waste soil and garden soil showed very less salinity [8].

The alkalinity of all the samples was almost similar and it ranges between 40 and 45 ppm and it was not reflected in pH which was neutral. Alkalinity in soils arises mainly because of the dissolution of calcium carbonate. This indicates the increase in pH [5].

Soluble ions referred to as soluble salts are major dissolved inorganic solutes. The concentration of soluble ions is related to soil conductivity. The soluble ions that are commonly analyzed are Mg^{2+}, Ca^{2+}, Na^{+}, K^{+}, Cl^{-}, No_3^{-}, NH_4^{+} and SO_4^{2-} [5]. This study also revealed the presence of soluble ions like chloride, phosphorous, sodium, potassium and calcium.

Phosphorous is an essential macronutrient for living organisms. It is a constituent of organic compounds with important structural and metabolic functions. Total phosphorous content was maximum in hospital waste soil and distillery effluent. Similarly Loganathan in 2007 also reported that the total phosphorous content was maximum in hospital waste soil and distillery effluent [8]. The concentration of phosphorous in the mineral soil is 0.02 – 0.15% and in sludge 0.8 to 11% [14].

In this study the level of potassium is higher than calcium and sodium in garden soil. Van Breeman and Finzi in 1998 & Sposito in 1980 reported the adsorption affinity of base cations to the soil exchange complex follows similar orders K > Ca > Na for vegetative land. Petrol bunk waste soil had high content of calcium than potassium and sodium [15&16]. Simeon and Ambah in 2013 reported that calcium level was richer than potassium and sodium levels in disposal waste soil [17]. Laboratory waste soil had 115ppm of sodium in this study. But according to Summan in 2006 the concentration of Na^{+} in municipal waste samples varied from 22 to 313 ppm [12].

The biological analysis of soil samples of this study revealed the presence of bacteria, fungi, algae, protozoa, nematodes and worms indicating the support of soil for rich diversity of living organisms. There were no protozoa and nematodes in the Trichy distillery effluent and garden soil which were exposed to distillery effluent and organic waste respectively. Soil environment supports diverse variety of microorganisms such as bacteria, actinomycetes and fungi [18]. In addition Trovisk et al., in 2002 reported that a variety of other living organisms like microalgae and invertebrates like protozoa, nematodes, worms etc. also live in soil [19]. Presence of innumerable bacterial population indicates the richness of soil in terms of nutrients. The soil microbial communities are known to be remarkably complex, and the estimates of soil diversity are as high as $8.3x10^6$ unique genomes per 30g of soil [1]. Isolated bacteria from different habitats contaminated with petroleum oil, i.e., Petrol pumps, garages and automobile workshops [20]. Zouboulis in 2004 isolated *Bacillus laterosporus* from polluted metal laden soil [21]. Jenny et al., in 2013 find out that soil acted as a novel source bacteria for CAT enzyme [22]. *Bacillus amyloliquefaciens* was isolated from the soil samples collected from potato field of north India [23]. *Pseudomonas fluorescens, Bacillus subtilis, E.coli* and *Serratia marsecens* were isolated from different environmental source of soil and screened for amylase production [24]. *Bacillus* sp were isolated from sewage soil and screened for the production of α- amylase [25]. Warcup in 1995 isolated fungi from hyphae which was found in soil [26].

CONCLUSION

Overall results of this study indicated that the physical, chemical and biological nature of soil differs in different environment and microbes have a role on it.

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