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Population Density of Soil Microbes Associated with Degraded Shrimp Shell Collected from Mallipattinam East Coast of Tamil Nadu

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Abstract

In the present study, population density and physicochemical parameters of Mallipattinam east and west degraded shrimp shell soil microbes were performed. Most of our land is covered in soil, which is the most diverse and nutrient-rich loose surface material. Both organic and inorganic materials can be found in soil. In this study, a total of 12 (KD1 to KD12) bacterial strains and 25 fungal strains were isolated by using the dilution plating technique and identified by biological microbial systems from the standard manual. Results showed that the maximum bacterial (48) and fungal (81) strains were observed at Mallipattinam east degraded soil. The Shannon's and Simpson's diversity indices denoted by the symbols H and D were calculated. The various physicochemical properties such as colour, texture, pH, electrical conductivity, organic carbon, organic matter, available nitrogen, phosphorus, potassium, zinc, copper, iron, manganese, cat ion exchange capacity, calcium, magnesium, sodium and potassium were analysed from two different areas of a degraded soil sample. The maximum parameters were recorded in the Mallipattinam west degraded soil. It was concluded that during the whole study duration, shrimp waste was more readily used by the microorganisms living in sandy soil, which found shrimp heads to be the most valuable and shells to be the least useful. Compost made from shrimp shells is added to other compost to promote plant development.

***Key words*:** Shrimp waste, Degraded soil, Microbial populations, Physicochemical, Shannon index, Simpson index

The most important natural resource is soil, which makes up the outermost layer of the earth's crust and is essential to maintaining life on the planet. In general, the term "soil" refers to the loose material composed of weathered rock and other materials, including partly decayed organic matter. Soil is the soul of infinite life. Extreme environments are those that, by definition, present conditions that make it difficult for any species to survive [1]. These conditions exert a selection pressure on the biodiversity of species, including microorganisms, which have evolved rapidly in these environments [2]. The biological balance of life on our planet is crucially maintained by the microorganisms found in soil. Depending on the soil conditions, different amounts of bacteria, fungi, and viruses can be present in all soils [3]. The nutrients in soil are increased by the byproducts and products of soil microorganisms, which also play an important role in food sources and plant growth [3-4]. Additionally, the soil's microorganisms play a major role in forming the nutrients into useful materials [5]. Soil microorganisms are important for biogeochemical cycles and the biosphere's continued sustainability [6]. Agriculture is significantly impacted by two or three major naturally occurring greenhouse gases that are produced and consumed by soil microorganisms [7]. A wide variety of organic matter in the earth supports the existence of a significant microbial community in the soil. Most of these microorganisms are bioactive and can survive in the soil's top few inches [8]. Nearly 500 new antibiotics are discovered each year, the most of which are obtained from soil bacteria [9-10]. Numerous authors have extensively discussed the use of fungus to increase the nutritional content of soil. Since fungi have a significant impact on ecosystem structure and functioning, they are important for many ecological services [11]. In the soil, fungi play an important role in nutrient cycling, disease prevention, and water dynamics, all of which promote the health and vigor of plants [12]. Currently, using fungi to recover nutrients is preferred by many agricultural practices over using chemical fertilizers. The use of fungi in agricultural activities appears to be a promising strategy for farmers, as this technique is an environmentally friendly and cost-effective solution to the issue of environmental pollution [11] that has been generated by the use of chemical fertilizers and pesticides [13]. The six constituents of soil—inorganic matter, organic matter, soil organisms, soil moisture, soil solution, and soil air—make up this complex system. The soil has roughly 50–60% mineral

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materials, 25–35% water, 15–25% air, and only a small amount of organic matter [14]. Organic matter also improves the soil's physiochemical properties but also stimulates microbial growth and increases enzymatic activity [15]. The physicochemical properties of soil are important indicators for determining its nutrient content and characteristics. The quantity and quality of organic matter (OM), soil structure, pH, and physicochemical properties are crucial indicators of soil quality [16]. Various factors, such as altitude, parent rocks, vegetation, and anthropogenic activities, can have an impact on the physicochemical characteristics of the soil, such as pH, organic matter, cation exchange capacity (CEC), soil texture, and water chemistry. pH 5 to 7 is the optimal range for soil, which affects the availability of nutrients [17]. In the current study, to isolate and identify shrimp shell degraded soil microorganisms, calculated Shannon's and Simpon's diversity, and analyzed physicochemical parameters.

MATERIALS AND METHODS

Sample collection

Shrimp shell-degraded soil samples were collected from two different locations in Thanjavur District, Mallipattinam East and West. Soil samples were weighed and kept at room temperature in a closed space with a moist atmosphere for no longer than 48 hours. The collected soil samples were taken by hand, allowed to air dry, and then brought to the laboratory in sterile polythene bags or cleaned bottles.

Isolation of microorganisms

Shrimp shell-degraded soil samples were isolated using a laminar-flow chamber, and manual operations were performed. For one to two weeks, petri dishes were incubated at 30 °C. Every day, cultures were checked for the presence of bacterial colonies and/or fungus mycelium using a stereo microscope.

Isolation of bacteria

The soil samples containing shrimp shell degradation were further homogenized and used to bacterial isolation [18-19]. The homogenate sample was subsequently serially diluted with 10^{-4}, 10^{-5} and 10^{-6} samples before being spread out on NA media separately for bacteria. As a control without a sample, one medium from each of them was maintained. Bacterial colonies were counted after the Petri plates were incubated at 37 °C for 24 hours.

Identification

The identified bacterial cultures were cultivated using peptone (5g/l), beef extract (1.5g/l), yeast extract (1.5g/l), sodium chloride (5g/l), and pH 7.0. The culture was kept at 29°C on nutrient agar slants until it was needed. Subculturing was carried out every two weeks. The shrimp shell degraded soil samples were diluted and plated on nutrient agar medium. Bergey's Manual of Determinative Bacteriology [20] states that the colonies were purified using the continuous streaking method and characterised using macroscopic and biochemical tests after being purified. The colony morphology, surface pigment, size, margin, surface on nutrient agar plates and microscopic examination, including gram's staining behaviour, shape and cell arrangement, were used to identify the bacterial isolates macroscopically [21].

Gram staining

It was used on bacterial cultures to determine whether they were Gram positive or negative, as well as their morphology.

Biochemical test of bacterial isolates [22]

For a preliminary study, subculture inoculums of an isolated bacterial strain were prepared. However, each strains pure culture inoculums were incubated for 24 hours. Each bacterial strains biochemical test was performed according to standard procedures. The indole production, methyl red, Voges Proskaur, citrate utilization, catalase, carbohydrate fermentation test, oxidase disc method, and triple sugar iron agar biochemical tests were performed. Bacterial Culture Growth and Maintenance [23].

Isolation of fungi

A soil sample of ten grammes was taken and placed in a conical flask of 250 ml filled with sterile distilled water. To obtain a homogenous solution and different dilutions of the soil sample, the flask was shaken on an electric shaker. After serially diluting the homogenate sample with 10^{-3}, 10^{-4} and 10^{-5} samples, it was then spread out on NA media separately for bacteria. Potato Dextrose Agar (PDA) was prepared and sterilised in an autoclave at 121 °C for 15 minutes. Before placing the medium in the petri plates, it was mixed with a streptomycin sulphate solution (1:1). After solidification, 0.1 mL of a serially diluted soil sample was added to the medium. The inoculum was spread equally and left undisturbed for three to five days in a room free of dust. The fungal colonies were counted. The pure cultures were kept on the common potato dextrose agar medium [24].

Identification

The fungi were identified by using standard manual such as Manual of Soil Fungi [25], Dematiaceous Hyphomycetes [26], More Dematiaceous Hyphomycetes [27], Hyphomycetes [28]. The fungi on PDA plates were identified based on characteristic features of colony morphology and reproductive structural characteristics like sporangiospore position columella and spore shape, a manual of penicillia [29-30]. Freshly grown mycelia with small amount of medium were stained with LCB and examined under stereo binocular microscope. Identified fungal cultures were maintained on the PDA medium in the laboratory by using conventional methods and sub cultured at regular intervals.

Physicochemical parameters

The physico-chemical parameters of collected shrimp shell degraded soil were analyzed by standard methods [31]. Diversity index is a mathematical measure of species diversity and species abundance of individuals in a given community. Two types of Shannon and Simpson diversity indices.

Shannon index

The statistic index which means it assumes all species are represented in a sample and they are randomly sampled. The values of diversity have been calculated as follows [32].

$$H = -\Sigma \, Pi \, Ln \, Pi$$

Where p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations and s is the number of species.

Simpson index

Simpson index is calculated using equation mentioned in [33].

as the following: $D=1-\Sigma(Pi)^2$

Where, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations. N total number of individuals.

Statistical analysis

The most popular diversity indices for determining the species variety of a region are those developed by Shannon (H) and Simpson (D) using Microsoft Excel 2007.

RESULTS AND DISCUSSION

Numerous scientists have selected soil as the location for the isolation of numerous bacteria that generate antibiotics. Twenty soil bacterial strains were identified as being effective against the pathogenic microbes by [34]. The agar well diffusion method, which uses cell free culture filtrates as a secondary screening medium for bacteria, has been widely used by scientists [35-37]. It carried out similar studies on various bacteria, and their findings revealed that the most of the Bacillus species have the ability to produce antibiotics [38]. The primary and secondary screening techniques employed in our work for the isolation and screening of bacterial isolates were used by [39-40]. The purpose of isolation in this study was to evaluate and identify the performance of various microorganisms with the highest capacity to produce degradation from shrimp shell through soil in Mallipattinam east and west. Two different sites amount of soil samples were serially diluted, spread out on Nutrient agar plates, dilution factors are 10^{-4}, 10^{-5}, 10^{-6} and incubated at 30 °C for 3 days. Eighty bacterial colonies in total were isolated from the two previously mentioned places. Colony Forming Unit (CFU), were used to count microbial colonies. The streak plate method was used to identify and purify the bacterial colonies with different morphologies. The total number of colonies were isolated maximum at 48 in Mallipattinam east and minimum at 32 in Mallipattinam west. Finally, most of the colonies are recorded at Mallipattinam east shrimp shell degraded soil than other (Table 1).

Table 1 Isolation of bacteria from shrimp shell degraded soil samples

Name of the places	Total no of colonies (CFU/ml)		
	Bacteria		
	10^{-4}	10^{-5}	10^{-6}
Mallipattinam East	12	16	15
Mallipattinam West	11	12	19

The morphological and biochemical characterization of isolates PR1, PR2, and PR3 was completed as it is a standard procedure used by microbiologists all over the world [41] and a tool for preliminary identification of bacteria. In order to identify the bacteria over the course of several decades, the most of laboratories have used microscopic identification and biochemical characterization [42]. This is because bacteria lack sufficient morphological features to confirm their identity. The selected isolates' abilities for decomposition as indicated the study have been reported in previous [43]. In this study of morphological characterization, the isolated bacterial strains such as colour, Gram's staining, cultural appearance after staining, endospore staining and mode of respiration were noted for the 12 isolated strains. Regarding Gram staining, 5 isolate were Gram positive and remaining were Gram negative (Table 2).

Table 2 Biochemical characterization of isolated bacteria in shrimp shell degraded soil samples

Strain	Colour of colony	Gram's staining	Cultural appearance after staining	Endospore staining	Mode of respiration
KD1	Milky white	-ve	Ellipsoidal to rod shape	-ve	Obligatory aerobic
KD2	Yellowish white	-ve	Rod shape	-ve	Anaerobes
KD3	White or slightly yellow	+ve	Rod shape	+ve	Facultatively anaerobic
KD4	Grayish white	+ve	Rod shape	+ve	Aerobic or anaerobic
KD5	Grayish to white colored layer	-ve	Rod shape	-ve	Facultatively anaerobic
KD6	Yellow to amber	-ve	Rod shape	-ve	Facultatively anaerobic
KD7	Brownish or yellow	-ve	Rod shape	-ve	Facultatively anaerobic
KD8	White	+ve	Rod shape	-ve	Facultatively anaerobic or micro aerophilic organotrophs
KD9	Blue or green	-ve	Rod shape	-ve	Aerobic facultatively
KD10	White to gray	+ve	Cocci shape	-ve	Facultatively anaerobic
KD11	Yellow to golden yellow	+ve	Spherical shape	-ve	Facultatively anaerobic
KD12	Dark purple	-ve	Curved or straight rods	-ve	Aerobic or facultatively anaerobic

In biochemical characterization, all the isolated bacterial strains were tested for different parameters such as Motility, indole, methyl red, voges proakeaur, citrate, catalase, lactose, sugar fermentation and oxidase. We propose using the strain designation KD to indicate the isolation of the bacteria from soil with degraded shrimp shells. Twelve well defined colonies (KD1 to KD2) were selected and were pure cultured. Almost isolates were rod shaped formers (KD1 to KD9), KD10 were cocci shaped, KD11 were spherical shaped and KD12 were curved or straight rods. KD1, KD2, KD5, KD6, KD7, KD9, KD12 were found to be gram negative and remaining all other isolates identify KD3, KD4, KD8, KD10, KD11 were gram positive in reaction. Endospore formed in two bacterial strains KD3 and KD4, but remaining being all the strains are no spore formation. The mode of respiration in bacterial strains, KD1 were obligatory aerobic and KD2 to KD12 were facultatively anaerobic. KD1 is milky white, KD2 is yellowish white, KD3 is white or slightly yellow, KD4 is grayish white, KD5 is grayish to white-colored large, KD6 is yellow to amber, KD7 is brownish to yellow, KD8 is white, KD9 is blue or green, KD10 is white to grey color, KD11 is yellow to golden yellow, and KD12 is dark purple, respectively. The majority of maximum bacterial colonies (KD6) were found in Mallipattinam east, KD5 in west, and minimums at KD8 in east and KD3, KD9 in west were examined. The morphological characteristics of each isolate, all of which showed good growths, were described in (Table 3).

In order to group and identify the bacteria up to the level of genus and species, various procedures have been developed based on their nutrition, metabolic activities, metabolic products, or enzymatic reactions [44]. In this study, totally 12 bacterial species were identified such as KD1 to KD12 from shrimp shell degraded soil in Mallipattinam east and west. The KD1 identified as *Acetobacter* sp, KD2 as *Aeromonas hydrophila*, KD3 as *Bacillus cereus*, KD4 as *Bacillus subtilis*, KD5 as *Enterobacter* sp, KD6 as *E. coli*, KD7 as *Klebsiella*

pneumoniae, KD8 as *Lactobacillus* sp, KD9 as *Pseudomonas* sp, KD10 as *S. anginosus*, KD11 as *S. aureus* and KD12 as *V. cholera*. The results of various biochemical tests performed to identify the bacterial strains were provided in the (Table 4).

Table 3 Morphological biochemical characterization of isolated bacteria in shrimp shell degraded soil samples

Strain	Motility	Indole	Methyl red	Voges proskeaur	Citrate	Catalase	Lactose	Sugar fermentation	Oxidase	Identification of bacteria
KD1	-	+	-	-	+	+	+	-	-	*Acetobacter* sp
KD2	+	+	-	-	+	-	-	-	+	*Aeromonas hydrophila*
KD3	-	-	-	+	-	+	-	+	+	*Bacillus cereus*
KD4	+	-	+	-	-	+	+	+	-	*B. subtilis*
KD5	-	-	+	-	+	+	-	+	-	*Enterococcus* sp
KD6	+	+	-	+	-	-	-	-	+	*Escherichia coli*
KD7	-	-	+	-	+	-	-	+	-	*Klebsiella pneumoniae*
KD8	-	-	-	+	-	+	-	+	+	*Lactobacillus* sp
KD9	+	-	+	-	+	-	-	+	-	*Pseudomonas* sp
KD10	+	+	+	-	-	+	-	-	+	*Streptococcus anginosus*
KD11	-	+	-	+	-	+	+	-	-	*Vibrio cholerae*
KD12	+	-	-	+	-	-	-	+	+	*Staphylococcus aureus*

Table 4 Identification of bacteria from shrimp shell degraded soil samples

Name of the bacteria	Different places	
	Mallipattinam East	Mallipattinam West
Acetobacter sp	07	02
Aeromonas hydrophila	02	-
Bacillus cerus	05	01
Bacillus subtilis	07	-
Enterobacter sp	03	11
Escherichia coli	12	04
Klebshiella pneumoniae	02	-
Lactobacillus sp	01	04
Pseudomonas sp	05	01
Streptococcus anginosus	04	03
Streptococcus aureus	-	02
Vibrio cholera	-	04
Total no. of colonies	48	32

These are the major factors that influence the population and diversity of fungi. To separate the fungus, soil was diluted in petri plates. More species and colonies were isolated on soil plates than on dilution plates, and more species were isolated overall as sample dilutions were increased [45]. Several studies have demonstrated that many soil fungus, particularly from the genera *Aspergillus* and *Penicillium*, have the ability to convert insoluble phosphates in soil into soluble forms by secreting organic acids [46]. Soil microorganisms have a big impact on the variation and productivity of plant communities [47].

Table 5 Isolation of fungi from shrimp shell degraded soil samples

Name of the places	No of colonies (CFU/ml)		
	Fungi		
	10^{-3}	10^{-4}	10^{-5}
Mallipattinam East	24	22	25
Mallipattinam West	20	21	22

In the present study, the fungi isolated from two different sites of Mallipattinam east and west recorded. The soil samples were serially diluted, spread out on Potato dextrose agar plates, dilution factors are 10^{-3}, 10^{-4}, 10^{-5}. Totally 134 colonies were isolated from the shrimp shell degraded soil. The maximum colonies 81 are presented at Mallipattinam east and minimum 53 at west. Almost colonies were recorded at the Mallipattium east soil sample. Finally, most of the colonies were recorded at the Mallipattinam east soil sample (Table 5). A total of 25 fungal isolates were identified such as *Absidia glauca*, *Alternaria alternata*, *Aspergillus alliaceus*, *A. awamori*, *A. candidus*, *A. chevalieri*, *A. flavipes*, *A. flavus*, *A. fumigatus*, *A. nidulans*, *A. niger*, *A. ochraceous*, *A. ruber*, *A. sydowii*, *A. terreus*, *A. versicolor*, *Curvularia lunata*, *Fusarium oxysporum*, *F. solani*, *Penicillium citrinum*, *P. janthinellum*, *P. purpurogenum*, *P. roqueforti*, *Trichoderma viride* and *Verticillium* sp.

Table 6 Identification of fungi from shrimp shell degraded soil samples

Name of fungi	Different places	
	Mallipattinum East	Mallipattinum West
Absidia glauca	-	04
Alternaria alternata	-	03
Aspergillus.alliceus	03	06
A. awamori	04	02
A. candidus	01	07
A. chevalieri	02	-
A. flavibes	03	-
A. flavus	11	06
A. fumigatus	09	07
A. nidulans	03	03
A. niger	09	04
A. ochraceous	02	-
A. ruber	03	-
A. sydowii	03	05
A. terreus	08	02
A. versicolor	-	01
Curvularia lanata	-	03
Fusarium oxysporum	01	02
F. solani	02	-
Penicillium citrinum	08	03
P. janthinellum	-	01
P. purpurogenum	01	-
P. roqueforti	-	-
Trichoderma viride	07	01
Verticillium sp	01	-
Total no. of colonies	81	53

The cultural and microscopic characteristics were used. The fungal isolates belonged to 8 genera as follows *Aspergillus* (7.43%), *Pencillium* (3.25%), *Trichoderma* (3%), *Fusarium* (2.5%), *Absidia* (2%), *Alternaria* (1.5%) and *Verticillium* (0.5%). *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus terreus*, *Penicillium citrinum* and

Trichoderma viride colonies are maximum presented in Mallipattinam east soil sample and minimum recorded at *Aspergillus candidus, Fusarium oxysporum, Penicillium purpurogenum* and *Verticillium* sp. While *A. candidus, A. fumigatus, A. alliaceus* and *Aspergillus flavus* are maximum at Mallipattinam west and minimum at *A. versicolor, P. janthinellum* and *Trichoderma viride*. Both places are compared with the colonies are recorded at *Aspergillus flavus* and *A. fumigatus*. In particularly, *Aspergillus* genera were mostly noted by the Mallipattinam east shrimp shell degraded soil sample (Table 6).

The dominance or relative concentration of the importance values for the first or first few species was primarily expressed by the Simpson index (D). The relative evenness or equitability of the importance values all through the entire sequence was expressed by the Shannon-Wiener index (H') [48-49]. In this study, the highest values of the Shannon and Simpson diversity indices were found in Mallipattinam east when compared with Mallipattinam west. In the Mallipattinam east, the Shannon diversity of bacteria was 2.105 H and that of fungi was 2.678 H, while the Simpson diversity of bacteria was 0.877 D and that of fungi was 0.939 D, respectively (Table 7).

Table 7 Shannon's and Simpson's diversity indices of bacteria and fungi from Mallipattinam east and west shrimp shell degraded soil sample

Marine water indices	Mallipattinam East		Mallipattinam West	
	Bacteria	Fungi	Bacteria	Fungi
Shannon diversity (H)	2.105	2.678	1.931	2.673
Simpson diversity (D)	0.877	0.939	0.842	0.938

Table 8 Analysis of physico-chemical parameters of degraded shrimp shell soil

Parameters	Different places	
	Mallipattinam East	Mallipattinam West
Colour	Ash gray	Ash gray
Texture	Fine	Fine
Temperature (°C)	24˚C	20˚C
pH	8.11	8.06
Electrical conductivity (dsm^{-1})	0.25	0.23
Organic carbon (%)	0.23	0.21
Organic matter (%)	0.37	0.32
Available nitrogen (mg/kg)	105.1	102.5
Available phosphorus (mg/kg)	4.15	4.10
Available potassium(mg/kg)	137	134
Available zinc (ppm)	1.21	1.02
Available copper (ppm)	0.68	0.52
Available iron (ppm)	4.61	4.25
Salinity (ppt)	3.40	2.87
Available manganese (ppm)	2.23	2.37
Cat ion exchange capacity (C. Mole $Proton^{+}$/kg)	25.6	24.4
Calcium (mg/kg)	14.2	13.5
Magnesium (mg/kg)	7.6	7.3
Sodium (mg/kg)	1.33	1.38
Potassium (mg/kg)	0.23	0.36

The significant component of the soil that improves soil fertility is organic matter. The basis of soil fertility is soil organic carbon. Nutrients are released for plant growth, increasing soil organic carbon improves soil fertility and health [50]. The master key element in soil quality is phosphorous. It is a crucial component of every living cell. It is essential for development, cell division, root growth, fruit and seed production, and early ripening [51]. The direct discharge of industrial effluents, especially those that are untreated, can have a significant impact on the physicochemical and biological characteristics of soil that are related to soil fertility [52]. In the current study, the physicochemical parameters including shrimp shell degraded soil were collected from two different sites with Mallipattinam east and west. The maximum parameters were recorded at Mallipattinam east soil sample such as colour, texture, Temperature (°C), pH, Electrical conductivity (dsm^{-1}), Organic carbon (%), Organic Matter (%), Available Nitrogen (mg/kg), Available Phosphorus (mg/kg), Available Potassium (mg/kg), Available Zinc (ppm), Available Copper (ppm), Available Iron (ppm), Salinity (ppt), Available Manganese (ppm), Cat ion Exchange Capacity (C. Mole Proton+/kg), Calcium (mg/kg), Magnesium (mg/kg), Sodium (mg/kg) and Potassium (mg/kg) were (ash gray), (fine), (24˚C), (8.11), ($0.25dsm^{-1}$), (0.23%), (0.37%), (105.1mg/kg), (4.15 mg/kg), (137 mg/kg), (1.21 ppm), (0.68 ppm), (4.61 ppm), (3.40 ppt), (2.23 ppm), (25.6 C. Mole Proton+/kg), (14.2 mg/kg), (7.6 mg/kg), (1.33 mg/kg) and (0.23 mg/kg). The Mallipattinam east soil sample were mostly recorded at physico-chemical properties (Table 8).

CONCLUSION

Population diversity and physicochemical properties from Mallipattinam east and west of degraded shrimp shell soil microorganisms were analyzed in the current study. Microorganisms are helpful in the production of food, the treatment of wastewater, the biofuel production, and the synthesis of numerous compounds and enzymes. They serve as excellent model organisms for study. They have been made into weapons and sometimes employed in bioterrorism and warfare. The immobilization of toxins and their reduced bioavailability after increasing the organic carbon may be among the possible benefits of increasing the amount of macro- and micronutrients in the soil that outweigh the negative effect. A crucial task in clinical microbiology will continue to be the development of the detection limits for microorganisms. By using a technique

known as bioremediation and keeping the health of our environment, microbes protect our environment from hazardous substances. Agricultural chemists consider the physicochemical analysis of factors to be crucial for managing soil and promoting plant growth. The state and direction of changes in the soil environment are indicated by defining the biological (microbiological and biochemical) as well as physicochemical parameters in soil in the area of uncontrolled landfills. They are important for both the environment and the welfare of people. These include the production of biomolecules, the production of pharmaceuticals, the manufacture of cosmetics, the processing and preservation of food, the recycling of soil nutrients, and so on. The collected data in this soil could be used as a baseline and reference point for future studies when analyzing major changes caused by the environment in these soils.

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Conflicts of interest

The authors declare no conflict of interest.

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