

Original Research Article

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Microbial Diversity of Soil in Some Coal Mine Generated Wasteland of Raniganj Coalfield, West Bengal, India

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ABSTRACT

The present study was conducted to determine the microbial diversity of soil in some coal mine generated wasteland of Raniganj Coalfield area. Seven different soil samples were collected from seven different sites namely Nagrakunda, Topsis colliery, Sidhuli, Sankerpur kenda, Bankola, Parascul, Sonapur Bazari of Raniganj Coalfield. Topography, vegetation, mining type, mining area, status of mining operation, biological reclamation activity was considered as basis of the sample selection. Soil physicochemical characteristics were also analyzed. For microbiological study, soil samples were processed according to standard microbiological techniques. The results of the present study enlightened that in our study area heterotrophic, gram negative, phosphate solubilizing bacterial population was quite high in Sankerpur kenda area whereas gram positive bacterial population was low in this area. Nagrakunda showed much higher gram negative bacterial population whereas Bankola showed lower gram negative, nitrate reducing and phosphate solubilizing bacterial population with low organic carbon, potassium content. Gram positive bacterial population was high in Topsis colliery and Sidhuli showed high nitrate reducing bacterial population. Overall, different area of Raniganj coalfield showed different picture of bacterial population with low nitrogen (except Bankola), potassium (except Nagrakunda), organic carbon (except Sonapur Bazari) and medium phosphorus content (except Sidhuli).

Keywords

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Introduction

Each soil habitat has unique and well adapted microbial guilds whose functionalities maintain its nutritional status, degrade pollutants and control different pests and diseases. Soil consists of layers of mineral of variable thicknesses having a difference from the parent materials in their morphological, physical, chemical, and mineralogical characteristics. Productivity and sustainability of soil's health is directly

influenced by qualitative and quantitative activities of microorganisms (Atlas et al, 1991, Kaneko et al, 1977). Soil contains carbon in the deep oceans (Raich and Potter, 1995 and Schimel, 1995), largest stores of nitrogen in terrestrial ecosystems (Schlesinger, 1997). With increasing rates of anthropogenic N deposition (Vitousek et al., 1997), there is a strong need to understand links between N inputs and soil respiration.

Nevertheless, most of the data available so far are limited to qualitative descriptions of bacterial distributions. In soil, a significant proportion of the microbes serve as pathogen/competitor/symbiotic agent, predator/antagonist of other microbes/organisms (Chatterjee *et al.*, 2008; Das *et al.*, 2008, Chatterjee and Ghosh, 2010; Chatterjee *et al.*, 2010, Chatterjee *et al.*, 2011, Chatterjee *et al.*, 2012). Coal is a valuable resource. It provides a significant amount of the world's energy supply and it is the basis for many industries. Coal mining becomes a major industry which assures the energy supply and becomes indispensable for the total development of a country. Coal mining started in the Raniganj Coalfield (RCF) area in 1774 during British East India period. The Raniganj Coalfield covers an area of 1530 sq.km, containing about 1306 sq.km of coal bearing land. There are about 117 coal mines and about 60 sq.km of the coalfield have been damaged by mining operations. The total estimated coal production is 950 Mt. Of these mines, twelve are opencast and 105 underground. In 1987-88 these mine produced 12.17 Mt and 15.84 Mt of coal respectively. Some 61.66 Mt/y of coal was produced by 2000, by which time 14000ha of land in the RCF had been damaged. Mining activities always lead to environmental degradation and pollution. Restoration is the process by which the impacts of mining on the environment are repaired. It is an essential part of developing mineral resources in accordance with the principles of sustainable development. Increasingly, today, the environmental protection sought by mining operators includes the maintenance of biodiversity. Present work has been designed to study the diversity of different groups of microorganisms in relation to the physicochemical properties in the soil-habitats of some coal areas of Raniganj, West Bengal.

Materials and Methods

The soil samples were collected from seven representative sites of Parascul, Sankerpur Kenda, Nagrakunda, Bankola, Sidhuli, Topsi Colliery, and Sonepur Bazari at Raniganj Coal Field. Top soil was removed and about 500 gm soil samples were collected from seven areas and mixed them thoroughly put in a clean sterile polythene bags, sealed with rubber bands and the samples were analyzed in the laboratory. After completion of assessment of the spoil physicochemical properties like pH, organic carbon, nitrogen, potassium, and phosphorus, following standard methods (Hajek *et al.* 1972, Isaac *et al.* 1984, Sumner *et al.* 1996 and APHA, 1998) soil samples were transported to the microbiological laboratory. By using different selective media and serial dilution method microbiological study were performed. Microbial colonies were enumerated as colony forming units (cfu). The heterotrophic, gram positive, gram negative, phosphate solubilizing, nitrate reducing bacteria were enumerated using the protocol of Pelczar *et al.* 1957.

Results and Discussion

Mining of coal causes massive damage of biological community. But a number of colonies have been found that indicates the presence of particular microbial species at those seven different sites of Raniganj Coalfield region. And microorganism in soil are critical for the maintenance of soil function in both natural and managed agricultural soils because of their involvement in such key processes as soil structure formation, decomposition of organic matter, toxin removal, and the cycling of carbon, nitrogen, phosphorus, and sulphur. Seven different sites of Raniganj Coalfield were inventorized and it was found that the color of soil of these sites was varied from brownish to black and soil

texture was coarse. The pH of soil was tabulated in Table: 1 which varied from 4.5 to 10. Microbiological studies were performed by using different media which tabulated in Table: 2. Serial dilution of soil were performed and by using selective media different agar plates were prepared for producing colonies in petriplate. These colonies suggest the presence of particular microbial population on those sites of Raniganj Coalfield. Heterotrophic bacterial population ranged from 1.2×10^4 to 8.5×10^4 and Nitrate reducing bacterial populations

was varied from 4.0×10^4 to 8.0×10^4 on those different sites of Raniganj Coalfield. Heterotrophic bacterial populations were much higher in Sankerpur kenda area where in Topsis Colliery region these populations were too much lower (Table 2). Nitrate reducing bacterial population was low in Bankola region, but found high in Sidhuli region (Table 2). Gram positive bacterial population ranged from 2.5×10^4 to 7.0×10^4 and gram negative from 1.0×10^4 to 7.0×10^4 at different sites of Raniganj Coalfield area.

Table.1 Physico-Chemical Characteristics of Soil Samples

Area	Color	Texture	pH	Nitrogen (Kg/Acre)	Potassium (Kg/Acre)	Phosphorus (Kg/Acre)	% of Organic Carbon
Nagrakunda	Brownish	Coarse	4.5	80	40	11	0.40
Parascul	Brownish	Coarse	4.5	80	20	8	0.45
Topsi Colliery	Brownish	Coarse	10.0	25	20	11	0.45
Sonepur Bazari	Brownish	Coarse	10.0	80	20	18	0.76
Bankola	Brownish	Coarse	5.0	300	20	11	0.36
Sankerpur kenda	Black	Coarse	8.5	25	20	18	0.45
Sidhuli	Black	Coarse	5.0	25	20	2	0.40

Table.2 Microbial Diversity in Different Soil Sample (Cfu/Gm of Soil)

Bacterial Population	Area						
	Nagrakunda	Parascul	Topsi Colliery	Sonepur Bazari	Bankola	Sankerpur Kenda	Sidhuli
Heterotrophic ($\times 10^{44}$)	3.5	5.0	1.2	7.5	2.0	8.5	6.5
Gram positive ($\times 10^4$)	4.5	3.0	7.0	3.6	5.0	2.5	3.1
Gram negative ($\times 10^4$)	7.0	4.0	1.5	4.8	1.0	7.0	5.0
Nitrate reducing ($\times 10^4$)	6.8	7.0	6.5	7.8	4.0	6.0	8.0
Phosphate solubilising ($\times 10^4$)	2.0	3.7	4.0	3.0	1.1	7.8	2.0

Cfu= colony forming unit

Gram negative bacterial populations were low in Bankola region, but found high in

Sankerpur kenda and Nagrakunda region (Table 2). Maximum gram positive were

found in Tosi Colliery area. Phosphate solubilizing bacterial pollution ranged from 1.1×10^4 to 7.8×10^4 at seven different sites of Raniganj Coalfield, that bacterial population was too much low in Bankola region where it was found high in Sankerpur Kenda area. Nitrogen quantity was too much lower at Tosi colliery area where as phosphorus quantity was much lower at Sidhuli area. Potassium quantity was averagely same and low in different areas of RCF except Nagrakunda. Organic carbon content was too much high in Sonepur Bazari area whereas other area was averagely low in according to organic carbon quantity. So it was found at Sonepur Bazari, higher quantity of organic matter present which was important for soil fertility and other regions were required to raise the level of organic carbon.

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