Microbial Diversity in the Sandy Soil of Nara Thar Desert Khairpur, Sindh, Pakistan

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The microbial diversity was studied by Standard Plate Count and Direct Root Inoculation in the Nara Desert eco-region soil Khairpur, Sindh, Pakistan. It was found that the bacterial count was 200000 to 280000 per gram of soil whereas fungal count was 84000 to 110000. Among the bacterial diversity it was observed that there was existence of *Bacillus* sp., and halophilic Gram negative rods and cocci and five species of fungi belonging to three genera viz, *Aspergillus, Alternaria* and *Cunninghamii* were present. Hence more exploration is needed to recover many other micro-organisms and their relation with various plants and people of this eco-region.

Introduction

Many micro-organisms that live in soil play indispensable role in maintaining life on this planet by their chemical modifying behaviour. One of the most important functions of microbes in soil is their degradation of dead and waste products. These microbes also produce a variety of potentially active compounds such as antibiotics, enzymes and other organic acids in soil for their survival. Some microorganisms form the positive symbiotic relationships such as symbiosis and mycorrhiza with plants. However, not all soil organisms are beneficial since soil is also habitat of a number of bacteria and fungi that are potentially pathogenic for humans, animals and plants (Nester *et al.,* 2001).

Keeping in view this enormous significance of soil microorganisms, the present work was carried out to study the microorganisms (bacteria and fungi) in the Thar Desert soil because hardy species can only survive such environment. Some physicochemical properties of desert soil were also studied.

Area of Study

The Thar Desert is the largest desert of South Asia which spreads between the several provinces of two countries i.e., India and Pakistan, covering an area of about 4,46,000 square kilometers. The desert in Pakistan covers two provinces; Cholistan occupying the Southeastern side of Punjab and Thar covering entire eastern side of Sindh.

The geomorphology of this area consists of four major features: (a) Sandy Desert (b) Alluvial valleys (c) traces of ancient River courses and (d) the lakes. All features further hold varied floral density suitable for the consumption of humans, animals and microbes and also for the construction of huts and household items.

In Thar region the common plants are: *Khabar Salvadora oleoides, Kirar Capparis decidua* and *Kandi Prosopis cineraria;* the shrubs are: *Phog Calligonium polygonoides, Ak Calotropis procera, Khip Leptadenia pyrotechnica, Booh Avera javanica* and *Lano Haloxylon stocksii;* the herbs are: *Chhapri Neurada procumbens, Ghorawal Cassia italica* and the grasses are: *Katan Cymbopogon jawarancusa, Lumb Stipagrostis plumosa, Boro Saccharum bengalensi* and *Sinnh Crotolaria burhia* (Qureshi, 2004).

The monsoonal grasses also supplement the resource. Nevertheless, the plants provide nutritive and appetizing pasturage for the animals and medicines for local inhabitants. These plants also provide suitable nutrients for the growth of microbes, the factor which was comprehended from present research of some specific plants.

Looking at the importance of the Thar desert from the point of view of vegetation and human cultural activities, the present work was carried out on the microbial biodiversity existing in Nara eco-region (Plate 1).

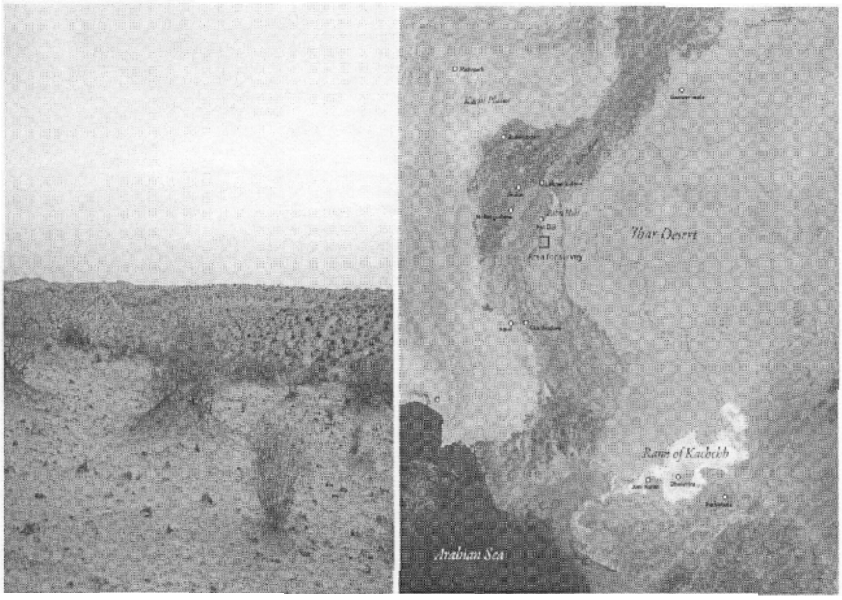

Plate 1
Shows the area of study (Nara eco-region)

Materials and Methods

The research methodology consists of three stages viz. Stage 1: collection of samples i.e. soil samples and plant roots; Stage 2: processing of data for which two methods were employed; such as: (a) the standard plate count and (b) root inoculation; and Stage 3 is based on the discussion, interpretation and results of the study.

Collection of Soil and Root Samples

Thirty soil samples and four plant root samples (*Salvadora oleoides, Capparis decidua, Prosopis cineraria* and *Aerva javanica*) root samples were collected from various sites of area of study and the exact coordinates were recorded through Global Positioning System (GPS). All samples were collected from surface, (Map). Each soil sample was collected in polythene bags 4" × 6" (Plate 2). Physico-chemical analysis and microbiological studies of soil were carried out at Microbiology Laboratories of the Department of Microbiology, Shah Abdul Latif University, Khairpur.

Standard Plate Count

This method has generally been used to estimate the number of micro-organisms per gram of the soil collected from surface and rhizosphere. The soil dilutions from 1:10 to 1:10000 were prepared. One milliliter of each dilution up to 10000 was inoculated on Sabouraud's Dextrose Agar (SDA) Medium for fungi and Nutrient Agar for Bacteria and incubated at 25°C for fungi and 37°C for bacteria, respectively. Colonies of mycoflora and bacteria were observed and identified (Domesh *et al.,* 1980).

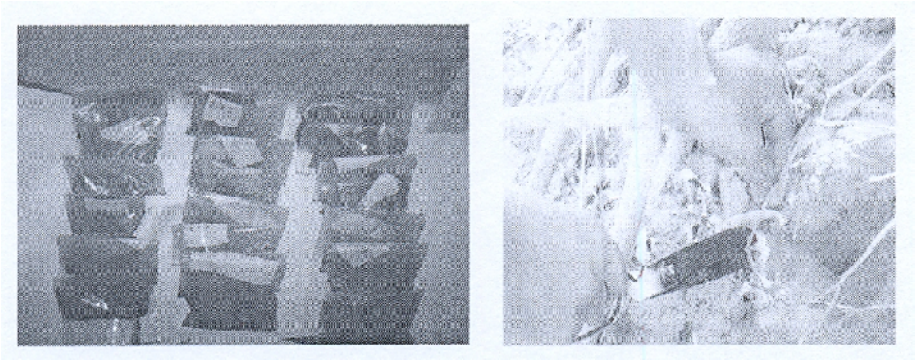

Plate 2
Shows the collected samples in polythene bags and the process of collection of roots

Direct Root Inoculation

The collected root samples were inoculated on the surface of culture medium SDA for one week at 25°C in order to isolate the mycoflora from Rhizoplane. Then fungi were observed and identified (Domesh *et a1.,* 1980) (Plate 3).

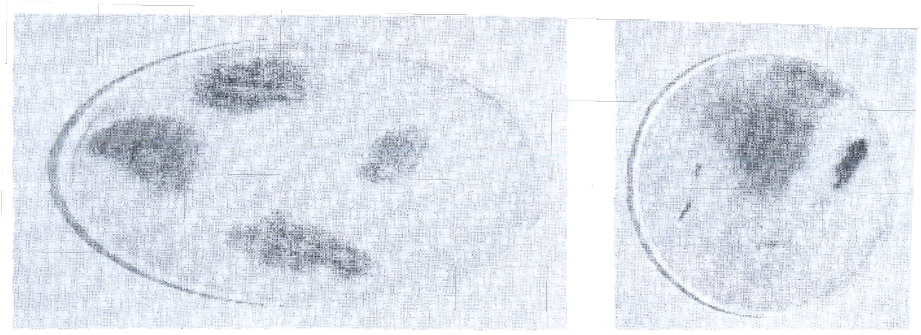

Plate 3
Shows different Mycofloral growth on the inoculated roots

Result and Discussion

Table 1 shows the coordinates locality and physico-chemical properties of soil sample. During the present study bacterial and fungal count was determined. The count of bacteria was within the range of 200000 to 280000 per gram of soil and fungi 84000 to 110000 (see Table 2), which is lower than that found on the surface of fertile soil which is 10^8 to 10^9, also the fungi are lower than normal number which is up to 400000. It is due to dryness and low nutrients in desert soil. Some of these bacteria were gram positive rods bacilli and cocci and other were gram negative rods and few were identified as actinomycetes. Of course these bacteria and fungi may have great impact on the life of the desert such as to make symbiotic relationship with the roots of vegetation to cause diseases in people and animals (wild and domestic) and affecting the economy of people. Some may be nitrogen fixers to provide fixed nitrogen to the plants symbiotically. They may be taking important role in regulating the cycle of different elements (Nitrogen, Carbon, Sulfur, Phosphorus, etc.) by biodegradation of organic matter from plant and animal origins. These fungi may provide the nutrients such as sulfur and phosphorus to the plant by making the positive association with different plants which is known as mycorrhiza. Micro-organisms living in dry desert soil must be able to tolerate long periods of desiccation

TABLE 1
Showing Co-ordinates Locality and Some Physicochemical Properties of Soils of Desert

S.No.	Location		Moisture Content	pH	Org. Mat.	E.C	HCO_3	Texture
	Latitude North	Longitude East	%		%			
1.	27°.30'.09.3"	69°.11'.03.8"	0.29%	7.29	1.353%	0.16	1.6	Sandy
2.	27°.29'.28.1"	69°.29'.08.1"	0.66%	7.16	0.57%	0.09	1.4	Sandy
3.	27°.32'.40.8"	69°.27'.56.4"	0.12%	7.49	0.30%	0.17	1.5	Sandy
4.	27°.28'.15.4"	69°.09'.40.3"	0.87%	7.38	0.13%	0.13	1.9	Sandy
5.	27°.27'.57.2"	69°.10'.57.8"	0.76%	7.19	1.6%	0.11	1.7	Sandy
6.	27°.29'.21.0"	69°.04'.27.6"	0.62%	7.36	0.13%	0.15	1.6	Sandy
7.	27°.29'.58.7"	69°.28'.25.8"	0.55%	7.38	2.33%	0.14	1.8	Sandy
8.	27°.30'.32.5"	69°.21'.15.9"	0.39%	7.41	1.823%	0.10	1.2	Sandy
9.	27°.30'.45.3"	69°.27'.44.9"	0.2%	7.25	1.1%	0.18	1.3	Sandy
10.	27°.30'.57.7"	69°.19'.21.2"	0.36%	7.31	1.97%	0.17	1.5	Sandy
11.	27°.29'.55.1"	69°.11'.22.4"	0.22%	7.15	0.61%	0.13	1.6	Sandy
12.	27°.29'.8.3"	69°.04'.0.4"	0.48%	7.59	1.5%	0.12	1.8	Sandy
13.	27°.46'.52.2"	69°.46'.44.6"	4.3%	6.46	1.25%	2.17	0.9	Sandy
14.	27°.47'.14.5"	69°.40'.12.2"	0.17%	7.44	0.64%	0.11	1.7	Sandy
15.	27°.48'.28.2"	69°.50'.03.9"	1.02%	7.33	1.86%	0.15	1.3	Sandy
16.	27°.50'.41.5"	69°.34'.16.6"	0.34%	7.27	1.75%	0.12	1.2	Sandy
17.	27°.38'.01.5"	69°.22'.38.6"	0.83%	7.42	1.9%	0.13	2.1	Sandy
18.	27°.36'.11.9"	69°.22'.1.2"	0.71%	7.45	1.8%	0.17	1.4	Sandy
19.	27°.39'.27.6"	69°.27'.20.9"	0.31%	7.21	0.05%	0.13	1.6	Sandy
20.	27°.57'.59.5"	69°.56'.14.8"	1.21%	7.35	1.4%	0.09	1.7	Sandy
21.	27°.27'.55.0"	69°.06'.17.2"	0.59%	7.18	1.81%	0.14	1.2	Sandy
22.	27°.53'.51.1"	69°.55'.33.9"	0.43%	7.31	1.45%	0.11	1.8	Sandy
23.	27°.27'.17.8"	69°.08'.37.3"	0.73%	7.41	1.62%	0.17	1.9	Sandy
24.	27°.53'.08.9"	69°.55'.45.3"	0.25%	7.40	1.533%	0.11	1.5	Sandy
25.	27°.44'.32.4"	69°.43'.26.8"	0.69%	7.35	0.40%	0.14	2.3	Sandy
26.	27°.37'.15.0"	69°.22'.16.3"	0.41%	7.37	2.01%	0.16	1.4	Sandy
27.	27°.27'.39.7"	69°.07'.58.8"	0.61%	7.26	1.63%	0.13	1.7	Sandy
28.	27°.49'.10.3"	69°.49'.08.8"	0.14%	7.48	2.4%	0.12	1.8	Sandy
29.	27°.45'.38.1"	69°.26' .39.6"	0.38%	7.32	1.5%	0.17	2.2	Sandy
30.	27°.48'.26.3"	69°.44'.05.3"	0.52%	7.31	1.3%	0.11	1.6	Sandy

TABLE 2
Number of Bacteria and Fungi Per Gram Desert Soil Determined by the Standard Plate Count of Various Samples

S.No.	Location		Colony Forming Unit Bacteria	Colony Forming Unit Fungi
	Latitude North	Longitude East		
1.	27°.30'.09.3"	69°.11'.03.8"	233000	90000
2.	27°.29'.28.1"	69°.29'.08.1"	256000	100000
3.	27°.32'.40.8"	69°.27'.56.4"	246000	89000
4.	27°.28'.15.4"	69°.09'.40.3"	226000	87000
5.	27°.27'.57.2"	69°.10'.57.8"	243000	90000
6.	27°.29'.21.0"	69°.04'.27.6"	253000	86000
7.	27°.29'.58.7"	69°.28'.25.8"	240000	88000
8.	27°.30'.32.5"	69°.21'15.9"	233000	85000
9.	27°.30'.45.3"	69°.27'.44.9"	270000	89000
10.	27°.30'.57.7"	69°.19'.21.2"	216000	90000
11.	27°.29'.55.1"	69°.11'.22.4"	250000	105000
12.	27°.29'.8.3"	69°.04'.0.4"	233000	95000
13.	27°.46'.52.2"	69°.46'.44.6"	200000	110000
14.	27°.47'.14.5"	69°.40'.12.2"	220000	96000
15.	27°.48'.28.2"	69°.50'.03.9"	266000	99000
16.	27°.50'.41.5"	69°.34'.16.6"	243000	91000
17.	27°.38'.01.5"	69°.22'.38.6"	216000	93000
18.	27°.36'.11.9"	69°.22'.1.2"	220000	90000
19.	27°.39'.27.6"	69°.27'.20.9"	280000	94000
20.	27°.57'.59.5"	69°.56'.14.8"	226000	87000
21.	27°.53'.51.7"	69°.55'.33.9"	260000	102000
22.	27°.27'.17.8"	69°.08'.37.3"	223000	96000
23.	27°.53'.08.9"	69°.55'.45.3"	236000	99000
24.	27°.44'.32.4"	69°.43'.26.8"	246000	85000
25.	27°.37'.15.0"	69°.22'.16.3"	223000	89000
26.	27°.27'.39.7"	69°.07'.58.8"	210000	103000
27.	27°.49'.10.3"	69°.49'.08.8"	253000	84000
28.	27°.45'.38.1"	69°.26'.39.6"	273000	94000
29.	27°.48'.26.3"	69°.44'.05.3"	276000	90000
30.	27°.45'.40.1"	69°.34'.54.2"	260000	91000

and draughts (Skujins, 1984). Many of the bacteria and fungi living in desert soil form spores that allow them to persist, if necessary. For decades between growth period when there is adequate moisture available, the spores germinate and for a brief period the organism can actively grow and reproduce (Atlas 1998). Most bacteria are unable to form endospore and they may be exposed to desiccation. In vegetative bacterial cells, desiccation may denature the protein and can also fragment nucleic acids, including lethal mutation. The combination of these effects may kill susceptible bacteria, therefore the count of bacteria and fungi is found low in desert soil during present study (Table 2). By producing the compatible solutes and synthesis of trehelose and sucrose the osmo-tolerant bacteria protect themselves against desiccation damage (Potts, 1994).

Besides, extra-cellular polysaccharide (EPS) in the form of sheath, capsule and slime provide protection to these organisms against desiccation e.g. *Nostoc commune,* a cyanobacteria.

When these microbes degrade the organic matter for nutrients, some of these produce the antibiotics to inhibit other types of organisms, in turn, reduce the competitors for nutrients, so important for pharmaceutical industries. As mentioned in the introduction of this study, not all soil organisms are beneficial since soil is also habitat of a number of pathogenic bacteria. It is important to explore more microorganisms of significance and their association with the fauna and flora of the desert under study.

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