Abstract

Culturable bacterial profile, bacterial chromium tolerance, chromium removal efficiency, their role in plant well-being and environmental cleaning were investigated in this study. The literature survey revealed that the microbes growing in heavy metal polluted soil can furnish an impressive mode of environmental heavy metal degeneration. In order to understand the activity of microbial heavy metal tolerance, rhizospheric microbes were isolated from the soil of three hot and humid, heavy metal depository sewage reservoirs in the south (Circular Canal, Tolly Nullah), east (East Kolkata Wetland), and north (Kestopur Khal) of Kolkata. Different morphological, physiological, and biochemical characteristics and antibiotic resistance patterns were analyzed with these isolated microbes. In order to compare the composition of the bacterial community, the selected microbes were subjected to molecular characterization after fulfilled the criteria of polyphasic classification accordingly. The heavy metal resistance patterns and possible biochemical mode of action behind chromium reduction of selected microbes and their impact in reducing the chromium concentration were subsequently investigated. The microbe inhabited at anoxic to hypoxic chromium polluted sewage environment, adapted itself by such a manner that, it can utilize the redox potential of chromium reduction to fulfil its own physiological needs in the absence of oxygen. The microbe produced extracellular organic acids, chelating compounds siderophore and EPS helped in microbial chromium absorption by inducing soil chromium mobility. Soil chromium mobility also influenced the reduction of plant chromium absorption and facilitated plant growth in chromium polluted environment by means of microbial chromium affinity. The Plant Growth Promoting Rhizobacteria (PGPR)-like traits of the isolated soil microbes were investigated and their influence on rhizospheric heavy metal absorption by the plant roots was studied. Three neutrophilic mesophilic chromium resistant microbial strains (*Microbacterium radiodurans* K12016, *Bacillus xiamenensis* 1E0018 and *Bacillus xiamenensis* 26K018) were chosen for their selective antibiotic sensitivity and effective chromium absorption and reduction capability, which are characteristics of a good bioremediating candidate. They may help to protect humans from heavy metal toxicity by reducing soil metal accumulation and also reduce heavy metal absorbance of edible plants.

List of Publications

Published research paper:

1. **Chatterjee C**., Bhattacharyya R., Sarkar Biswas S., 2018. Characterize heavy metal tolerant rhizospheric sewage bacteria isolated from Tolly nullah (with special emphasis on strain *Microbacterium radiodurans* K12016). IJESM. 7, 84-95.

Conferences attended:

1. **Chatterjee C**., Sarkar Biswas S, Bhattacharyya R., "Investion of plant growth promoting traits exhibited by heavy metal tolerant soil bacteria retrieved from Tolly Nullah (Kolkata)". **Poster Presentation** at **International Conference** on "The Green Planet: past, present and future" organized by Department of Botany, University of Calcutta; December 21-23, 2016; [Abstract Vol. pp. 166, Poster No. PP-T13-15].
2. **Chatterjee C**., Bhattacharyya R., Sarkar Biswas S. "Isolation and partial characterization of heavy metal resistance sewage bacteria from tolly nullah and their potential in the plant growth promotion". **Poster Presentation** at **National Conference** on Advances in Life Sciences organized by IISER, Kolkata; January 13-15, 2017; [Poster No. 15].
3. **Chatterjee C**., Bhattacharyya R., Sarkar Biswas S. "Isolation, Characterization and Genetic Study of heavy metal resistance sewage bacteria from Tolly Nullah and their potentiality in plant growth promotion". **Poster Presentation** at the UGC-CPE sponsored **International Conference** on Facets of Basic Science and Application (FBSA) organized by Bijoy Krishna Girls' College, Howrah; February 5-7, 2018; [Abstract Vol. pp. 34].
4. **Chatterjee C**., Bhattacharyya R., Sarkar Biswas S. "The Role of Heavy Metal Resistance Indole Producing Municipal Sewage Microbes in Plant Heavy Metal Absorption and Accumulation". **Poster Presentation** at the 6th India Biodiversity Meet (**International Conference**) organized by the Agricultural and Ecological Research Unit, Indian Statistical Institute, Kolkata; February 14-16, 2019; [Abstract Vol. pg 108].
5. **Chatterjee C**., Bhattacharyya R., Sarkar Biswas S. "The Role of Municipal Sewage Microbes in Chromium Accumulation and Reduction". **Oral Presentation** at **National Conference** on Future India: Science and Technology jointly organized by

City College, Kolkata and Indian Science Congress Association, Kolkata Chapter; February 27-28, 2019; [Abstract Vol. pp. A9, Abstract No. AE-07].

6. **Chatterjee C**., Bhattacharyya R., Sarkar Biswas S. "*Microbacterium radiodurans* and *Bacillus xiamenensis* isolated from different sewage microbial communities of Kolkata, perform chromium bioremediation and cropping". at **National conference** on Wildlife, Ecology and Biodidersity (WEB – 2020) jointly organized by Department of Zoology, Shibpur Dinobundhoo Institution (college), West Bengal Biodiversity Board and Department of Zoology, Dr. Kanailal Bhattacharyya College; March 28, 2020. [Abstract accepted for **Oral Presentation** but called off due to unanticipated Covid situation.]

List of Symbols and Abbreviations:

Abbreviations	Full Forms of the Abbreviations
µM	**M**icro-**M**olar
16S rDNA	**16S r**ibosomal **DNA**
AAS	**A**tomic **A**bsorption **S**pectrophotometer
ANOVA	**An**alysis **o**f **Va**riance
APHA	**A**merican **P**ublic **H**ealth **A**ssociation
ASTM	**A**merican **S**ociety of **T**est and **M**aterials
BCF	**B**io-**c**oncentration **F**actor
BLAST	**B**asic **L**ocal **A**lignment **S**earch **T**ool
$CaCl_2$	**C**alcium **Ch**l**o**ride
CAS agar	**C**hrome **A**zurol **S** agar
Cd	**C**a**d**mium
CFU	**C**olony **F**orming **U**nit
Co	**Co**balt
COD	**C**hemical **O**xygen **D**emand
Cr(III)	**Tri**valent **C**h**r**omium
Cr(VI)	**Hexa**valent **C**h**r**omium
Cr^{3+}	**Tri**valent **C**h**r**omium
Cr^{6+}	**Hexa**valent **C**h**r**omium
DHA	**D**e**h**ydrogenase **A**ctivity
DNA	**D**eoxyribo**n**ucleic **A**cid
DNP	2,4 **d**i**n**itro**p**henol
DO	**D**issolved **O**xygen
DTT	**D**i**t**hio**t**hreitol
EDTA	**E**thylene **d**i-Amine **t**etra **A**cetic acid
EDXRF spectrometer	**E**nergy **D**ispersive **X**-ray **F**luorescence spectrometer
EPA	**E**nvironmental **P**rotection **A**gency
EPS	**E**xo**p**oly**s**accharide
FAO	**F**ood and **A**griculture **O**rganization
FAS	**F**errous **A**mmonium **S**ulphate
FDA	**F**ood and **D**rug **A**dministration

FDA	**F**ood and **D**rug **A**dministration
Fe^{3+}	Trivalent iron
$FeCl_3$	**Fe**rric **c**h**l**oride
H_2O_2	Hydrogen Peroxide
H_2SO_4	Sulfuric Acid
H_3PO_4	Phosphoric Acid
$HClO_4$	Perchloric acid
HDTMA	**H**exa**d**ecyl**t**ri**m**ethyl**a**mmonium Bromide
HNO_3	Nitric Acid
HPTLC	**H**igh-**P**erformance **T**hin-**L**ayer **C**hromatography
IAA	**I**ndole **A**cetic **A**cid
IBA	**I**ndole **B**utyric **A**cid
k2p Model	**K**imura **2**-**p**arameter Model
LB	**L**uria **B**ertani
L-trp	**L** **Tryp**tophan
MEGA	**M**olecular **E**volutionary **G**enetic **A**nalysis
MG	**M**ethyl**g**lyoxal
MHA	**M**ueller **H**inton **A**gar
MIC	**M**inimum **I**nhibitory **C**oncentration
mM	**Mi**lli-**M**olar
MRVP	**M**ethyl **R**ed **V**oges-**P**roskauer
NA	**N**utrient **A**gar
NaCl	Sodium Chloride
NAG	**N**-**a**cetyl**g**lucosamine
NAM	**N**-**a**cetyl**m**uramic acid
NaOH	Sodium hydroxide
NB	**N**utrient **B**roth
NCBI	**N**ational **C**entre for **B**iotechnology **I**nformation
NCCLS	**N**ational **C**ommittee for **C**linical **L**aboratory **S**tandard
NH_4OH	Ammonium hydroxide
nM	**N**ano-**M**olar
nm	**N**ano**m**eter

O.D.	**O**ptical **D**ensity
PBS	**Ph**osphate **B**uffered **S**aline
PCR	**P**olymerase **C**hain **R**eaction
PGPR	**P**lant **G**rowth **P**romoting **R**hizobacteria
PMSF	**P**henyl**m**ethyl**s**ulfonyl **F**luoride
ppm	**P**arts **P**er **M**illion (mg/l)
ROS	**R**eactive **O**xygen **S**pecies
SEM	**S**canning **E**lectron **M**icroscope
SPSS	**S**tatistical **P**ackage for **S**ocial **S**ciences
TAE	**T**ris-**A**cetate-**E**DTA
TEM	**T**ransmission **E**lectron **M**icroscope
TLC Scanner	**T**hin **l**ayer radio**c**hromatograph
TTC	**T**riphenyl **T**etrazolium **C**hloride
UV-VIS spectrophotometer	**U**ltraviolet **Vis**ible **spectrophotometer**
WHO	**W**orld **H**ealth **O**rganization
YEM	**Y**east **E**xtract **M**annitol

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