पश्चिमबङ्ग पश्चिम बंगाल WEST BENGAL Z 818458

ICAR

CIFA

Sl. NO. 15

Umbrella Memorandum of Understanding

between

ICAR-Central Institute of FreshwaterAquaculture
(An ISO 9001:2008 Certified Institution)
(Indian Council of Agriculture Research)
Kausalyaganga, Bhubaneswar 751002, Odisha

and

The University of Burdwan, Burdwan 713104, West Bengal

University/DU [Within NARS (AUs/ICAR DUs) or **Outside NARS** (Central/State Govt./Public Sector Funded Institutions/**State Universities**/Autonomous Bodies/Private Universities or Institutions)]

for facilitating

Students' Training/Postgraduate Research

This Memorandum of Understanding (hereinafter referred to as MoU) is made on this twenty seventh day of the month of March in the year 2018 by and between the **ICAR-Central Institute of Freshwater Aquaculture** (Name of the ICAR Institute) having its

Jitendra Kumar Sundaray Dalo Ram Jangir

Head Office at **KAUSALYAGANGA, BHUBANESWAR 751002, ODISHA** [hereinafter called **"ICAR-CIFA"**/ First party], a constituent Research Institution of the Indian Council of Agricultural Research, Krishi Bhavan, New Delhi-110 001 on the ONE PART and the **The University of Burdwan** [Name of the AU/ICAR-DU (Within NARS) or Central/State Govt./Public Sector Funded Institution/State University/Autonomous Body/Private University or Institution] having its headquarters at **BURDWAN 713104, WEST BENGAL** [hereinafter called **"BU"**/ Second party] on the OTHER PART (who for the purpose of this MoU are hereinafter collectively referred to as the parties).

The parties, having discussed fields of common research interests and allied activities between the two institutions, have decided to enter into long-term collaboration for promotion of students' training and quality postgraduate research in cutting edge areas in accordance with the provisions contained in the Guidelines issued *vide* Letter No. 2-8/2012-HRD dated 11th December, 2012 or as revised from time to time.

WHEREAS the "**ICAR-CIFA**" is involved in the studies on Freshwater Aquaculture (fish nutrition and physiology; fish health management; fish genetics and biotechnology; fisheries extension, economics and information sciences),

AND WHEREAS the "**BU**", established on 15th June 1960 by **Govt. of West Bengal** *vide* **Act No. XXIX** of **1959** and recognized by University Grants Commission (under Section 12B of the UGC Act, 1956) at its **Department of Zoology** is involved in studies on various disciplines of Aquaculture and Fisheries (fish nutrition and probiotics, aquatic ecology and toxicology, fish diseases and immunology),

AND WHEREAS it has been considered expedient to agree in writing to participate jointly in the projects requiring expertise and logistics from both the parties.

Now this instrument witnesses as follows:

Jitendra Kumar Sundaray

(Signature of First Party)

निदेशक/DIRECTOR
भा.कृ.अनु.प.-सीफा/ICAR-CIFA
पो.-कौशल्यागंग/P.o-Kausalyaganga
भुवनेश्वर/Bhubaneswar-751002

27.3.15

(Signature of Second Party)

REGISTRAR
THE UNIVERSITY OF BURDWAN
BURDWAN - 713104

Article 1. Scope

1.1 The **BU** will recognize the **ICAR-CIFA** as an Institute for conducting research related to the thesis requirement of the research students for Ph.D./M.Phil./Masters. The **BU** will recognize Scientists of the **ICAR-CIFA** as recommended by its Director in accordance with the University rules and regulations for guiding students working for the said degree.

1.2 Operational details of research effort and collaboration will be made in common research programmes and/or projects restricted to specific mandated domain within the approved disciplines/divisions. The objective(s) for research work for a student coming from a Second party outside NARS should be exclusively different as far as possible.

1.3 Research instrumentation facility and library facilities available with the **ICAR-CIFA** and the **BU** will be made available to the faculty and research scholars. However, the costs of specific consumables will be borne by the respective organizations.

1.4 There shall be an exchange of students for academic, research and training purposes. Accommodation in the Hostel shall be arranged, wherever possible, as per extant rates. The duration of exchange visits will be determined by mutual consent between both the parties.

Article 2. Management

2.1 Director of the **ICAR-CIFA** and the Vice-Chancellor/Head of the Institution of the **BU** will be responsible to work out operational details of co-operation between the two organizations and ensure proper and effective implementation of this MoU.

2.2 The Advisory Committee will meet at least once in a year alternatively in the institutions of the First party and the Second party to review the activities. This meeting shall include presentation on the academic and research activities, which should be open to the students, faculty and scientists.

Article 3. Exchange of Information

3.1. The term "information" includes scientific or technical data, results and/or methods of investigation, and other information intended to be provided, exchanged, or arising under project descriptions entered into pursuant to this MoU.

3.2. The parties support the widest possible dissemination of information. Each party in joint projects shall be given the right to use, disclose, publish or disseminate such information for any and all purposes.

Article 4. General Provisions

4.1 It is understood that the **ICAR-CIFA** and the **BU** subscribe to the principle of equal opportunity and do not discriminate on the basis of race, sex, age, caste or religion. Both the Institutions shall abide by these principles in the administration of this agreement and neither party shall impose criteria for exchange of scholars or students, which violate principles of non-discrimination.

Jitendra Kumar Sundaray

(Signature of First Party)

निदेशक/DIRECTOR
भा.कृ.अनु.प.-सीफा/ICAR-CIFA
पो.-कौशल्यागंग/P.o-Kausalyaganga
भुबनेश्वर/Bhubaneswar-751002

29.3.18

(Signature of Second Party)

REGISTRAR
THE UNIVERSITY OF BURDWAN
BURDWAN - 713104

4.2 Both parties understand that all financial agreements will have to be negotiated separately and will depend on the availability of funds.

4.3 Both parties acknowledge that exchange of students from one party to the other shall be subject to the availability of funds and shall comply with the regulations and policies of the First party and the Second party.

4.4 Any research publications arising will be jointly published in accordance with the provisions laid out in Item 3.2.1C of the Guidelines for the students to conduct research for their degree programme as trainees at ICAR institutions as notified *vide* Letter No. 2-8/2012-HRD dated 11th December, 2012 or revised guidelines, if any, as may be issued from time to time.

4.5 A copy of the thesis/dissertation submitted by the research students affiliated to the **ICAR-CIFA** will be deposited to the **ICAR-CIFA** after the award of the degree by the **BU**.

4.6 All questions related to this MoU arising during its term will be settled by the parties by mutual agreement. Disagreements at the operating level shall be forwarded to respective higher officials for appropriate resolution failing which an arbitrator of mutual acceptance may be identified for the settlement of dispute, if any.

4.7 All questions not foreseen related to this MoU will be handled by the parties by mutual agreement.

4.8 Nothing in this MoU is intended to affect other cooperation or collaborations between the parties.

Article 5. Intellectual Property Rights

5.1 The **BU** will be expected to ensure protection of the Intellectual Property Rights generated or likely to be generated during the student's research work. The **ICAR-CIFA** and the **BU** shall be the joint applicants for IPRs and the students and involved scientific staff shall be included as the inventor/breeder/author. The 'ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization' as amended from time to time shall be the reference for exploitation of the generated intellectual property, whose management and benefits sharing shall be mutually decided in each case, by the parties hereto.

Article 6. Admission and Fees

6.1 All those who wish to register as trainees or for Master/Doctoral programme under this MoU must apply for admission at the **BU**. The allocation of Major Guide/Advisor would be finalized before the registration and will be governed by the provisions laid out in Items 3.2.1A and 3.2.2A of the Guidelines for the students to conduct research for their degree programmes as trainees at ICAR institutions as notified *vide* Letter No. 2-8/2012-HRD dated 11th December, 2012 or revised Guidelines, if any, as may be issued from time to time, for the students from within NARS and outside NARS, respectively.

6.2 Admission of the students and the award of degrees for different programmes will be the responsibility of the **BU** as per the rules and regulations.

6.3 Allotment of the students at the **ICAR-CIFA** will be done by the approval of Director of the **ICAR-CIFA** and Vice-Chancellor/Head of the Institution of the **BU**.

6.4 The **ICAR-CIFA** and **BU** would have the right to screen the student's eligibility for admission based on their academic period.

Jatindra Kumar Sundaray

(Signature of First Party)

27.3.18

(Signature of Second Party)

निदेशक/DIRECTOR
भा.कृ.अनु.प.-सीफा/ICAR-CIFA
पो.-कौशल्यागंग/P.o-Kausalyaganga
भुबनेश्वर/Bhubaneswar-751002

REGISTRAR
THE UNIVERSITY OF BURDWAN
BURDWAN - 713104

6.5 The PME Cell of the **ICAR-CIFA** in consultation with the representative of the **BU** shall decide the location and sharing quantum of research work.

6.6 The number of student(s) at any particular time will be subjected to the availability of research facilities and scientists' time to guide thesis research at the **ICAR-CIFA**.

6.7 Any student(s) admitted to the **ICAR-CIFA** for training/postgraduate research, if found violating the rules and regulations laid down by the **ICAR-CIFA** or indulge in such activities that amount to tarnishing the image of the Institute, or cause damage to the property, the registration of such student(s) would be summarily terminated. The **BU** will not complete the formalities of issuing the certificates to such students until they compensate the losses to the **ICAR-CIFA**.

6.8 Fees will be charged from the students by the **ICAR-CIFA** as per Guidelines for the students to conduct research for their degree programmes as trainees at ICAR institutions *vide* Letter No. 2-8/2012-HRD dated 11th December, 2012 or revised Guidelines, if any, as may be issued from time to time. No fee may be charged by the First party from the students registered with AU/DU within NARS. However a student registered with a Second party, outside NARS, will deposit fee of Rs. 10,000/- for training duration of 3 months (not leading to a degree/dissertation) and Rs. 30,000/- per semester (six months) for training, research, dissertation exceeding three months. Any change in fee structure by ICAR will be applicable from the date of revision and shall be charged by the **ICAR-CIFA**.

Article 7. Entry into effect, modification and termination

7.1. This MoU shall become effective on the date it is signed by the parties and shall be valid for three years extendable up to five years. Both parties shall review the status of the MoU at the end of each five year period to determine any modification, whenever necessary. The period of validity of this MoU may be extended by mutual consent up to five years. This MoU may be amended by mutual written agreement and may be terminated at any time by either party upon written notification signed by the competent authority of the party initiating termination. Such notification must be given to the other party at least six months in advance from the effective date of termination.

7.2. All joint activities not completed at the expiration or termination of the MoU may be continued until their completion under the terms of this MoU.

7.3 No amendment or modification of the MoU shall be valid unless the same is made in writing by both the parties or their authorized representatives and specifically stating the same to be amendment of the MoU. The modifications/changes shall become part of the MoU and shall be effective from the date on which they are made/executed, unless otherwise agreed to.

Jitendra Kumar Sundaray

(Signature of First Party)

निदेशक/DIRECTOR
भा.कृ.अनु.प.-सीफा/ICAR-CIFA
पो.-कौशल्यागंग/P.o-Kausalyaganga
भुवनेश्वर/Bhubaneswar-751002

27.3.18

(Signature of Second Party)

REGISTRAR
THE UNIVERSITY OF BURDWAN
BURDWAN - 713104

This MoU has been executed in two originals, one of which has been retained by the **ICAR-CIFA** and the other by the **BU**).

IN WITNESS WHEREOF, the parties have executed this MoU on the 27. March 2018 first above written and represent that they approve, accept and agree to terms contained herein.

ICAR-Central Institute of Freshwater Aquaculture Kausalyaganga, Bhubaneswar 751002 Odisha	**The University of Burdwan Burdwan 713104, West Bengal**
Name of the Director of the First Party	**Name of Head of the Institution of the Second Party**
DR J K SUNDARAY	**DR D K PANJA**
Tel No. (0674) 2465421, 2465446	**Tel. No. (0342) 2634 015**
Date	**Date** 27-03-2018
Signature with Seal Jatindra Kumar Sundray 27.3.18	**Signature with Seal**

निदेशक/DIRECTOR
भा.कृ.अनु.प.-सीफा/ICAR-CIFA
पो.-कौशल्यागंग/P.o-Kausalyaganga
भुवनेश्वर/Bhubaneswar-751002

THE UNIVERSITY OF BURDWAN RAJBATI BURDWAN 713104

REGISTRAR
THE UNIVERSITY OF BURDWAN
BURDWAN - 713104

Witness 1..... C.P. Lakra Pr Scientist ICAR-CIFA Bhubaneswar	Witness 1... Anandamay Barik 27/03/18 Dr ANANDAMAY BARIK Associate Professor & Head Department of Zoology The University of Burdwan Golapbag, Burdwan-713104
Witness 2 ..... CA. BARAT PRINCIPAL SCIENTIST ICAR-CIFA Bhubaneswar.	Witness 2 ..... 27/03/18 DR. KOUSHIK GHOSH ASSOCIATE PROFESSOR DEPARTMENT OF ZOOLOGY THE UNIVERSITY OF BURDWAN GOLAPBAG, BURDWAN-713104, W.B., INDIA

पश्चिमबङ्गा पश्चिम बंगाल WEST BENGAL

Z 816631

Sl.NO.--16

MEMORANDUM OF AGREEMENT

This MEMORANDUM OF AGREEMENT is made on this **twenty first** day of **May** Two thousand and **Eighteen** BY AND BETWEEN President of India, acting through **Secretary**, Department of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi, hereinafter referred to as the 'DBT' (which expression unless excluded by or repugnant to the subject shall mean and include its successor-in-office and assigns) of the ONE PART;

AND

The University of Burdwan , a society under the Societies Registration Act – 1860, having its registered office at **Rajbati, Burdwan,** hereinafter referred to as **BU** (which expression shall where the context so admits include its successors and permitted assigns) of the OTHER PART;

REGISTRAR (Officiating)
THE UNIVERSITY OF BURDWAN
BURDWAN-713104

WHEREAS DBT being desirous of cancer immunology decided to support a project submitted by **Dr. Anupam Basu** for the attainment of the objectives, hereinafter described in the Annexure I annexed hereto;

This Memorandum of Agreement (MoA) defines the role and responsibilities of the participating agencies, monitoring and other matters related to the **"Study on the role of TLR-4 signaling in breast cancer progression"**

NOW THE PARTIES HERETO AGREE AS FOLLOWS:-

1.0 . ROLE OF DEPARTMENT OF BIOTECHNOLOGY, NEW DELHI

To provide funds to the extent of **81,30,600/-** over a period of **3** years from the date of sanction of the project, to **The University of Burdwan** for undertaking activities as detailed in Annexure 1. Details of the funds to be provided are given in Annexure II.

2.0. ROLE OF THE UNIVERSITY OF BURDWAN (Institute)

2.1. To provide their contribution of **81,30,600/-** for **3** years from date of sanction of the project as detailed in Annexure – II. *(if a jointly supported project)*

2.2. To provide existing facilities as mentioned in the project document.

2.3. To be responsible for accomplishing objectives identified and activities listed.

2.4. To allow the Scientists authorized by DBT to work with the Research & Development team of the center in all stages of process development and production.

2.5. To recruit all scientific and non-scientific staff as sanctioned by DBT.

2.6. To prepare and submit all periodical reports and other documents that would be required by DBT.

2.7. To maintain a separate audit head of account for the grants received from DBT for the project.

2.8. To submit an annual audited statement of expenditure incurred under the project.

2.9. To ensure effective utilization of the grant given by DBT for the purpose for which it was granted and to ensure timely progress of project work.

2.10. The manpower, both scientific and non-scientific, recruited shall be purely on contractual terms & conditions such that the contract for engagement of the manpower shall run concurrently with the said project period only.

REGISTRAR (Officiating)
THE UNIVERSITY OF BURDWAN
BURDWAN-713104

3.0 DURATION OF PROJECT

3.1 Duration of project shall be **3** years from the date the Project has been sanctioned by DBT.

Dr. Anupam Basu
PROFESSOR
Department of Zoology
The University of Burdwan

4.0 RIGHTS OF OWNERSHIP/TECHNOLOGY TRANSFER AND UTILIZATION

4.1 The know-how generated from the project by **Dr. Anupam Basu** will be the joint property of **The University of Burdwan** and DBT, Government of India. It shall

4.2 be the responsibility of **Dr. Anupam Basu & The University of Burdwan** to take necessary action for protection of the intellectual property arising out of the PROJECT through proper instruments, such as, patents, copy rights, etc.

4.3 The know-how developed may be transferred to other entrepreneurs on a non-exclusive basis on such terms and conditions as may be determined by DBT.

4.4 All the assets including the equipment and produce acquired will be the property of DBT and shall not be utilized for purposes other than those for which the grant has been sanctioned. The rights of **The University of Burdwan** under this MoA shall not be transferred to any other party without prior approval in writing of DBT.

4.5 It shall be the responsibility of **Dr. Anupam Basu** to ensure that support of DBT is suitably acknowledged in the publications (papers, reports, etc.) arising out of the PROJECT.

5. SECRECY

It is hereby agreed that the participating agencies shall keep information and data collected completely secret provided that the right to transfer the technology shall rest with the DBT.

6. MONITORING

6.1 The progress of implementation of the project and proper utilization of grant shall be reviewed by the DBT and by the Monitoring Committee set up by DBT.

6.2 The periodic progress of physical achievements and the utilization of funds, statement of expenditure shall be evaluated by the Monitoring Committee.

6.3 The Comptroller and Auditor General of India, at his discretion shall have the right of access to the books and accounts of **The University of Burdwan** for the grants received from DBT for this project.

6.4 The DBT may terminate the grant at any stage if it is convinced that the grant has not been properly utilized or appropriate progress has not been made. In the event, DBT terminates the grant, **Dr. Anupam Basu & The University of Burdwan** shall hand over all documents including technical details and equipment purchased related to the project.

REGISTRAR (Officiating)
THE UNIVERSITY OF BURDWAN
BURDWAN-713104

Dr. Anupam Basu
PROFESSOR
Department of Zoology
University of Burdwan

7.0 DURATION OF MEMORANDUM OF AGREEMENT

This MoA will remain inforce for the duration of the project and until all claims are settled between DBT and **The University of Burdwan**

8.0 ARBITRATION

In the event of any question, dispute or difference whatsoever arising between the parties to this Agreement out of or relating to the construction, meaning, scope, operation or effect of this Agreement or the validity of the breach thereof shall be referred to an Arbitrator to be appointed by mutual consent of both the parties herein. If the parties cannot agree on the appointment of the Arbitrator within a period of one month from the notification by one party to the other of existence of such dispute, then the Arbitrator shall be nominated by the Secretary, Department of Legal Affairs, Ministry of Law & Justice, Government of India. The provisions of the Arbitration and Conciliation Act, 1996 will be applicable and the award made thereunder shall be final and binding upon the parties hereto, subject to legal remedies available under the law. Such differences shall be deemed to be a submission to arbitration under the Indian Arbitration and Conciliation Act, 1996, or of any modifications or reenactments thereof.

9.0. GOVERNING LAW

This Contract shall be governed by the Law of India for the time being in force.

IN WITNESS WHEREOF the parties hereto have signed, sealed and delivered this Agreement on the day, month and year first above written in presence of:

Witnesses:

1.

REGISTRAR (Officiating)
THE UNIVERSITY OF BURDWAN
BURDWAN-713104

Signed by ----------

(Designation)

For and on behalf of The President of India

Witnesses:

Dr. Anupam Basu
PROFESSOR
Department of Zoology
University of Burdwan

Dr ANANDAMAY BARIK
Associate Professor & Head
Department of Zoology
The University of Burdwan
Golapbag, Burdwan-713104

2.

Signed by ----------

Registrar (officiating)
THE UNIVERSITY OF BURDWAN
For and on behalf of
The University of Burdwan

TERMS & CONDITIONS OF THE GRANT

(To be signed and enclosed with concern filled proforma)

1. Approval of the Research proposal and the grant released would be for the specific project mentioned in paras I to V of this proposal and grant should be exclusively spent on the project for which it has been sanctioned within the stipulated time. The Institute is not permitted to seek or utilise funds from any other organisation (Government, Semi Government, Autonomous or Private) for this research project. Any unspent part of amount would be surrendered to the Govt. of India through an account payee demand draft drawn in favour of the "Drawing and Disbursing Officer, Department of Biotechnology, New Delhi", and carry forward of funds of the next financial year for utilization for the same project may be considered only with the specific approval of the Department of Biotechnology (DBT).

2. For permanent/semi-permanent assets acquired solely or mainly out of the grant, an audited record in the form of a register in the prescribed proforma (enclosed at **Appendix-'A'**) shall be maintained by the Institute. The term **"assets"** means (I) immovable property and (II) movable property of a capital nature, where the value exceeds Rs. 1000/- The grant will not be utilised for construction of any immovable property, Full facilities by way of accommodation, etc. for the project will be given by the Institute.

3. All the assets acquired from the grant will be the property of Govt. of India and should not without the prior sanction of the Deptt. of Biotechnology, be disposed of, or encumbered or utilised for purpose other than those for which the grant has been sanctioned.

4. At the conclusion of the project, the Govt. of India will be free to sell or otherwise dispose of assets which are the property of the Government. The Institute shall render to Govt. necessary facilities for arranging the sale / disposal of these assets. **The Government may, however, consider the request of host institutions to retain the assets created under a project for carrying out similar work for the promotion of science.**

5. The implementing Institute/PI will furnish progress report of work on the project every six months. The progress of the project will also be reviewed/monitored at least once a year by the concerned Task Force/Project Monitoring Committee, etc. In addition the DBT shall designate Scientists/Specialists to visit the Institute periodically for reviewing the progress of work and for suggesting such measures as to ensure early realisation of the objectives of the project. On completion of the project five copies of a consolidated report of the work done on the subject would be submitted to the Department of Biotechnology.

6. The Institute is required to send to DBT a list of assets referred to at Sl. No. 2 above at the end of each financial year as well as at the time of seeking further installments of the grant.

7. The Institute would furnish to the Deptt. of Biotechnology a Utilization Certificate (Copy enclosed at **Appendix - 'B'**) and an audited statement of expenditure (**Copy enclosed at Appendix - 'C'**) duly signed by the P.I., the Head of the Institute and the Head of the Finance wing, pertaining to the grant at the end of each financial year as well as a consolidated statement of expenditure at the end of the completion of the project.

8. A stamped receipt be sent to the Deptt. of Biotechnology on receipt of the Cheque/ Demand draft towards each release.

9. The Comptroller and Auditor-General of India at his discretion shall have the right of access to the books and accounts of the Institute for the grant received from the Government.

10. The Institute would maintain separate audited accounts for the project. If it is found expedient to keep a part or whole of the grant in a bank account earning interest, the interest thus earned should be reported to the Deptt. of Biotechnology.

11. Sale proceeds, if any, as a result of the development of the project arising directly from funds granted by the Deptt. of Biotechnology shall be reported to the Govt. of India. The Govt. of India may at its discretion allow a portion of such receipt to be retained by the Institute for its utilisation for the project activities.

12. Investigators/Institutes wishing to publish papers based on the research work done under Deptt. of Biotechnology projects should acknowledge the financial support received from the Deptt. of Biotechnology.

13. Investigators/Institutes may utilize various resources such as the Bioinformatics resources, experimental materials, reagents, cell lines, animals, etc. from the National facilities/Institutes/Centres established by this Department as per the terms of transactions followed by them. More information may be obtained about such facility from DBT websites: http://www.dbtindia.org// www.dbtindia.nic.in, www.btisnet.ac.in.

14. Investigators / Institutes shall follow the detailed instructions on technology transfer and Intellectual Property Rights (IPR) as given at Annexure - V. The same has the approval of the Ministry of Finance, Govt. of India vide Deptt. of Expenditure, Plan Finance II – Division Letter No. 33 (5) /PF.II/99 dated 22nd February, 2000. Any deviation from these instructions may be brought to the notice of this Department.

15. Investigators / Institutes may file patents with the help of the Biotechnology Patents Facilitating Cell (BPFC) established at DBT on priority bases. The format for filing the patents may be seen at Annexure –VI.

16. The Govt. of India (Deptt. of Biotechnology) will have the right to call for drawings, specifications and other data necessary to enable the transfer of know-how to other parties and the Institute shall supply all the needed information at the request of the Department of Biotechnology which will ensure confidentiality. The information required for commercializing Biotechnologies may be furnished to this Deptt. as per the format enclosed at Annexure – VII. More information on commercialization can be found at the website www.ebc.nic.in.

17. The Institute may not entrust the implementation of the work for which the grant is being sanctioned to another institution and to divert the grant receipts as assistance to the latter institution. However, in such situations the express permission of DBT may be obtained. In case the grantee is not in a position to execute or complete the project, it may be required to refund forthwith to the Govt. of India (Department of Biotechnology) the entire amount of grant received by it.

18. The human resources that may be engaged for the project by the Institute are not to be treated as employees of the Govt. of India and the deployment of such human resource at the time of completion or termination of project, will not be the concern/responsibility of the Govt. of India. The Organisation may make reservations for Scheduled Castes, Schedule Tribes etc. in the human resource to be engaged for the project in accordance with the instruction issued by the Govt. of India from time to time.

19. The Deptt. of Biotechnology reserves the right to terminate the grant at any stage and also to recover the amounts already paid if it is convinced that the grant has not been properly utilized or the work on the project has been suspended for any unduly long period or appropriate progress is not being made.

20. The project will become operative with effect from the date of release of the first installment for the project.

21. If the Investigator to whom a grant for a project has been sanctioned leaves the institution where the project is being implemented, he shall submit five copies of complete and detailed report of the work done by him on the project and the money spent till the date of his/her release and shall also arrange to refund the unspent balance , if any.

22. The organisation should maintain subsidiary accounts of the Govt. of India grant and furnish it to the Audit Officer as and when the recurring and non-recurring expenditure exceeds the limits of Rs. 5.00 lakhs.

Signature of Executive Authority of Institute/ University With seal

REGISTRAR (Officiating)
THE UNIVERSITY OF BURDWAN
BURDWAN-713104

Date :

Signature and stamped of Principal Investigator :
Date :

Dr. Anirban Basu
Professor
Department of Zoology
The University of Burdwan

Signature and stamped of Co-Investigator
Date :

Dr ANANDAMAY BARIK
Associate Professor & Head
Department of Zoology
The University of Burdwan
Golapbag, Burdwan-713104

SL. NO. 17

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Original Paper

Screening and optimization of indole-3-acetic acid production by bacterial strain isolated from rice rhizosphere and its effects on plant growth

Environmental and Experimental Biology

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UNIVERSITY OF LATVIA

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Abstract

The present study deals with the isolation of plant growth-promoting bacterial strains from rhizospheric soil collected from a rice field of Purba Bardhaman District, West Bengal, India. Among the isolated five strains, A5 was the best-performing strain as it had, plant growth promoting traits like, production of indole-3-acetic acid (IAA), siderophore, hydrogen cyanide and exopolysaccharides, ammonia, phosphate solubilization, nitrogen fixation etc. Strain A5, identified as *Bacillus xiamensis* by phenotypic characters and 16S rDNA sequence-based homology, was able to produce a copious amount of IAA, particularly in the case of 42-h culture with 1.5% L-tryptophan as a precursor. Media optimization with different carbon and nitrogen sources was conducted for maximum production of IAA. Strain A5 used fructose and casamino acid most efficiently as carbon and nitrogen sources, respectively. Growth parameters were increased in A5-treated seedlings of mung bean compared to control seedlings. Considering the observed traits, strain A5 can definitely be considered as a novel plant growth-promoting bacterial strain that may serve very well as a biofertilizer in agricultural fields.

Key words: *Bacillus xiamensis*, indole-3-acetic acid, plant growth-promoting rhizobacteria, plant growth promoting traits.
Abbreviations: ACC, 1-aminocyclopropane carboxylic acid;EPS, exopolysaccharide; IAA, indole-3-acetic acid; OD, optical density; PGPR, plant growth-promoting rhizobacteria

Introduction

The rhizosphere is the portion of soil surrounding the plant root and this region of soil is greatly influenced by plant root activity and metabolism (Prasad et al. 2019). A number of beneficial microbes inhabit the rhizosphere, among which bacteria are a dominant group. One gram of soil contains about 10^8 to 10^9 bacteria, 10^3 to 10^6 fungi, 10^7 to 10^8 actinomycetes, 10^3 to 10^6 algae, 10^6 to 10^8 archaea, 10^3 to 10^5 protozoa and 10 nematodes (Rughöft et al. 2016). Some groups of bacteria that have the capacity to utilize organic compounds released by plant roots (Jones 1990), and the plant forms a microenvironment where these few groups of bacteria can survive (Marilley et al. 1999; Barriuso et al. 2008). The groups of bacteria that are associated with plant roots have important roles in plant growth and productivity, and are collectively known as plant growth promoting rhizobacteria (PGPR) (Backer et al. 2018). PGPR are soil bacteria that colonize on the exterior and interior portion of the root (Backer et al. 2018). These bacteria belong to genera such as *Microbacterium, Alcaligenes, Pantoea, Achromobacter, Rhizobium, Pseudomonas, Bacillus, Burkholderia, Erwinia, Azospirillum, Serratia* etc. (Egamberdiyeva 2000; Tilak et al. 2005). PGPR have several traits by which they can accelerate plant growth via direct or indirect methods like phosphate solubilization, indole-3-acetic acid (IAA) production, atmospheric nitrogen fixation, ammonia production, HCN production, exopolysaccharide production etc. (Rodriguez et al. 1999).

IAA is the most active plant hormone of the auxin family and has important physiological roles in plants, such as embryo development, geotropism, phototropism, root initiation and root elongation etc. (Finet, Jaillais 2012). In addition, IAA contributes in root hair development and in the development of lateral branches of roots, facilitating nutrient uptake from the soil (Datta et al. 2000). Both plants and PGPR can synthesize physiologically active amounts of

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ORIGINAL PAPER

Effectiveness of Phosphate-Solubilizing *Aspergillus fumigatus* MCC 1721 in Boosting Fenugreek Yield in Red Laterite Soil

Biyas Mukherjee[1] · Sanchali Roy[2] · Nasrin Parvin[2] · Sikha Dutta[2]

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Abstract
Phosphorus is an essential nutrient vital for the growth of plants, rapidly becomes immobile and inaccessible to plants when applied as fertilizer. Rock phosphate (RP), abundantly present in Indian soils, serves as phosphate source. Phosphate-solubilizing fungi (PSF) possess the capacity to solubilize insoluble forms of phosphate, rendering it bioavailable and thereby enhancing plant growth. PSF were isolated and screened based on in vitro plant growth-promoting traits. The best-performing strain was identified using molecular tools. The phosphate-solubilizing capacity of the selected isolate was assessed in vitro. A 2-year field experiment was conducted to investigate the impact of RP and PSF, alone or together on fenugreek in red laterite soil. The result was compared against the use of chemical fertilizer (di-ammonium phosphate) and arbuscular mycorrhizal fungus (*Funneliformis mosseae*) focusing primarily on crop yield and soil fertility. Six PSF were obtained among them AP2 was selected and identified as *Aspergillus fumigatus*. AP2 demonstrated significant growth promoting properties and effectively solubilized various insoluble phosphate forms. Additionally, AP2 produced acid phosphatase and various organic acids while growing with different insoluble phosphate. The combined application of AP2 alongside RP fertilization showed enhanced growth and total phosphate uptake in fenugreek, surpassing the effects of other treatments. Moreover, soil fertility exhibited notable improvement where AP2 were inoculated alongside RP fertilization compared to other treatments. The findings suggested that incorporating AP2 with RP fertilization offers a promising solution for farmers seeking to reduce dependence on chemical phosphorus fertilizers while advocating for environmentally-friendly agricultural practice.

Keywords *Aspergillus fumigatus* · Di-ammonium phosphate · *Funneliformis mosseae* · Phosphate solubilizing fungi · Red laterite soil · Rock phosphate

1 Introduction

Phosphorus (P) stands as a crucial macronutrient pivotal for the growth and development of plants, following nitrogen (Hameeda et al. 2008; Sharma et al. 2013). In recent years, in response to the escalating demand for crop yields, various phosphate fertilizers have been extensively employed in agricultural contexts. However, plants fail to fully utilize the total amount of applied fertilizers due to the rapid conversion of inorganic phosphate into insoluble forms (Chen et al. 2006a; Goldstein 1986). Approximately 99% of soil P forms complexes with various cations such as iron (Fe), calcium (Ca), and aluminum (Al) (Son et al. 2006), leaving only a minute portion soluble and directly accessible to plants (Barroso and Nahas 2005). Consequently, plants endure P deficiency, impeding their growth.

Additionally, prolonged use of chemical fertilizers and pesticides has led to a decline in both the diversity of soil microbes and their beneficial relationships with plants within the plant's ecosystem (Huang et al. 2019). The experimental site, characterized by red laterite soil, is notably deficient in nutrient content. Regarding phosphate compounds, it is predominantly rich in iron phosphate, with occluded phosphate, calcium phosphate, and aluminium phosphate present in lesser amounts (Sarkar et al. 2013). Hence, restoring

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RESEARCH ARTICLE

Characterization of a potent plant growth promoting fungal strain *Aspergillus fumigatus* MCC 1721 with special reference to indole-3 -acetic acid production

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Abstract

In the present study, indole-3-acetic acid (IAA) producing plant growth promoting fungus was isolated from rice field of Purba Bardhaman district, West Bengal, India. Among the isolated 6 strains, AP2 (*Aspergillus fumigatus*) was selected as best-performing plant growth promoting fungal strain as it was an efficient indole-3-acetic acid producer as well as exhibits different plant growth promoting ability viz, phosphate solubilization, siderophore production, ammonia and hydrogen cyanide production etc. Media and different growth conditions (pH, temperature, concentration of sodium chloride) were optimized for augmentation of the indole-3-acetic acid production. The genus of the selected isolate AP2 was identified as *Aspergillus fumigatus* both by 18S rDNA sequence-based homology and MALDI-TOF analyses of ribosomal protein. Plant growth promoting ability of *Aspergillus fumigatus* has been confirmed by measuring different morphological and biochemical growth parameters in *Trigonella foenum-graecum* L. So, AP2 (*Aspergillus fumigatus*) can be considered as novel plant growth promoting fungal strain that can be applied as bio-inoculants on agricultural field.

Keywords

Aspergillus, IAA producing fungi, indole-3-acetic acid, plant growth promoting fungi

Introduction

Now-a-days, pesticides and chemical fertilizers are excessively used in crop production (1). Although, these chemical fertilizers may increase crop nutrient in adverse condition but it has many negative impact in our environment (2). Chemical fertilizer made up of phosphate, potassium, nitrate salts are potential source of heavy metals and radio-active elements that may accumulate in soil and may enter into plant body (2). In this point, there is an extreme thrust for an alternative eco-friendly and environmentally sustainable method. A sustainable agricultural practice significantly reduces the use of hazardous chemical input to the agricultural field to ensure protection of the environment but should maintain the nutrient quality of crops (1).

Current research has focused on different soil borne plant growth promoting microbes that can be a good alternative of the harmful chemical fertilizers (1). Several rhizosphere fungi plays important role in growth and productivity of host plant (3). Different fungal stains that inhabit in rhizosphere region of host plants are able to increase the plant growth and productivity in various ways (4). Some commonly reported plant growth

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BMC Genomics

RESEARCH

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Delving into the lifestyle of Sundarban Wetland resident, biofilm producing, halotolerant *Salinicoccus roseus*: a comparative genomics-based intervention

Bhramar Dutta[1], Urmi Halder[1], Annapurna Chitikineni[2,3], Rajeev K. Varshney[2,3] and Rajib Bandopadhyay[1*]

Abstract

Background Microbial community played an essential role in ecosystem processes, be it mangrove wetland or other intertidal ecologies. Several enzymatic activities like hydrolases are effective ecological indicators of soil microbial function. So far, little is known on halophilic bacterial contribution and function on a genomic viewpoint of Indian Sundarban Wetland. Considering the above mentioned issues, the aims of this study was to understand the life style, metabolic functionalities and genomic features of the isolated bacterium, *Salinicoccus roseus* strain RF1H. A comparative genome-based study of *S. roseus* has not been reported yet. Henceforth, we have considered the inclusion of the intra-species genome comparison of *S. roseus* to gain insight into the high degree of variation in the genome of strain RF1H among others.

Results *Salinicoccus roseus* strain RF1H is a pink-red pigmented, Gram-positive and non-motile cocci. The bacterium exhibited high salt tolerance (up to 15% NaCl), antibiotic resistance, biofilm formation and secretion of extracellular hydrolytic enzymes. The circular genome was approximately 2.62978 Mb in size, encoding 574 predicted genes with GC content 49.5%. Presence of genomic elements (prophages, transposable elements, CRISPR-Cas system) represented bacterial virulence and multidrug-resistance. Furthermore, genes associated with salt tolerance, temperature adaptation and DNA repair system were distributed in 17 genomic islands. Genes related to hydrocarbon degradation manifested metabolic capability of the bacterium for potential biotechnological applications. A comparative pangenome analysis revealed two-component response regulator, modified C4-dicarboxylate transport system and osmotic stress regulated ATP-binding proteins. Presence of genes encoding arginine decarboxylase (ADC) enzyme being involved in biofilm formation was reported from the genome. In silico study revealed the protein is thermostable and made up with ~ 415 amino acids, and hydrophilic in nature. Three motifs appeared to be evolutionary conserved in all *Salinicoccus* sequences.

Conclusion The first report of whole genome analysis of *Salinicoccus roseus* strain RF1H provided information of metabolic functionalities, biofilm formation, resistance mechanism and adaptation strategies to thrive in climate-change induced vulnerable spot like Sundarban. Comparative genome analysis highlighted the unique genome content that contributed the strain's adaptability. The biomolecules produced during metabolism are important sources of compounds with potential beneficial applications in pharmaceuticals.

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such as amino acid composition, extinction coefficient, instability index, aliphatic index and grand average of hydropathy (GRAVY) of the ADC proteins of *S. roseus* RF1H, *S. carnicancri*, *S. cyprini*, *S. halodurans* and *S. sediminis* were calculated by using Expasy ProtParam tool [https://web.expasy.org/protparam/]. Secondary structure prediction of ADC was carried out by SOPMA from the NPS server [https://npsa-pbil.ibcp.fr/cgi-bin/npsa_automat.pl?page=/NPSA/npsa_sopma.html]. *S. roseus* strain RF1H was selected to predict the tertiary structure of ADC. SWISS-MODEL [https://swissmodel.expasy.org/] was used to build 3D models and the model quality was assessed by ProSA-web [https://prosa.services.came.sbg.ac.at/prosa.php]. Multiple protein sequences were aligned with COBALT tool [https://www.ncbi.nlm.nih.gov/tools/cobalt/re_cobalt.cgi] to understand the amino acid differences in the structure. The conserved protein motifs were analyzed by MEME tool [https://meme-suite.org/meme/index.html]. The deduced domains were subjected to find protein family using the NCBI conserved domain database (CDD) [https://www.ncbi.nlm.nih.gov/cdd].

Biochemical characteristics

Qualitative detection of extracellular hydrolytic enzymes like amylase, cellulase, protease, lipase/esterase, catalase and carbohydrate fermentation using various sugars like-ribose, fructose, starch, mannose and triple sugar (lactose, sucrose, glucose and iron) were performed on agar plate assays [63].

Statistical analyses

Statistical analyses of the basic genomic features like genome length, GC content, number of CDS etc. were performed with a t-test in R Studio [47]. The p-value of < 0.05 was considered as significant threshold. Experiments were performed in triplicates. Standard errors were calculated and shown in charts as error bars.

Abbreviations

ABC transporter	ATP-binding cassette transporter
ADC	Arginine decarboxylases
AGEs	Accessory Genomic Elements
AI	Autoinducer
AIP	Autoinducing Peptide
AMP	Antimicrobial Peptides
ANI	Average nucleotide identity
BLAST	Basic Local Alignment Search Tool
CGViewer	Circular Genome Viewer
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
EHT	Electron High Tension
GBDP	Genome BLAST Distance Phylogeny
GI	Genomic Island
HGT	Horizontal Gene Transfer
KEGG	Kyoto Encyclopedia of Genes and Genomes
MES	Microbial Electrochemical Systems
MHA	Mueller–Hinton Agar
NCBI	National Centre for Biotechnology Information
QS	Quorum Sensing
RAST	Rapid Annotations using Subsystems Technology
SEM	Scanning Electron Microscopy
TEM	Transmission Electron Microscope
TYGS	Type (Strain) Genome Server

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12864-023-09764-w.

Additional file 1: Supplementary Table S1. Matrix consisting of Average Nucleotide Identity (ANI) values of the fourteen genomes of Salinicoccus. **Supplementary Table S2.** RAST subsystem analysis for proteins involved in various metabolic activities of Salinicoccus roseus RF1H. **Supplementary Table S3.** Functional annotation of genes present in Genomic Islands of S. roseus strain RF1H. **Supplementary Table S4.** Assembly and annotation report of all available Salinicoccus roseus genomes from NCBI GenBank. **Supplementary Table S5.** Features assigned to subsystems from RAST server present in all S. roseus strains. **Supplementary Table S6.** Antibiotic sensitivity of Salinicoccus roseus strain RF1H. **Supplementary Table S7.** ResFinder FESA server generated antimicrobial test results of S. roseus RF1H. **Supplementary Table S8.** Distribution of three motifs with best possible amino acid. **Supplementary Figure S1.** Osmoadaptation strategies of S. roseus revealed by genome analysis.

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Authors' contributions

RB: Conceptualization, supervision. BD: Experimental work, data analysis and draft manuscript writing. UH: Annotation. AC and RKV: sequencing and assembly. All authors reviewed the manuscript.

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Availability of data and materials

The whole genome shotgun project of *Salinicoccus roseus* strain RF1H has been deposited in NCBI GenBank under the accession number JAIMFU010000000.1 (BioProject number PRJNA756885 and BioSample number SAMN20929570).
Supplementary material related to this article is available online.

Declarations

Ethics approval and consent to participate

The research does not involve any studies with human participants and/or animals.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Article

Synthesis, Kinetics, Reaction Mechanism, and Bioactivity Assays of a Dimeric Palladium Complex

Anwesha Dey,[#] Ramesh Kumar,[#] Bhramar Dutta, Rajib Bandopadhyay, Sankha Chakrabortty, Moonis Ali Khan, Byong Hun Jeon,* and Alak Kumar Ghosh*

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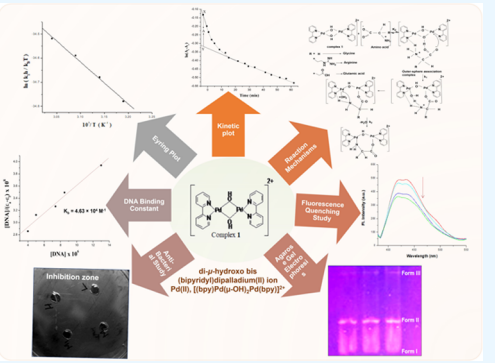
ABSTRACT: A dimer of Pd(II), $[(bpy)Pd(\mu\text{-}OH)_2Pd(bpy)]^{2+}$, (complex **1**) (where bpy = 2,2′-bipyridyl) has been synthesized at physiological pH (7.4) and characterized by electronic spectroscopy, electrospray ionization mass spectrometry (ESI-MS) spectroscopy, and Fourier transform infrared (FT-IR) analysis. Reaction kinetics of **1** with glycine (L^1H), L-glutamic acid (L^2H), and L-arginine (L^3H) were investigated in an aqueous medium at pH of 7.4 and constant ionic strength via a spectrophotometer as a function of temperature and different concentrations of substrate-complex and ligand. The interactions were supported by two discrete successive steps, i.e., ligand-dependent and ligand-independent steps. The equilibrium constant of complex formation (outer-sphere association) and the rate constant during complex-substrate−ligand interaction were calculated. The Eyring equation was applied to evaluate activation factors ($\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$), and associative mechanisms of all reactions were proposed. Thermodynamic parameters ($\Delta H°$ and $\Delta S°$) were also estimated from the standard plot of ln K_E against $10^3/T$. Spectroscopic titration of **1** at pH 7.4 in Tris−HCl buffer with calf thymus DNA, electronic emission titration with ethidium bromide (EtBr), antimicrobial activities, and an agarose gel electrophoresis run of **1** on pBR322 plasmid DNA have shown strong evidence of anticancer activity. Moreover, it has nontoxic water molecules as leaving groups.



1. INTRODUCTION

Metal-based anticancer chemotherapeutic drugs that are less toxic to normal cells and more effective to cancerous cells have been in search ever since the successful clinical application of cisplatin, *cis*-diamminedichloroplatinum(II) (*cis*-DDP) in cancer therapy.[1,2] However, various types of side effects, such as vomiting, nausea as well as nephrotoxicity, neurotoxicity, hemolytic anemia, and ototoxicity, have limited the wide application of cisplatin as an anticancerous drug.[3] Other newly synthesized Pt(II)-based anticancer drugs viz. carboplatin, nedaplatin, lobaplatin, and oxaliplatin are not as successful as cisplatin due to severe side effects and no longer have the clinical advantages.[4,5] Moreover, inherent and acquired resistances have marred the success of cisplatin and limited its efficacy during chemotherapy.[6] The adverse effect of Pt(II)-based anticancer drugs leads the attention toward the less toxic[7] but similar efficacy of Pd(II) complexes showing isostructural pattern (square planar) and analogues with Pt(II) complexes.[8,9] Moreover, Pd(II) complexes could attain rapid equilibrium in comparison to Pt(II) (10^5 times faster)[10,11] analogues which might be applied as a model complex for studying the mechanism of interaction of Pt-analogues with DNA.[12]

From this background, we have chosen Pd(II)[13] as the metal center and an aromatic ligand having an N,N donor center (2,2′-bipyridine)[14,15] as a building block considering the donor center of cis-DDP to explore its kinetic and mechanistic behavior for in vitro studies using three selected amino acids: glycine, L-arginine, and L-glutamic acids. In addition, such metal complexes interrelate noncovalently with DNA due to their planar aromatic rings, which have the potential of powerful anticancerous drugs.[16,17] The calf thymus (ctDNA) has been used primarily for DNA binding studies during the development of metallodrugs for chemotherapeutic applications using different metal-based complexes such as Pd, Cu, Zn, and Ru.[14,18] In vitro studies, such as evaluation of the linear Stern−Volmer quenching constant (K_{sv}), ability to cleave plasmid DNA (pBR 322), and antimicrobial activity of the complex and ligand, are beneficial to understand the

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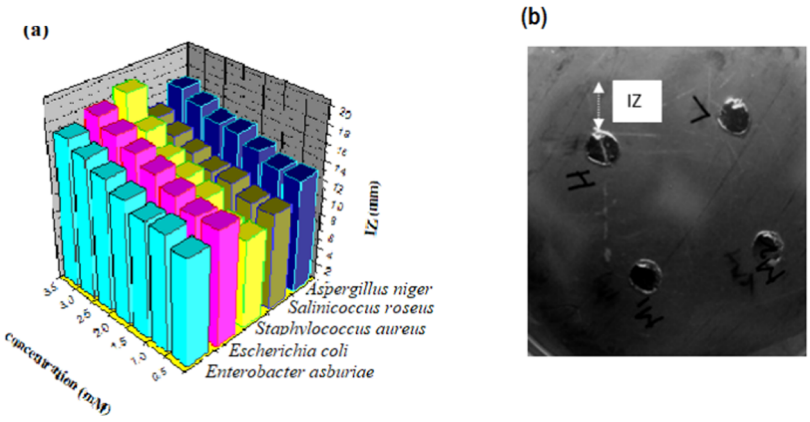

Figure 15. (a) Plot of inhibition zone versus concentration of antimicrobial study of **1** and (b) inhibition zone of bacterial agar Petri dish.

4. CONCLUSIONS

The dimer of the Pd(II) complex was synthesized at pH 7.4 and characterized by electronic spectroscopy, FT-IR, and ESI-MS spectroscopy. Reaction kinetics of **1**'s substitution reactions with the three selected amino acids containing N and O donor centers at 7.4 pH in the aqueous solution have been studied to optimize reactivity and selectivity. Low positive values of enthalpy of activation ($\Delta H_1^{\neq}$ and $\Delta H_2^{\ddagger}$) and high negative values of entropy of activation ($\Delta S \neq 1$ and $\Delta S \neq 2$) for the three reactions suggest a reasonable degree of ligand participation in the associative mode of the transition state, which implies ligand-dependent step I. In contrast, step II is ligand-independent ring closure. The high nucleophilicity of glycine among the three amino acids leads to greater stabilization of the transition state with the Pd(II) dimer and requires the lowest activation enthalpy. In vitro DNA binding studies suggest a strong interaction of **1** with ctDNA. The antimicrobial and antifungal activities reveal that **1** can be active against selected bacterial and fungal strains. Comparing the K_b and K_{SV} values (Table 6), it is found that **1** has a higher value than **2** but a lower value than the other (Pd 1, Pd 2, Pd 3, and Pd 4). So, dimerization from **2** to **1** increases DNA binding capacity. In the case of Pd 2, Pd 3, Pd 4, and Pd 5, though they are dimers having a higher DNA binding value than **1**, each of the four has toxic chloride (Cl^-) as a leaving group, while **1** has a nontoxic water molecule as a leaving group.

Further studies can be carried out to evaluate its pharmacological properties in vivo and the definite mechanism of its bioactivity. However, the results of this study can be beneficial in understanding the reaction kinetics and the interaction of the Pd(II) complex with amino acids, DNA, and selected microbes. It can encourage the development and production of superior anticancer therapeutic reagents. The following points summarize the novelty of this study, such as a correlation between kinetic study and bioactivity assay in an aqueous medium at physiological pH, optimization between reactivity and selectivity, optimum rate, nontoxic side product (H_2O), and antimicrobial activity.

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Notes

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Detailed genomic and biochemical characterization and plant growth promoting properties of an arsenic-tolerant isolate of *Bacillus pacificus* from contaminated groundwater of West Bengal, India

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ABSTRACT

In this study, arsenic tolerating bacteria *Bacillus pacificus* (AKS1a) was isolated from arsenic contaminated groundwater of Purbasthali, Purba Bardhaman, West Bengal, India and its bioremediation potential was preliminary screened. This multimetal resistant strain was able to grow against more than 20 mM arsenate and 10 mM arsenite salts. The genome was more than 5.16 Mb in length, with an average of around 35.2% GC content, bearing 5403 protein coding genes. Arsenic resistant genes like *arsC*, *arsB*, *arsR*, etc. were also identified. Rapid Annotation using Subsystem Technology (RAST) identified 328 subsystems within the genome. Presence of six Genomic Islands (GIs) and five phage virus genomic parts indicated its ecological adaptations to overcome environmental stresses. The production of about 415 μg mL^{-1} indole acetic acid (IAA), 258.0 μg mL^{-1} gibberellic acid (GA), and 183 μg mL^{-1} proline by the bacterium, along with nitrogen fixation ability under *in-vitro* conditions, indicate its plant growth promoting potential. This was further confirmed through rice seedling growth enhancement under arsenic stress. Beside arsenite oxidation to arsenate, its arsenic adsorption property was confirmed through X-ray Fluorescence spectroscopy (XRF), Fourier Transform Infrared spectroscopy (FTIR), and Energy Dispersive X-ray spectroscopic (EDS) analysis. Genomic comparisons among 25 different strains of *B. pacificus* showed that there are tremendous genetic differences in respect to their accessory genome content. In future, this strain can be applied as biofertilizer or biostimulant for improving rice plant growth.

1. Introduction

Arsenic and its detrimental impacts on different organisms are well established today (Sher and Rehman, 2019). Arsenic, a metalloid, is ubiquitously distributed in environment and its presence markedly dependent on biotic and abiotic factors like nature of soil, microbial population, pH, water content, etc. Background concentration of arsenic ranges from 0.1 to 40 mg kg^{-1} in soil and <0.5 to

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Copper removal capability and genomic insight into the lifestyle of copper mine inhabiting *Micrococcus yunnanensis* GKSM13

Krishnendu Majhi [a,b], Moitri Let [a], Urmi Halder [a], Annapurna Chitikineni [c,d], Rajeev K. Varshney [c,d], Rajib Bandopadhyay [a,*]

[a] Microbiology Section, Department of Botany, The University of Burdwan, Burdwan, West Bengal, 713104, India
[b] Department of Botany, Ananda Chandra College, Jalpaiguri, 735101, India
[c] Center of Excellence in Genomics and Systems Biology, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India
[d] State Agricultural Biotechnology Centre, Centre for Crop and Food Innovation, Murdoch University, Murdoch, 6500, Australia

ARTICLE INFO

Handling Editor: Aijie Wang

Keywords:
Bioremediation
Copper mining
Copper homeostasis
Copper removal
Multimetal resistant

ABSTRACT

Heavy metal pollution in mining areas is a serious environmental concern. The exploration of mine-inhabiting microbes, especially bacteria may use as an effective alternative for the remediation of mining hazards. A highly copper-tolerant strain GKSM13 was isolated from the soil of the Singhbhum copper mining area and characterized for significant copper (Cu) removal potential and tolerance to other heavy metals. The punctate, yellow-colored, coccoid strain GKSM13 was able to tolerate 500 mg L^{-1} Cu^{2+}. Whole-genome sequencing identified strain GKSM13 as *Micrococcus yunnanensis*, which has a 2.44 Mb genome with 2176 protein-coding genes. The presence of putative Cu homeostasis genes and other heavy metal transporters/response regulators or transcription factors may responsible for multi-metal resistance. The maximum Cu^{2+} removal of 89.2% was achieved at a pH of 7.5, a temperature of 35.5 °C, and an initial Cu^{2+} ion concentration of 31.5 mg L^{-1}. Alteration of the cell surface, deposition of Cu^{2+} in the bacterial cell, and the involvement of hydroxyl, carboxyl amide, and amine groups in Cu^{2+} removal were observed using microscopic and spectroscopic analysis. This study is the first to reveal a molecular-based approach for the multi-metal tolerance and copper homeostasis mechanism of *M. yunnanensis* GKSM13.

1. Introduction

The term "heavy metal" refers to the group of metallic elements and metalloids with high molecular weight and atomic density greater than 5 g cm^{-1} (Dhaliwal et al., 2020). The non-degradable and persistent metals such as copper (Cu), cadmium (Cd), chromium (Cr), lead (Pb), arsenic (As), nickel (Ni), cobalt (Co), zinc (Zn), and mercury (Hg) (Kumar et al., 2021) exacerbate the negative impacts on the ecosystem. The bioaccumulation and biomagnification of these heavy metals in ecosystems pose an acute threat to the entire food chain (Duruibe et al., 2007; Das et al., 2022). These pollutants are cytotoxic in nature, create gastrointestinal complications, short time memory loss, mental retardation, etc. even at low concentrations (Priyadarshanee and Das, 2021). In addition, adverse effects on human are generally dose-dependent and metal specific. For example, Pb causes oxidative damage by forming reactive oxygen species (ROS), Cr (VI) and Cd effect on cellular integrity, As and Hg form toxic derivatives of methyl and thiol groups, and Fe cause lipid peroxidation (Balali-Mood et al., 2021; Priyadarshanee and Das, 2021).

Among the heavy metals, copper (Cu) is considered an essential micronutrient and acts as a cofactor for multiple enzymes and proteins involved in photosynthesis, oxidation, nitrogen fixation, and other cellular metabolisms (Rehman et al., 2019). According to the World Health Organization (WHO), the permissible limit of Cu in drinking water is 2 mg L^{-1} (Chan et al., 2022). However, several natural and anthropogenic activities such as soil erosion, leaching, mining, smelting, automobile exhaust, coal combustion, municipal compost, fertilizers, pesticides, and fungicides are the major contributors for the excessive Cu inputs into the environment (Kumar et al., 2021; Saha et al., 2022). This may cause vegetation loss, soil nutrient depletion, and human health risks (Shabbir et al., 2020). In humans, Cu toxicity generates free radicals within the cell and causes nausea, headache, vomiting, diarrhoea, respiratory infections, liver and kidney failure (Rathi and Yogalakshmi, 2021; Shabbir et al., 2020). Nevertheless, the excessive Cu

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Copper removal capability and genomic insight into the lifestyle of copper mine inhabiting *Micrococcus yunnanensis* GKSM13

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Keywords:
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ABSTRACT

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1. Introduction

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Among the heavy metals, copper (Cu) is considered an essential micronutrient and acts as a cofactor for multiple enzymes and proteins involved in photosynthesis, oxidation, nitrogen fixation, and other cellular metabolisms (Rehman et al., 2019). According to the World Health Organization (WHO), the permissible limit of Cu in drinking water is 2 mg L^{-1} (Chan et al., 2022). However, several natural and anthropogenic activities such as soil erosion, leaching, mining, smelting, automobile exhaust, coal combustion, municipal compost, fertilizers, pesticides, and fungicides are the major contributors for the excessive Cu inputs into the environment (Kumar et al., 2021; Saha et al., 2022). This may cause vegetation loss, soil nutrient depletion, and human health risks (Shabbir et al., 2020). In humans, Cu toxicity generates free radicals within the cell and causes nausea, headache, vomiting, diarrhoea, respiratory infections, liver and kidney failure (Rathi and Yogalakshmi, 2021; Shabbir et al., 2020). Nevertheless, the excessive Cu

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SHORT COMMUNICATION

Splachnobryum (Splachnobryaceae A.K. Kop.) a New Generic Record to the Mosses of Sikkim Himalaya, India

S. S. Dash[1] · Subhajit Lahiri[2] · Pamela Saha[2] · Asok Ghosh[3] · B. K. Sinha[1]

Received: 14 March 2018 / Revised: 3 August 2018 / Accepted: 9 January 2020 / Published online: 30 January 2020

Abstract *Splachnobryum obtusum* (Brid.) C. Muell. (Splachnobryaceae A.K. Kop.) has been recently collected from Dzongri regions of west district of Sikkim at an altitude of 3732 msl. The collection of this species from such a higher elevation in Sikkim indicates its greater adaptability to survive in a varied range of habitats in Sikkim Himalaya and also an indication for possible climate change. The description of the species along with an illustration is provided in the present paper. Occurrence of the genus *Splachnobryum* has been recorded for the first time from Sikkim Himalaya and also from a subalpine region.

Keywords Moss · Eastern Himalaya · New · Generic record · Sikkim · *Splachnobryum*

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Introduction

The genus *Splachnobryum* Muller: 1896 (Splachnobryaceae), consisting of about 10 species [1, 2], is distributed worldwide in the northern tropical and subtropical regions, except a few species that are introduced in temperate glasshouses in South America and Europe. The plants are usually grown in moist and wet inorganic calcareous subtracts, and commonly at low altitudes, extending up to 1870 m [1]. It has greatly been considered that many species that were previously considered under this genus in family Splachnaceae were amalgamation of many taxonomic complexes which were subsequently transferred to many allied genera *Bryum, Syrrhopodon, Distichophyllum, Archidium,* and *Gymnostomiella*or reduced to synonyms [1, 3]. The genus *Splachnobryum* is characterised by small unbranched dioicous gametophytes, erect slender stem, leaves largely deformed, crowded towards apex, median large laminal cells, with a variable shape, smaller towards the margin and large towards the costa; pair of axillary hairs near leaf insertion, rhizoids in the lower part of stem; terminal clustered antheridia solitary-necked archegonia, while the sporophyte is solitary, with a thin, smooth seta and erect, cylindrical theca. In the current circumscription, the genus is represented in India by three species: *Splachnobryum aquaticum* C. Muell. (known from Uttarakhand and Gujarat); *Splachnobryum assamicum* Dixon (known from Uttarakhand and Assam); and *Splachnobryum obtusum* (Brid.) C. Muell. known from Gangetic South Bengal, Orissa, Western Himalaya, and Western Ghats [1, 4].

During identification of some of the recent moss collections, we came across an interesting specimen of *Splachnobryum* Muller. collected from a place between Tshoka and Phedang (3732 m), 27° 27′ 34.24″ N, 88° 10′

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A contribution to the flora of Kanchenjunga Biosphere Reserve, Sikkim, India

Subhajit Lahiri[1], Sudhansu SekharDash[2*], Asok Ghosh[3] and B.K. Sinha[2]

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कांचनजंधा जीवमंडल रिजर्व, सिक्किम, भारत की वनस्पतिजात में संयोजन

सुभोजित लाहिड़ी, सुधांशु शेखर दाश, अशोक घोष, बी. के. सिन्हा

सारांश

कांचनजंधा जीवमंडल रिजर्व, सिक्किम में बाइस पादप जातियों का संयोजन हुआ है । इसके अतिरिक्त सिक्किम हिमालय क्षेत्र से प्रथम बार रूबस लासियोस्टाइलस फोके यहां प्रतिवेदित किया गया है । सरल अभिनिर्धारण के लिए प्रत्येक जाति के पुष्पण अवधि व पारिस्थितिकी पर एक विस्तृत विवरण व जानकारी प्रदान की गई है ।

ABSTRACT

Twenty two species reported here as addition to the Flora of Kanchenjunga Biosphere Reserve, Sikkim. Besides *Rubus lasiostylus* Focke reported here for the first time from Sikkim Himalaya. A comprehensive description, information on phenology and ecology of each of the species has been provided here for easy identification.

Keywords: Floristic Diversity, KBR, New Additions, Sikkim

INTRODUCTION

The Kanchenjunga Biosphere Reserve (KBR) is located in West and North district of Sikkim between 27°15′-27°57′N latitude and 88°02′-88°40′E longitude. The biosphere reserve comprises an area of 2619.92 sq. km of which the core zone is about 1784 sq. km and the buffer zone is 835.92 sq. km. Due to its great biodiversity along with multi-ethnic culture, UNESCO acknowledged this biosphere reserve as World Heritage Site in the year 2018. The biosphere reserve falls within the Himalaya global biodiversity hotspot and shows an unrivaled range of sub-tropical to alpine ecosystems. Khangchendzonga Biosphere Reserve is covers 25% of the State of Sikkim, recognized as one of India's most noteworthy biodiversity concentrations. Maity & al., (2018) enumerated 1584 species of flowering plants from the area while dealing the Flora of Kanchenjunga Biosphere Reserve. However, certain parts of the KBR are yet to be explored and documented. Recently, during our visit to KBR in connection with setting up permanent plots under the project "Biodiversity Assessment through Long-term Monitoring Plots in Indian Himalayan Landscape" for monitoring of plant diversity change in the Dzongri-Gocha La area, we have collected a total of 400 plant specimens. Interestingly, 22 species belonging to 13

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SL. NO. 21

University of Calcutta

Senate House, Kolkata - 700073

Date of Enrollment : **14th March 2016**
Registration Number : **04407/Ph.D.(Sc.)Proceed/2018**
Date of Registration : **18th June 2018**
Date of Letter : **20th June 2018**
(Please quote the above Number and Date in all future Correspondence)

From:
The Registrar,
University of Calcutta

To:
Smt Piu Banerjee
23/A/4, A.K.Banerjee Lane,
P.O.- Konnagar, Dist.- Hooghly,
Pin- 712235.

Madam,

I am desired to inform you that you have been granted registration for the Ph.D. programme under this University in **Zoology** in terms of 4.8 of the Regulations for the Degree of Doctor of Philosophy (Ph.D.) .

This registration shall remain valid for next five years with effect from the date of registration as indicated above.

You are to comply with the usual rules of migration in case you have passed the qualifying examinations for the Ph.D. programme from a University/Institute other than the University of Calcutta.

Title of Thesis

"Diversity, Biosystematics And Management Of Mites Infesting Tea Plantations Of Himalayan And Sub-Himalayan Regions Of West Bengal, India."

Name of the Supervisor : **Prof. Dr. Goutam Kumar Saha**
Name of the Joint Supervisor : **Dr. Sanjoy Poddar**
Name of the Associate Supervisor : **X**

Yours faithfully,

21 JUN 2018
Dy. Registrar

Piu Banerjee

University of Calcutta

Senate House, Kolkata - 700073

Date of Enrollment : **19th June 2017**
Registration Number : **00980/Ph.D.(Sc.)Proceed/2019**
Date of Registration : **21st February 2019** Date of Letter : **25th February 2019**
(Please quote the above Number and Date in all future Correspondence)

From:
Dy. ~~The~~ Registrar (Actg.),
University of Calcutta

To:
Sri Arghya Laha
44, Haran Chandra Laha Main Road,
Suksanatantala, P.O.- Chandannagar,
Dist.- Hooghly, Pin- 712136.

Dear Sir,

I am desired to inform you that you have been granted registration for the Ph.D. programme under this University in **Zoology** in terms of **6.6** of the Regulations for the Degree of Doctor of Philosophy (Ph.D.), C.U., framed under UGC Guidelines, **2016.**

This registration shall remain valid for next six years with effect from the date of enrolment as indicated above.

You are to comply with the usual rules of migration in case you have passed the qualifying examinations for the Ph.D. programme from a University/Institute other than the University of Calcutta.

Title of Thesis

"Identification Of Susceptible Genetic Variants Associated With Food Allergy Within Population Of West Bengal, India."

Name of the Supervisor : **Prof. Dr. Goutam Kumar Saha**
Name of the Joint Supervisor : **Dr. Sanjoy Poddar**
Name of the Associate Supervisor : **X**

Yours faithfully,

28/02/19
Dy. Registrar (Actg.)

N.B. Please see the instructions overleaf.

NIBMG

राष्ट्रीय जैव-चिकित्सा जीनोमिकी संस्थान

(भारत सरकार का स्वायत्त संस्थान, जैवप्रौद्योगिकी विभाग)

NATIONAL INSTITUTE OF BIOMEDICAL GENOMICS

(An Autonomous Institution of the Government of India, Department of Biotechnology)

AGREEMENT TO COLLBORATIVE WORK (ATC)

ON

"NEXT GENERATION SEQUENCING SERVICE"

BETWEEN

THE

NATIONAL INSTITUTE OF BIOMEDICAL GENOMICS, HAVING ITS REGISTERED OFFICE AT **PO: N.S.S, KALYANI, DISTRICT: NADIA, WEST BENGAL, INDIA, PIN: 741251**, HEREIN REFERRED TO AS

"NIBMG"

AND

THE UNIVERSITY OF BURDWAN, RAJBATI, PURBO BARDHAMAN: 713104, HEREIN REFERRED TO AS

"BU",

AND

ON AND FROM 11th. October, 2018 TO 11th. October, 2019

1. Statement of Purpose

1.1 The purpose of this agreement is to establish a framework for research experimentation between **BU** and NIBMG on "Next Generation Sequencing"

2. Statement of Work

2.1 Where as **BU** is desirous of undertaking research on ' Next generation Sequencing " and has the necessary expertise for the overall conduct of the study.

2.2 Whereas NIBMG has the necessary scientific expertise and technology platform required for the said work and is desirous of sharing the same with MBHGL through its **Core Technology Research Initiative** (herein referred to as **CoTeRI**).

2.4 BU will provide NIBMG with required quality and quantity of biospecimens (DNA samples) as required and specified by NIBMG.

2.5 NIBMG shall carry out the necessary sequencing work in it's facility .

2.6 NIBMG will provide the generated sequencing data to the Principal investigator of BU for which due credit will be provided to NIBMG with the clause "Next generation sequencing was performed at the National Institute of Biomedical Genomics, Kalyani, India" in the acknowledgement section of any publication/s arising from the data generated at the NIBMG.

2.7 BU will bear costs of all reagents, consumables and associated costs as estimated by NIBMG and provide the same to NIBMG in advance of initiation of work, which may be phased out as mutually agreed.

2.8 NIBMG shall provide Principal investigator of BU with an acknowledgement of the receipt of the money and **invoice** , immediately after receiving the fund as well as statement of expenditure and utilization certificate for the funds remitted by BU within three months after the completion of the work.

2.9 Any intellectual property arising out of this work shall be shared jointly by BU and NIBMG based on the due contribution of the both the side and cost sharing and by mutual understanding.

2.10 NIBMG will maintain complete confidentiality of the work as well as the data and the scientific conclusions drawn therein.

2.11 Remainder, if any, of bio specimens provided by Principal Investigator (PI) of BU to NIBMG for experiments carried out in NIBMG shall be returned by NIBMG to BU after the due completion of the required experiments.

3. General Provisions

3.1 This agreement will be effective upon placement of signature of authorized signatories of BU and NIBMG.

3.2 This agreement may be amended by mutual consent of BU and NIBMG.

3.3 This agreement may be reviewed and terminated by BU or NIBMG by providing a notice to the other parties at least 90 days in advance of the termination date.

3.4 Any dispute arising out of the collaborative work between BU and NIBMG may be settled jointly by Principal Investigator/ Authorised signatory of BU and of NIBMG.

3.5 Principal Investigator of BU undertakes that the required institutional ethics approval for the said work has been duly obtained and that NIBMG is not responsible for any question or dispute that may arise in future regarding the ethics approval required for conducting the experiments in NIBMG.

4. Specific Provisions

4.1 Principal Investigator of BU shall submit samples of DNA/RNA, of appropriate quantity and purity as required by NIBMG.

4.2 Based on the experimental need, Principal Investigator of BU will provide specific sequencing requirements (Whole exome/ Whole genome/ expanded exome/Trascriptome/or others) to **CoTeRI,** NIBGM. Accordingly, **CoTeRI,** will provide cost /per sample to the Principal Investigator of BU.

4.2. Principal Investigator of BU will provide the Cost of required minimum of samples size to the NIBGM, which will be decided by the **CoTeRI,** NIBMG, based on the experimental condition. BU shall transfer total cost of samples to NIBMG's bank account in advance of initiation of work.

For and on behalf of BU

Name: Dr. T. Hossain

Designation: Registrar

Place: Rajbati, Burdwan

Signature: 11.10.18

Seal: REGISTRAR (Officiating) THE UNIVERSITY OF BURDWAN BURDWAN-713104

Witness:

Name : Dr. Anuapm Basu

Principal Investigator, Dept. of Zoology, BU

Signature: 4/10/18

Dr. Anupam Basu PROFESSOR Department of Zoology The University of Burdwan

For and on behalf of NIBMG

Name: Dr. Saumitra Das

Designation: Director

Place: Kalyani, West Bengal

Signature:

Seal: सौमित्र दास / Saumitra Das निर्देशक / DIRECTOR राष्ट्रीय जैव-चिकित्सा जीनोमिकी संस्थान NATIONAL INSTITUTE OF BIOMEDICAL GENOMICS पी.ओ.:एन.एस.एस., कल्याणी-741251, जिला :नदीया, (प०बं०) P.O.:N.S.S., Kalyani-741251, Dist.-Nadia.(W.B.)

Witness:

Name : Dr. Arindam Maitra

Associate Professor, NIBMG

Signature:

National Institute of Biomedical Genomics

(An Autonomous Institution of Govt. of India, Dept. of Biotechnology)

Core Technologies Research Initiative (CoTeRI)

Principal Investigator
Prof. Anupam Basu
Principal Investigator,
DBT /SERB Funded project
Molecular Biology and Human Genetics Laboratory
Department of Zoology
The University of Burdwan
Purbo Bardhaman: 713104

Date: 24.09.2018
Reference Number: CoTeRI/BU/001/2018-19

Project Name: Expanded Exome Sequencing

1. Some of the experiments to be carried out in this project require expertise and instrumentation of NIBMG. Hence, the Principal Investigator (PI) of BU would like the help of NIBMG in carrying out the experiments in a collaborative manner.

2. PI shall submit 16 samples of genomic DNA of optimal quality and quantity (500 ng DNA per sample) for expanded exome Sequencing.

3. NIBMG will perform quantitation, exome enrichment, sequencing library preparation and 2 x 100 bp paired end read sequencing for samples to generate 30X average sequence depth per sample.

4. The results of the experiments and data will be shared jointly between PI and NIBMG. NIBMG should be provided due credit for the experimental work performed at NIBMG.

5. NIBMG is providing below a statement of cost required for execution of the experiments which will be remitted by PI to NIBMG in advance.

6. NIBMG will provide PI with details of its bank account for the same. NIBMG will also provide PI with an acknowledgement of the receipt of the money.

7. NIBMG will provide PI with the statement of expenditure and utilization certificate for the collaborative work done on the project from funds remitted by PI within three months after the completion of the work.

8. Actual time required for completion of the project is dependent upon the delivery times of all reagents and consumables required for the work and also the queue of work scheduled for the platform at the time of transfer of samples to NIBMG. Projected time required and schedule of experiments will be provided by NIBMG after the receipt of samples.

9. **Reagents and consumables cannot be purchased by NIBMG without transfer of the total money required for the entire project from PI. Partial remittance shall not be accepted by NIBMG.**

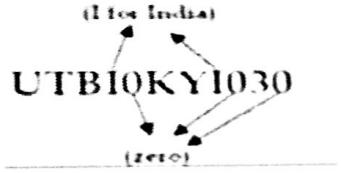
Cost Details:

S. No.	Item	No. of Samples	Total Cost (₹)
1.	DNA quantitation, Sequencing library preparation and 2 x 100 bp sequencing in NovaSeq 6000 S2 flowcell (30X average sequence depth per sample)	16	4,94,400.00
GST @ 18%			88,992.00
Total			**5,83,392.00**

Total Cost: Rupees five lakhs eighty three thousand three hundred ninety two only.

अरिंदम मैत्रा पीएचडी / Arindam Maitra Ph.D.
सह-प्रोफेसर / Associate Professor
राष्ट्रीय जैव-चिकित्सा जीनोमिकी संस्थान
NATIONAL INSTITUTE OF BIOMEDICAL GENOMICS
पी.ओ.: एन.एस.एस., कल्याणी-741251, जिला.:नदीया, (प०बं०)
P.O.: N.S.S., Kalyani-741251, Dist.-Nadia.(W.B.)

BANK ACCOUNT DETAILS of NIBMG

Name of the Beneficiary Account	National Institute of Biomedical Genomics (CoTeRI)
Bank Account Number	**0 5 7 9 0 1 0 4 5 9 1 1 2**
Nature of Bank Account	Saving Bank Account
MICR No.	7 0 0 0 2 7 3 0 3
Name of the Bank	*United Bank of India*
Name and Address of the Bank Branch	Kalyani Branch, Plot No. A-9/7(S), Kalyani, Nadia-741235 91-33-2582-8520 bmkyi@unitedbankofindia.co.in
Bank Branch code	**KYI030**
IFSC Code	**U T B I 0 K Y I 0 3 0** 

SL NO. 22

DAAD Deutscher Akademischer Austauschdienst
German Academic Exchange Service

Letter of Award

Name:	Trinetra Mukherjee
Date of birth:	14/03/89
Personal ref. no.:	91649472
Funding programme/-ID:	Research Grants - Bi-nationally Supervised Doctoral Degrees, 2017/18 (57299293)
Nationality:	India

You are being granted a DAAD scholarship.

Start of funding	End of funding	Destination country	Institution
01/10/17	30/09/18	Germany	Ruhr-Universität Bochum

The scholarship includes the following benefits:

Preparatory language course

Start of course	End of course	Course location	Organiser
01/08/17	30/09/17	Marburg	speak and write

Costs for the above language course totalling: EUR 2.700,00.
DAAD transfers this scholarship directly to the course organiser, who covers the costs of the course and accommodation with these funds and pays you pocket money of 410,00 EUR a month.

Scholarship and supplementary benefits

Benefit	Destination country	Amount	Payment	From	To
Scholarship instalment	Germany	1,000.00 EUR	monthly	01/10/17	30/09/18
Research allowance	Germany	460.00 EUR	01/10/17		
Travel allowance	Germany	350.00 EUR	01/08/17		
Travel allowance Germany	Germany	50.00 EUR	01/10/17		

For months with a funding period of less than 23 days, the scholarship payment will be calculated on a daily basis and the exact number of funding days paid. The payments listed above are subject to possible changes.

Insurance benefits

- Primary health insurance (fully comprehensive insurance)

  Unless you hear otherwise, you will be automatically registered for health insurance by the DAAD with Continentale for the duration of your language course and your scholarship. You are required to inform yourself about the conditions of your health insurance cover in Germany by reading chapter 1.5.1. „General information“ and Point II in the brochure „Ihr DAAD-Stipendium/Your DAAD-scholarship“.

- Insurance for accident and personal liability

The enclosed booklet „Ihr DAAD-Stipendium/Your DAAD-scholarship“ is an integral and complimentary part of this Letter of Award and therefore legally binding.

Conditions and requirements
The flat-rate travel allowance for your return travel will be paid together with your final scholarship instalment. The amount payable will be in accordance with the subsidy rates valid at the point in time.

Other comments

§ 34 of the Ordinance Governing Residence applies to this scholarship. According to this, the visa for academics and scientists and dependants (spouses or partners, if the marriage or civil partnership already existed upon arrival in Germany, and minor, unmarried children) accompanying or subsequently joining them is not subject to the approval of the foreigners' authorities if the scientists are assigned a place by German scientific organisations or a German public body and in this connection are receiving a publicly funded scholarship in Germany.

The scholarship granted as part of the above funding programme is financed entirely from federal public funds.

Bonn, 12/04/17

Secretary General of the German Academic Exchange Service

Personal ref. no.:	91649472
Section in charge:	Section ST34
Head of Section:	Hannelore Bossmann
Person in charge:	Melanie Lemke
Telephone number:	+49 228 882-8958

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Microstructural, electrical and mechanical characterizations of green-synthesized biocompatible calcium phosphate nanocomposites with morphological hierarchy

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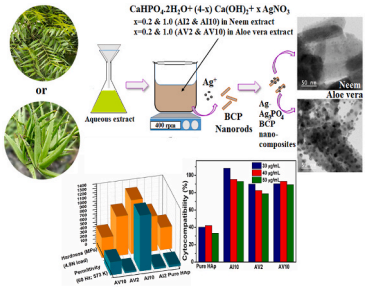
[b] Materials Science Division, Dept. of Physics, The University of Burdwan, Golapbag, Burdwan, 713104, India
[c] Department of Biotechnology, National Institute of Technology, Durgapur, 713209, India

HIGHLIGHTS

- $Ag–Ag_3PO_4$-BCP nanocomposites hydrothermally synthesized in neem and aloe vera media.
- Epitaxial attachments of metallic phases to mesoporous uniaxial BCP nanorods.
- Biocompatibility and stability up to high dosage for 72 h studied on healthy cells.
- High interfacial polarization and surface charge retention ability for osteoconduction.
- Bulk porosity and unique structure-dependent dielectric and mechanical properties.

GRAPHICAL ABSTRACT



ARTICLE INFO

Keywords:
Nanocomposites
Electron microscopy
Porosity
Dielectric properties
Impedance
Mechanical properties

ABSTRACT

The present work reports the development of novel ternary silver-silver phosphate-biphasic calcium phosphate nanocomposites by plant-extract mediated hydrothermal route. Unique epitaxial morphological growth of the $Ag–Ag_3PO_4$ core-shell structure influences the internal grain-grain boundary arrangement. The green-assisted development of the constituent phases helps significant biocompatibility enhancement (~89–93% for 50 μg/mL; 72 h). Hence long-term bone-replacement purposes and polar fluid osmosis are favorable due to higher cell attachment on the rough surface of the mesoporous nanocomposites. The heterogeneous attachment between the three phases creates defect states indicating intense interfacial polarization, as elucidated by the dielectric spectroscopic studies. The surface charge essential for bone regeneration is likely to be developed. Besides, the porous nanocomposite compacts exhibit superior phase-composition-dependent mechanical (Hardness ~1.3 GPa; load 4.9 N) and dielectric properties (permittivity ~1.2×10^3; 200 Hz, 613 K) helping in conduction through bones. Thus the green-synthesized ternary nanocomposites exhibit the essential aspects of a promising bone-implant material.

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