Consolidated Progress Report for DBT Twinning R&D Project Work
Project Report for the Year (2012-16)

GIS Modeling Based Impact Assessment of Ground Water Arsenic Contamination In Brahmaputra Basin And Development of A Remediation Strategy Using Endemic Lignocellulosic Agrowaste Based Nanobiosorbants.

Sanction Order: BT/258/NE/TBP/2011 dated 23/04/2012

(Year- 2012-2016)

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Scientific and Technical Progress Report (STPR)

(R & D Projects)

Section A: Project Details

A1. Project Title: GIS modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and Development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbants

A2. DBT Sanction Order No. & Date: BT/258/ NE/TBP/2011 Dated: 23.04.2012

A3. Principal Investigator: Dr. E. Kalita, Department of MBBT, T.U.

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A8. Approved objectives of the project:

Period of study	Achievable targets
6	Literature survey, experimental design and procurement of equipment.
12	Phase 1 sample collection and sample analysis
18	Phase 1 sample collection and sample analysis Development and characterization of different agrobased nanobiosorbents
24	Phase 2 sample collection and sample analysis Development and characterization of different synthetic nanosorbents
30	Phase 2 sample collection and sample analysis Development and characterization of different carbonized nanobiosorbents
36	GIS based modeling of collected data and optimization of different strategies for remediation of arsenic.

A9. Specific Recommendations made by the Task Force (if any): NA

DBT has granted sanctions for our project proposal entitled *"GIS modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and Development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbants"* vide letter no. BCIL/NER-BPMC/2012/-650 dated 8.5.13 and BCIL/NER-BPMC/2012/-650 -916 dated 13.7.2012 through the sanction (BT/258/ NE/TBP/2011 Dated. 23.04.2012), which is the 1st installment for the implementation of the project.

Section B: Details of the achieved progress

B1.Progress made against the Approved Objectives, Targets & Timelines during the Reporting Period

Period of study	Achievable targets
6 Months	Literature survey, experimental design and procurement of
12 Months	Phase 1 sample collection and sample analysis
18 Months	Phase 1 sample collection and sample analysis Development and characterization of different agrobased nanobiosorbents
24 Months	Phase 2 sample collection and sample analysis Development and characterization of different synthetic nanosorbents
30 Months	Phase 2 sample collection and sample analysis Development and characterization of different carbonized nanobiosorbents
36 Months	GIS based modeling of collected data and optimization of different strategies for remediation of arsenic.

B1.1. Introduction

The study area covers the entire Brahmaputra valley of Assam comprising of 33 districts (2016), as proposed in the work-plan. The guideline values exercised by the World Health Organization (WHO) and the United States Environmental Protection Agency (USEPA) conform to the availability of Arsenic in potable water beyond 10 ppb as hazardous to human health with chronic intake resulting in neurotoxicity, mutagenic and carcinogenic anomalies, developmental defects and cardiovascular disorders. The literature survey carried out in the early juncture of the Phase 1 study, provided an overview of the areas where the groundwater is suspected to be contaminated by arsenic. It further indicated that the groundwater contamination was limited to the alluvial aquifers of the Gangetic delta comprising sediments, which were carried from the sulphide-rich mineralized areas of Bihar and elsewhere, surrounding the basin of deposition. The sites for the collection of groundwater samples were thus selected based on the detailed literature survey established during the Phase 1 of the period of study. Additionally, parameters like topography, presence of industries, agricultural field, depth of water, urban environment, soil/rock type etc. have also been taken into consideration. The initial groundwater map of Assam was collected from the Central Ground Water Survey department. It has been further geo-referenced and digitized using the ArcGIS software to model the presence of the sites pertaining to contamination of arsenic above the permissible WHO standards.

B1.2. Study Area

The area selected for the study comprises of the major habitable areas in the borderline of the Brahmaputra basin which encompasses a total of 33 districts (2016) of Assam. The Phase 1 sample collection and analysis accounted for the acquisition of groundwater samples from 52 different sampling sites during the aforementioned period. The completion of the Phase 1 sample collection and the initial period of Phase 2 sample collection witnessed the acquisition of groundwater samples from an additional 45 sampling sites. At the end of the final period of the Phase 2 sample collection, a total of 200 groundwater samples were acquired from different sampling sites located in rural and urban areas of 14 major districts of Assam.

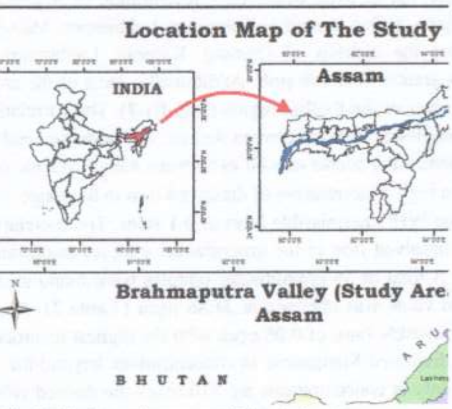


Fig. B1.1: Location map of the study area

B1.3. Collection, Preservation and Analysis the Samples

Deep tube wells accounting for a depth of more than 60 ft. were selected as the desired source for groundwater samples. However, a few locations accounting for depth in the range below 60 ft. were also taken into consideration to ascertain a possible correlation between water depth and the concentration of Arsenic present. The containers used for the storage of collected groundwater samples were rinsed three times with the water to be sampled prior to collection to reduce the chances of type I errors in analysis. The water was pumped out for about 5-10 minutes so that fresh ground water could be collected for sampling. The pH of the collected samples were measured instantly in the field. The collected samples were subsequently acidified with hydrochloric acid HCl and nitric acid HNO_3 in a ratio of 3:1 ml for every 100 ml of the water sample. The acidified samples were then stored at ~4^0C, till they were analyzed. The geographical coordinates of each and every sample site was acquired with the help of a handheld GPS and were successively utilized for the generation of GIS based modelling of sample collection sites. The field measurements included pH, and temperature of the collected water samples. The sample site was also photographed for gathering photographic evidence. The as acidified samples were adequately catalogued, given identification tags and transferred to the laboratory for further analysis.

The transferred samples were subjected to further analysis in the laboratory for the estimation of the total arsenic content present. The acidified water samples were treated with potassium iodide and ascorbic acid to prepare it for the analysis through the hydride generation method. Standard solutions of arsenic with varying concentrations were freshly prepared for the generation of a standard curve and the instrument was accurately calibrated prior to analysis. Upon successful calibration and generation of the necessary standard curve, the acidified samples were proceeded with for analysis by the hydride generation route. The as determined arsenic content in the samples were tabulated and the standard error in measurement was accounted. The Phase 1 study comprising literature survey also indicated the presence of common elemental contaminants including Iron (Fe) along with other heavy metals *viz.* Zinc (Zn), Lead (Pb), Copper (Cu), Cadmium (Cd) and Manganese (Mn) in the area under study. The collected groundwater samples were thereby assessed for the presence of the aforementioned elemental impurities to enable the identification of the locations harbouring high contaminant values of the respective elements in accordance to the permissible limits exercised by WHO & USEPA. Additionally, statistical correlation between the concentration of Arsenic in the groundwater samples and geographical parameters *viz.* sample depth and the pH of the groundwater source was also assessed by establishing the coefficient of determination. Similar studies were also carried out to establish significant statistical correlation between the concentration of Arsenic in the groundwater samples and the concentration of the other noted elemental contaminants in the collected groundwater samples.

Fig. B1.2: Photographs showing different groundwater sample collection sites (a-f) included in the study.

Fig. B1.3: Sample collection and field testing of pH, dissolved oxygen, salinity etc. during field visits by Collaborating Institution group at Gauhati University (a) Sample analysis for Arsenic concentration determination by Parent Institution group at Tezpur University (b).

B1.4. Results

The World Health Organization (WHO) standards indicate potential health hazards from the utilization of potable water wherein the concentration of dissolved Arsenic exceeds 0.01 mgL^{-1} (10 ppb). A total of 200 samples have been collected from 14 different districts in Assam during the entire period of study. Each of the collected samples were stringently analyzed and a total of **126** samples having Arsenic concentration beyond WHO permissible limit of **10 ppb** were observed. The highest concentration of Arsenic at **~352.56 ppb** was observed in the sample collected from a collection site in the district of Nagaon (source= tubewell, recorded depth= 120 ft, location: Samaguri Higher Secondary School). Furthermore, the districts where the concentration of Arsenic was found to persist beyond the WHO permissible limit include Baksa, Barpeta, Darrang, Dhubri, Golaghat, Goalpara, Jorhat, Kamrup, Kokrajhar, Lakhimpur, Marigaon, Nagaon, Nalbari, Sivasagar and Sonitpur. Moreover, the majority of the groundwater samples collected from the districts of Darrang, Kamrup, Lakhimpur, Nagaon, Nalbari and Sonitpur exhibited a significant contamination of dissolved Arsenic having concentrations greater than **100 ppb**. Additionally, most of the areas, where the As contamination in ground water is found high, are observed to be located close to the Brahmaputra river or the foothill region (**Fig. B1.3**). The correlation studies (**Fig. 4 a, b**) show a strong correlation between Arsenic concentration and the depth of the groundwater samples as well as between Arsenic concentration and the pH of the samples which suggests a strong association between a high Arsenic concentration and depth of the groundwater source as well as between a high Arsenic concentration and groundwater source having pH >7.

Furthermore, a total of **156** groundwater samples reported a high concentration of dissolved Iron in the range **>0.1 ppm** and the highest recorded value for dissolved Iron was found to be **17.73** ppm which exceeds way beyond the WHO permissible limit of **0.1 ppm**. The correlation studies (**Fig. 4**) show a strong correlation between the detected Arsenic concentration and the concentration of dissolved Iron in the groundwater samples suggesting a strong association between the elemental contents of Arsenic and Iron in contaminated aqueous environments. A total of **36** groundwater samples were found to contain dissolved Zinc in concentrations far exceeding the WHO desired limit of **5.0 ppm** with the highest recorded value was obtained at **31.86 ppm** (**Table 2**). Also, a total of **126** groundwater samples tested positive for concentrations of dissolved Lead exceeding the WHO permissible limit of **0.05 ppm** with the highest recorded value was obtained at **0.25 ppm** (**Table 2**). Moreover, a total of **147** groundwater sampled were found to contain dissolved Manganese in concentrations beyond the WHO desired limit of **0.05 ppm**. However, toxicological effects from manganese are accepted as a health concern only at concentrations are ≥10 times the desired value. Thus, a total of **45** groundwater samples were deemed hazardous for potable use owing to Manganese concentrations exceeding the WHO permissible limit of **0.5 ppm**. Additionally, no significant statistical correlation between the dissolved Arsenic content and the content of heavy metals the Zn, Cu, Cd, Pb and Mn in the collected groundwater samples was observed.

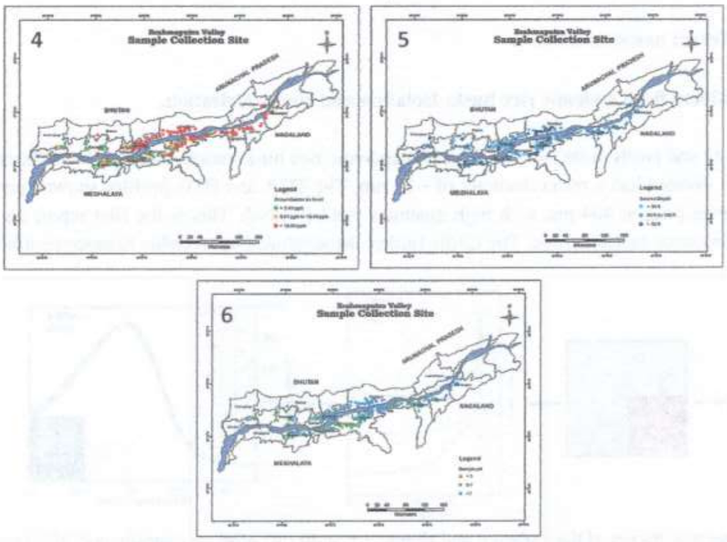


Figure B1. GIS based location map of sample collection sites showing the prevalence of Arsenic (4). GIS based location map of sample collection sites included in the study showing the depth of the groundwater sources (5). GIS based location map of sample collection sites included in the study showing the pH of the groundwater sources (6).

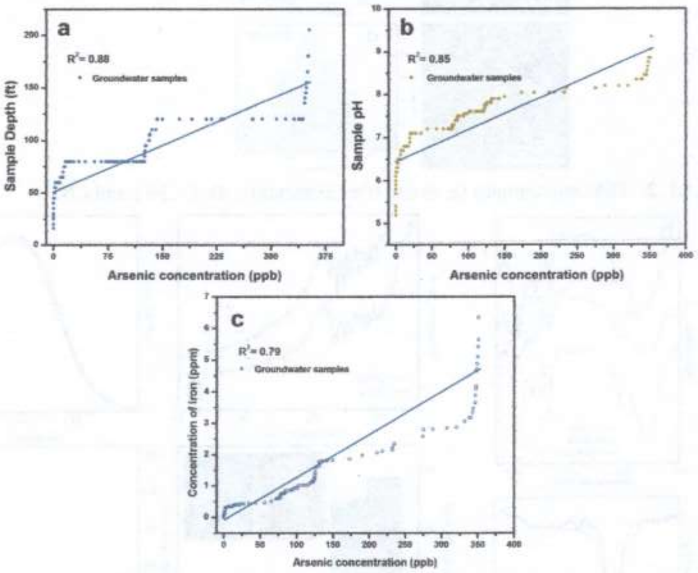


Figure B1.7. Regression graphs showing the correlation between As concentration and sample depth (a), As concentration and sample pH (b) and As concentration and Fe concentration of collected groundwater samples.

B2. Summary and Conclusions of the Progress made so far.

A total of **200** groundwater samples were collected from **14** different districts in Assam during the entire period of study and were analyzed for the presence of Arsenic. Of the **200** samples, **126** groundwater samples showed Arsenic in the range **>10 ppb** which is well beyond the WHO permissible limit and **110** groundwater samples showed Arsenic in the range **>50 ppb** which is well beyond the acceptable limit in India (in the absence of an alternative source of potable water). During the three year work plan, **7** different biosorbents with a total of **23** different sub-types were developed and analyzed for structural and functional attributes using various techniques including transmission electron microscopy (TEM), scanning electron microscopy (SEM), atomic force microscopy (AFM), X-ray diffraction (XRD) spectroscopy, fourier transform infrared (FTIR) spectroscopy, photon correlation spectroscopy, thermogravimetry (TGA) and differential thermogravimetry (DTG). Furthermore, batch adsorption experiments were carried out to assess their performance as potential adsorbents for dissolved Arsenic and their adsorption efficiency was charted. The details of the investigations are summarized in brief below.

B2.1. Development and characterization of different nanobiosorbents.

B2.1.1. High quality fluorescent cellulose nanofibers from endemic rice husk: Isolation and characterization.

Abstract:

Cellulose nanofibers (CNFs) with high crystallinity and purity were isolated from two endemic rice husk varieties using a hydrothermal approach followed by acid-alkali treatments and mechanical disruption. The CNFs isolated had a mean diameter of ~35 nm. The TGA and DTG profiles showed good thermostability of the CNFs. The CNFs also showed a prominent photoluminescence peak at 404 nm with high quantum yield (~58%). This is the first report on the native fluorescence property of nanocellulose in absence of any conjugated fluorescence molecule/dye. The CNFs further demonstrated appreciable hemocompatibility in the hemolysis test, exhibiting its potential for biomedical applications.

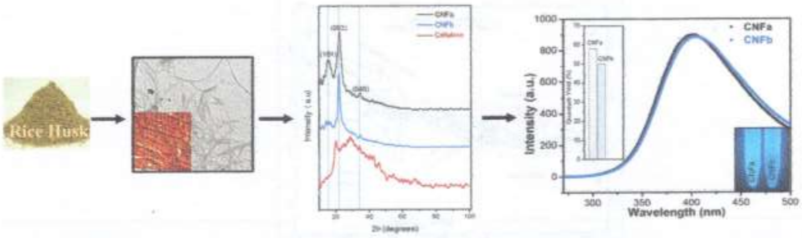


Fig B2.1.1.1. Schematic representation of the isolation and characterization of Cellulose nanofibers (CNFs) from rice husk.

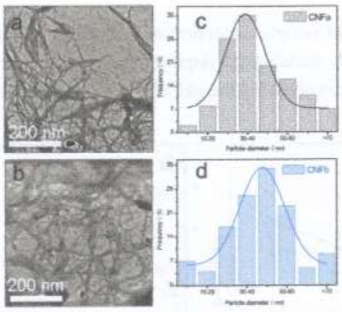


Fig. B2.1.1. 2. TEM micrographs (a, b) and fiber diameter (c, d) of CNFa and CNFb

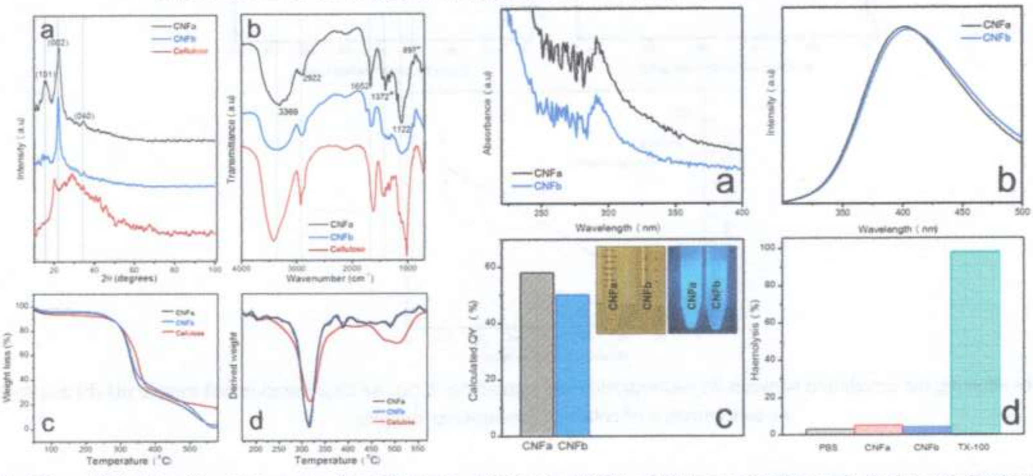


Fig. B2.1.1.3. Comparative X-ray diffraction (a), FTIR spectra (b), TGA (c) and DTG (d) of CNFa, CNFb, and Cellulose. Optical properties (a), UV-vis PL (b), Quantum yield with inset showing the fluorescence pictographs (c) and Hemolytic assay (d) of CNFa and CNFb

Conclusion:

CNFa and CNFb were synthesized from *O. sativa (L) ssp. Indica* varieties (autumn and summer) by a hydrothermal process followed by acid-alkali treatments. The isolated CNFs demonstrate high crystallinity, purity and thermostability. The FTIR based spectroscopic analysis reveal the reduction of the non-cellulosic biopolymers to trace levels, which is further confirmed by the TGA-DTG analysis. The CNFs also exhibit a unique optical property of fluorescence emission with high quantum yield, which is being reported for the first time for a native cellulosic nanomaterial. The fluorescence may be attributed to the presence of the trace lignin components, more specifically the coumarone groups and syringyl units, in the isolated CNFs, which were observed in the FTIR spectra. Further, the CNFs demonstrated excellent bioamenability in the hemolysis test. Thus, CNFs isolated from the readily available agrowastes like rice-husk, through such means, can perform as economical and high quality precursors for assorted biomedical applications like fluorescence-tags, probes, tracers, thin-films etc.

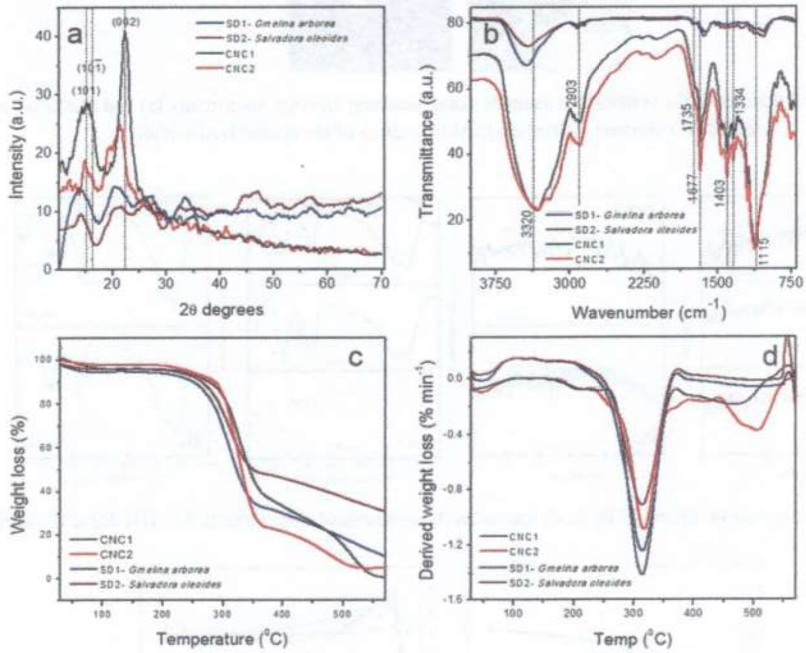
B2.1.2. Isolation and characterization of crystalline, autofluorescent, cellulose nanocrystals from saw dust wastes.

Abstract:

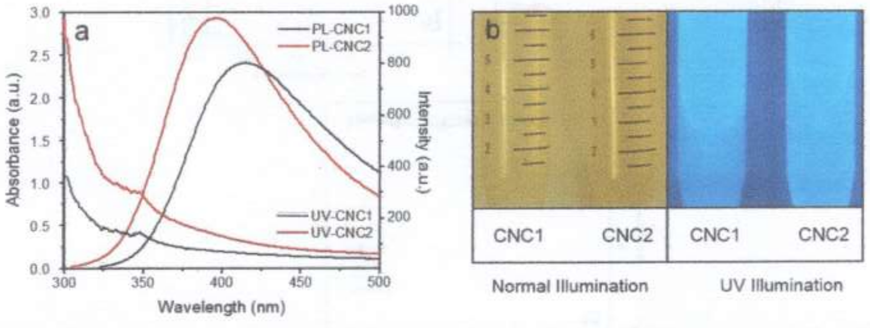
Saw dust, generated as a waste by-product of the timber industry finds limited industrial applications and are mostly discarded or incinerated, causing environmental problems. This paper discusses the isolation of cellulosic nanocrystals (CNCs) from two different varieties of commercially used timber *viz. Gmelina arborea* and *Salvadora oleoides*, through a chemically engineered hydrothermal process. The CNCs derived after a series of chemical pretreatments followed by hydrothermally assisted fibrillation and subsequent neutralization, were carefully characterized for their chemical composition and microstructural attributes. Transmission electron microscopy (TEM) and dynamic light scattering (DLS) measurements demonstrate the fibrillation of the wood cellulosic fibers to ~18-35 nm diameter range, with nearly uniform lengths in the range of ~101-107 nm. The X-ray diffraction (XRD) spectra shows the crystalline nature of the CNCs and corroborates to the spectra of known crystalline cellulosic derivatives. The Photoluminescence (PL) studies showcase an interesting property of autofluorescence at ~400 nm with high quantum yields, (~

59%), which is attributed to the presence of fluorescent subunits identified in the FTIR spectra. The results demonstrate a simplistic method for conversion of the saw dust to high quality, fluorescent, cellulosic precursors that can find novel applications in the manufacturing, biomedical and pharmaceutical industries.

Fig. B2.1.2.1. Schematic representation of the procedure for the isolation of Cellulose Nanocrystals (CNCs) (1). Microstructural features of the isolated CNCs demonstrated by TEM images and DLS measurements for CNC1 (a, b) and CNC2 (c, d) (2).



B2.1.2.3. Comparative analysis of the isolated CNCs with respect to the native saw dust samples through XRD analysis (a), FTIR analysis (b), TGA (c) and DTG (d).



B2.1.2.4. Comparative UV-Vis and PL (a) spectra of the isolated CNCs and (b) pictorial representation of the aqueous suspensions of the CNCs under bright light and UV illumination.

Conclusion.

The stepwise mechano-chemically assisted hydrothermal processing of the saw dust samples, from *G. arborea* and *S. oleoides*, resulted in the successful transformation of the lignocellulosic saw dust into crystalline, cellulose nanocrystals (CNCs). The X-ray diffractograms of the isolated CNCs strongly resembles that of crystalline cellulose (Cellulose I) derivatives and the comparative FTIR spectra shows the dominant presence of cellulose. The optical property analysis, through the UV-Vis and photoluminescence studies exhibit a unique native fluorescence property in the CNCs. The evidences provided by the different studies, indicating the presence of trace amounts of lignin in the CNCs, may be attributed to the presence of the unique autofluorescence observed. The study illustrates the isolation of the CNCs from the saw dust samples through a simple methodology, bringing about the transformation of waste to potential wealth. These CNCs, harboring the native autofluorescence, can be used for generating fluorescent, biodegradable and biocompatible nanocellulosic systems for development of bio-composites, biosensors, drug delivery systems, bio-imaging probes and other pharmaceutical products. Thus, it appears to be a promising alternative to the hazardous organometallic fluorophores, which are currently being used today.

B2.1.3. Synthesis and characterization Iron Oxide impregnated lignocellulosic nanobiosorbents from rice husk for arsenic remediation.

Abstract:

Restrictions on the availability of potable water levied by the unwarranted Arsenic content in groundwater aquifers sources offer a global concern. The current study reports the generation of Iron Oxide impregnated lignocellulose based nanobiosorbents using a facile solvothermal approach. Multiple variants of the nanocomposites were synthesized and the microstructural analysis of these refluxed variants was carried out using TEM, XRD and FTIR, which confirmed the incorporation of the nanoscaled iron oxide into the nanocellulosic matrix. The batch adsorption experiments shows adsorption efficiency of the reflux variant R5 to be relatively higher than the other refluxed variants allowing a mean adsorption efficiency of ≥ 92% using an adsorbent concentration of 1gL^{-1}at an adsorbate dosage of 1000 ppb and solvent pH range 3-12. The sorption mechanism of As on the nanobiosorbent was found to follow pseudo second order kinetics and conform to the Langmuir adsorption isotherm. The high adsorption efficiency of the synthesized nanobiosorbents thus advocates their use in the development of matrices, fillers and devices to generate arsenic free potable water for assorted uses.

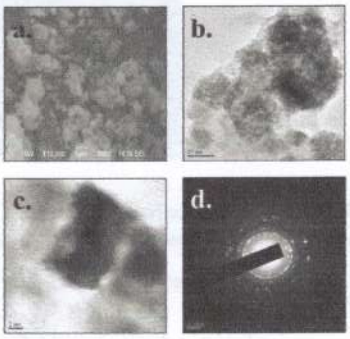


Fig. B2.1.3.1. Study of the microstructural features of the synthesized samples using Scanning electron microscopy (a) and transmission electron microscopy (b, c). Selected area electron diffraction (SAED) pattern of the synthesized sample.

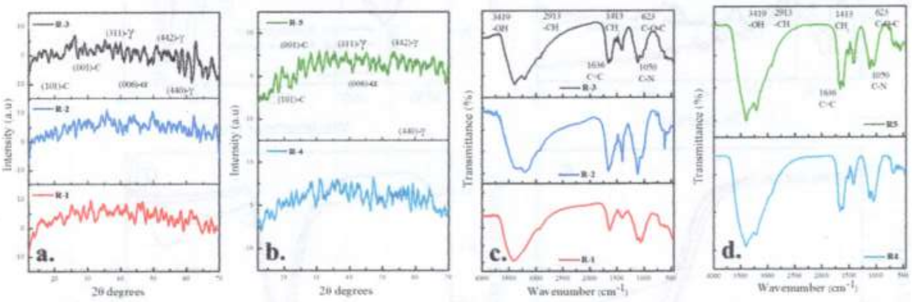


Fig. B2.1.3.2. Comparative XRD diffractograms (a, b) and FTIR (c, d) spectra of the synthesized time variants R1 (1H), R2 (2H), R3 (3H), R4 (4H) and R5 (5H).

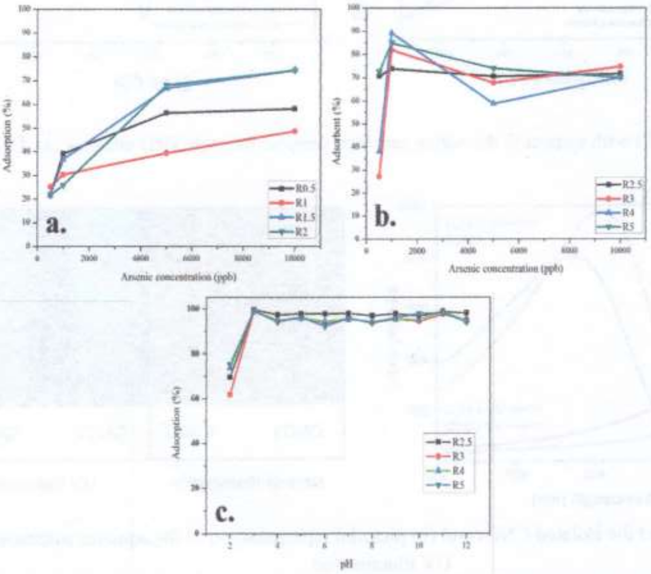


Fig. B2.1.3.3. Batch adsorption studies of the synthesized time variants R0.5 (0.5H), R1 (1H), R1.5 (1.5H), R2 (2H), R2.5 (2.5H), R3 (3H), R4 (4H) and R5 (5H), using varying concentrations of Arsenic (a, b) in aqueous medium. Adsorption studies for the optimal adsorbent samples at different pH values (c).

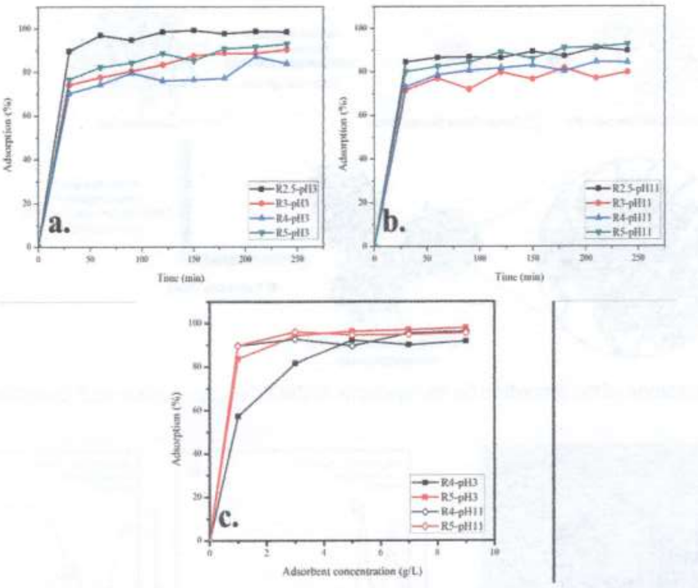


Fig. B2.1.3.4. Adsorption studies of the optimal adsorbent samples with respect to variation in time period of incubation (a, b). Adsorption studies of the optimal adsorbent samples with respect to variation in adsorbent dosage.

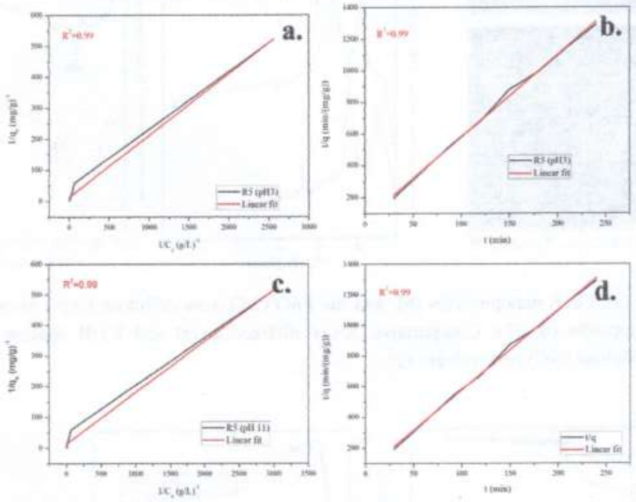


Fig. B2.1.3.1.5. Langmuir adsorption isotherms for the optimal adsorbent sample R5 at pH=3 (a) and (c) pH=11. Pseudo second order kinetics for the adsorption process of the optimal adsorbent sample R5 at (b) pH=3 and (d) pH=11.

Conclusion:

Multiple variants of the Iron Oxide impregnated lignocellulose based nanobiosorbents were synthesized using a facile solvothermal approach. The micrographs obtained from the SEM, TEM microscopic studies show the synthesized nanobiosorbents to be within the nanoscale range and having an average size of ~110 nm. The SAED patterns confirm the successful incorporation of the Iron oxide nanoparticles into the nanaocellulose matrix and is concurrent with the characteristic signatures of γFe_2O_3 in the XRD diffractograms and in the FTIR spectra. The batch adsorption studies of the reflux variants show R5 to have a relatively higher adsorption efficiency in comparison to the other variants thereby harboring a mean adsorption efficiency of ≥ 92% under an adsorbent concentration of $1gL^{-1}$at an adsorbate dosage of 1000 ppb and solvent pH range 3-12. The kinetic studies of the nanobiosorbent showed conformity to the pseudo-second order kinetics thus suggestive of a covalent chemisorption. Furthermore, the adsorption was successfully described using Langmuir adsorption isotherm, indicative of a monolayer adsorption achieved over a homogeneous layer. The high adsorption efficiency of the synthesized nanobiosorbents thus suggests their inherent potential for use in the development of assorted matrices, fillers and filtration devices that help in the generation of arsenic water for potable use.

B2.1.4. Synthesis and characterization of $ZnO:CeO_2$:nanocellulose:PANI bionanocomposite. A bimodal agent for arsenic adsorption and antibacterial action

Abstract:

In the present study we report the generation of a bimodal, $ZnO:CeO_2$:nanocellulose:Polyaniline bionanocomposite having an appreciable remediation efficiency for dissolved Arsenic along with a noticeable antibacterial activity. The microstructural analysis of the synthesized bionanocomposite was carried out by TEM, XRD and FTIR studies, which confirmed the incorporation of the nanoscaled ZnO and CeO_2 in the polymeric nanocellulose:polyaniline matrix. The bionanocomposite exhibited a remediation efficiency above ~95 % against As under different adsorbent concentrations and pH conditions. The biosorption mechanism of As on the nanobiosorbent was found to conform to the Freundlich and Dubinin-Radushkevich isotherms. Antibacterial assays for the bionanocomposite showed a high antibacterial activity with MIC_{50} values of 10.6 μg ml^{-1} against the Gram-positive *B. subtilis* and 10.3 μg ml^{-1} against the Gram-negative *E. coli*. Thus, the bionanocomposite shall be of high interest as a novel and sustainable matrix for the design of coats/devices that effectuate arsenic adsorption and microbial control, to generate contaminant free potable water.

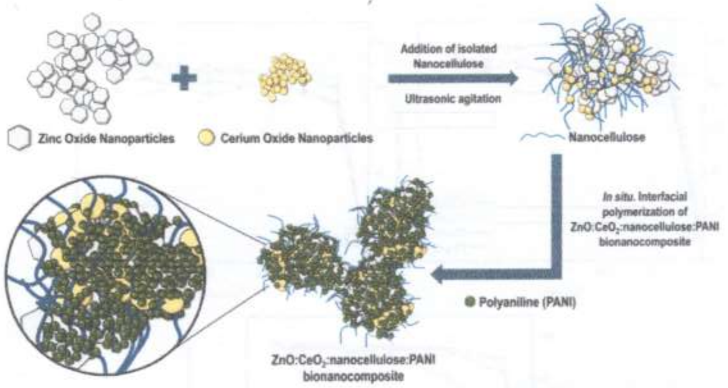


Fig. B2.1.4.1. Schematic representation of the procedure for the synthesis of ZnO:CeO_2:nanocellulose:Polyaniline bionanocomposite

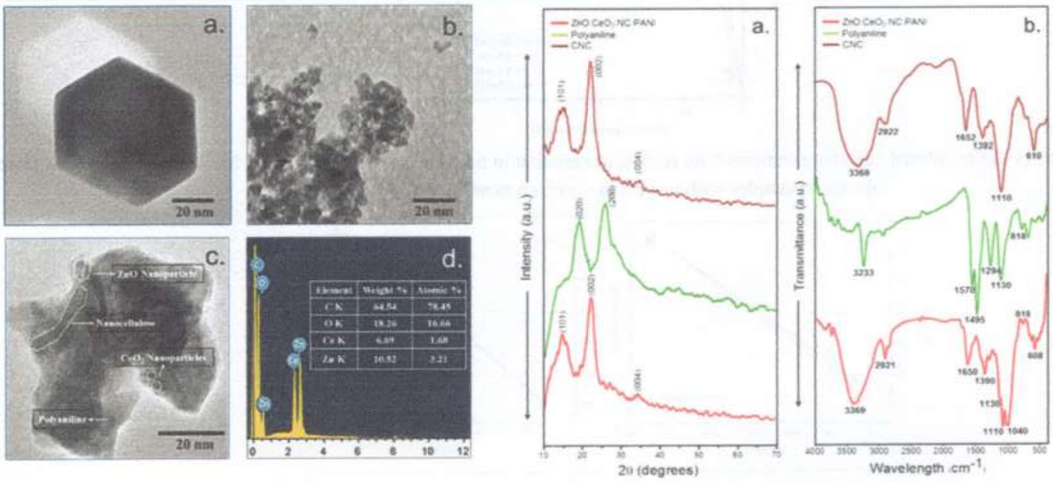


Fig. B2.1.4.2. TEM micrographs of ZnO nanoparticles (a), CeO_2 nanoparticles (b), and the ZnO:CeO_2:nanocellulose:PANI bionanocomposite (c); SEM-EDS elemental analysis of ZnO:CeO_2:nanocellulose:PANI bionanocomposite (d) (1), Comparative X-ray diffraction (a) and FTIR spectra (b) of ZnO:CeO2:nanocellulose:PANI bionanocomposite, Polyaniline, and the isolated Nanocellulose (NC) respectively (2).

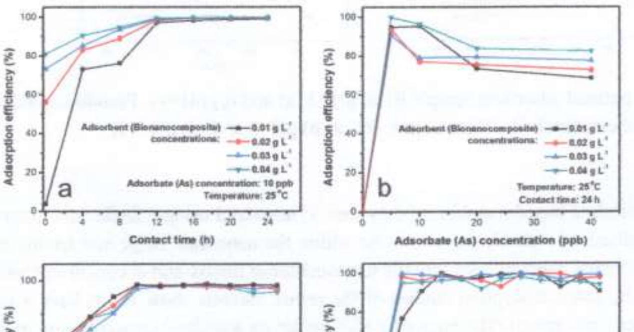


Fig. B2.1.4.4. Effect of contact time with the adsorbent (a), adsorbate concentration (b), adsorbent concentration (c) and solution pH (d) on the adsorption of Arsenic on the ZnO:CeO_2:nanocellulose:PANI bionanocomposite.

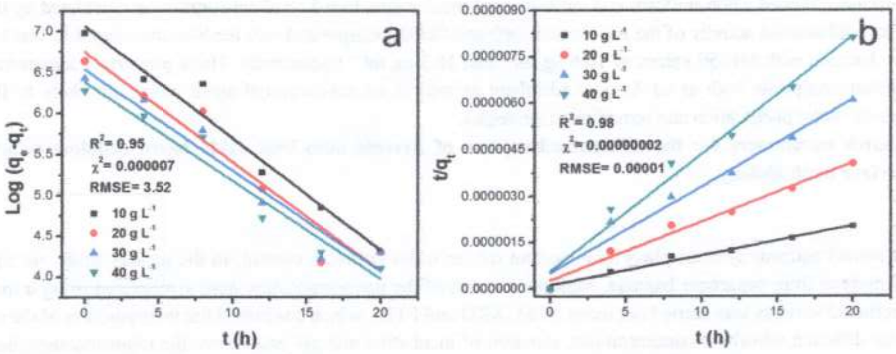


Fig. B2.1.4.5. Pseudo first order (a) and pseudo second order (b) adsorption kinetics curves for the adsorption of Arsenic on the ZnO:CeO$_2$:nanocellulose:PANI bionanocomposite

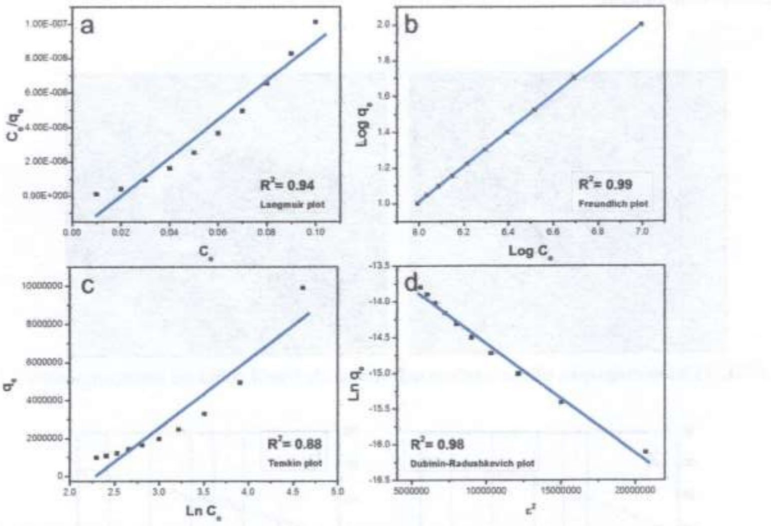


Fig. B2.1.4.6. Langmuir adsorption isotherm plot (a), Freundlich adsorption isotherm plot (b), Temkin adsorption isotherm plot (c), Dubinin- Radushkevich adsorption (d) for the adsorption of Arsenic by the ZnO:CeO$_2$:nanocellulose:PANI bionanocomposite.

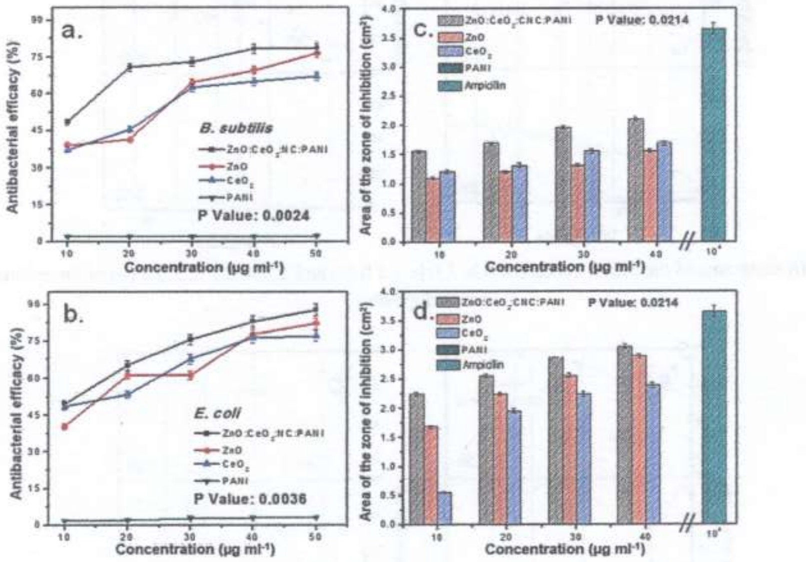


Fig. B2.1.4.7. Comparison of the inhibitory concentrations of the ZnO:CeO$_2$:nanocellulose:PANI bionanocomposite, ZnO nanoparticles, CeO$_2$ nanoparticles and native PANI against Gram positive *Bacillus subtilis* (a) and Gram negative *Escherichia coli* (b) using MTT based cell viability assay. Comparative zones of inhibition of Agar cup diffusion assay for varying concentrations of the ZnO:CeO$_2$:nanocellulose:PANI bionanocomposite, ZnO nanoparticles, CeO$_2$ nanoparticles and native PANI against Gram-positive *Bacillus subtilis* (c) and Gram-negative *Escherichia coli* (d).

Conclusion.

Nanocellulose isolated from the lignocellulose rich, natural Arsenic adsorbent rice husk, was effective as a matrix for the further integration of the remediation efficient and antibacterial ZnO and CeO$_2$ nanoparticles, using Polyaniline as the binding agent. The batch adsorption studies reveal the rapid removal of As by the bionanocomposite that appeared to be independent of the pH variations, while indicating a linear correlation between the adsorption efficiency and the adsorbent concentration. The kinetic studies of the bionanocomposite showed conformity to the pseudo-second order kinetics and is believed to be mediated by covalent chemisorption. Furthermore, the biosorption followed a non-uniform and multi-layered mechanism, based on chemisorption as elucidated by the Freundlich and Dubinin-Radushkevich adsorption isotherms. The antibacterial activity of the nanoscaled ZnO and CeO2 incorporated into the bionanocomposite was found to be effective against both Gram-positive and Gram-negative bacteria with MIC50 values of 10.6 µg ml^{-1} and 10.3 µg ml^{-1} respectively. These properties demonstrate the bimodal potential of the ZnO:CeO$_2$:nanocellulose:PANI bionanocomposite both as an Arsenic adsorbent as well as an antimicrobial agent which are likely to find potential application as coating agents for efficient and economical water purification and remediation strategies.

B2.1.5. Statistical optimization of batch parameters for the efficient adsorption of Arsenic onto iron oxide based cellulose nanocomposites derived from sugarcane bagasse using response surface methodology.

Abstract:

The adsorption of arsenic from contaminated aqueous systems plays an important role in water pollution control. In the present study, we report a development of iron oxide based cellulose nanocomposites derived from sugarcane bagasse. Multiple variants of the nanocomposites were synthesized using a facile solvothermal approach. The microstructural analysis of these refluxed variants was carried out using TEM, XRD and FTIR, which confirmed the incorporation of the nanoscaled iron oxide in the polymeric lignocellulosic matrix. Under different adsorbent concentrations, duration of incubation and pH conditions, the bionanocomposites showcased a remediation efficiency ~95% against dissolved Arsenic. The single factor and multivariate interactions between the adsorption parameters were studied using central composite design of response surface methodology based on five level four factors. The statistical significance of the variables on the adsorption was evaluated using ANOVA and the correlation between solvent pH, adsorbate (As) concentration and adsorption efficiency was found to be statistically significant. The current study thus provides a preliminary insight into the adsorptive capabilities of the synthesized nanocomposites thereby advocating their use as highly efficient bio-based sorbents for the remediation of dissolved arsenic from aqueous environments.

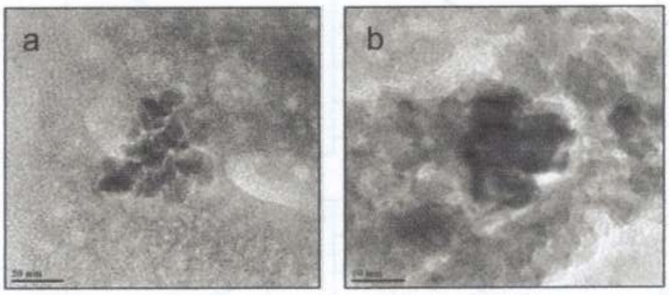


Fig. B2.1.5.1. TEM micrographs of the synthesized Iron oxide based cellulose nanocomposites (a, b).

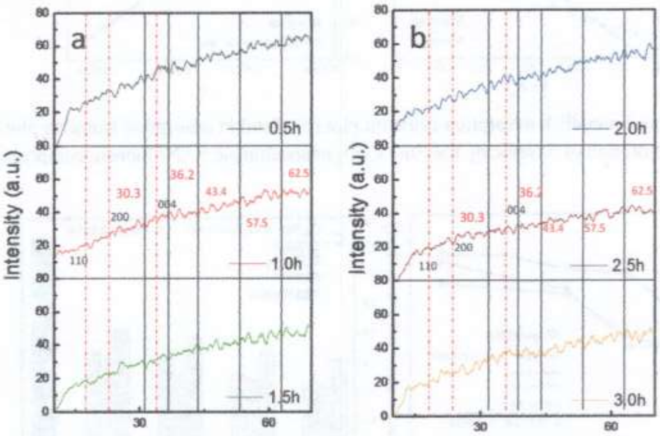


Fig. B2.1.5.2. Comparative X-ray diffractograms of the reflux variants 0.5 h, 1.0 h, 1.5 h (a) and 2.0 h, 2.5 h, 3.0 h (b) of the synthesized iron oxide based cellulose nanocomposites.

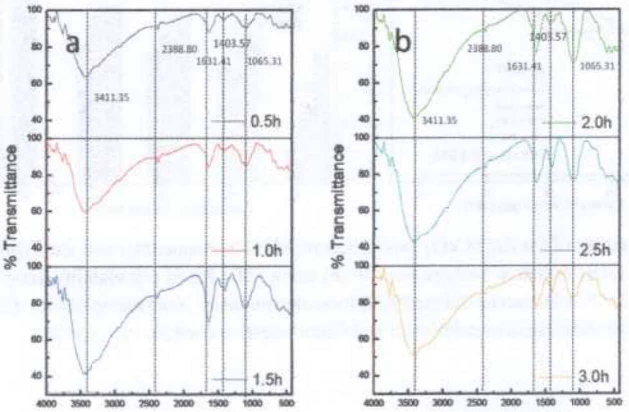


Fig. B2.1.5.3. Comparative FTIR spectra of the reflux variants 0.5 h, 1.0 h, 1.5 h (a) and 2.0 h, 2.5 h, 3.0 h (b) of the synthesized iron oxide based cellulose nanocomposites.

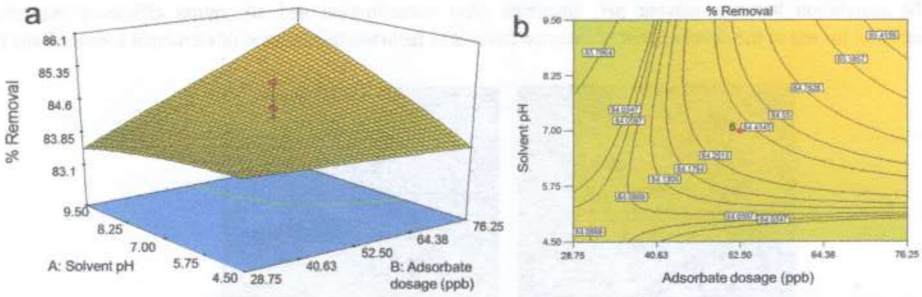


Fig. B2.1.5.4. Response surface 3D plot (a) and response surface contour plot (b) described by the central composite design model for the association between adsorbate (As) dosage and solvent pH.

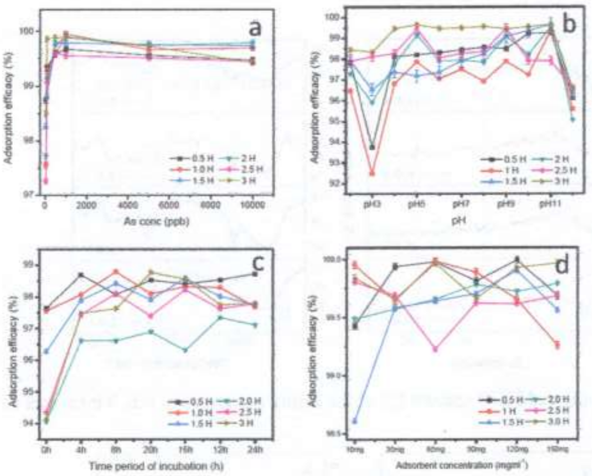


Fig. B2.1.5.5. Effect of adsorbate concentration(a), solvent pH (b) contact time with the adsorbent (c) and adsorbate concentration (d) on the adsorption of Arsenic on the iron oxide based cellulose nanocomposites.

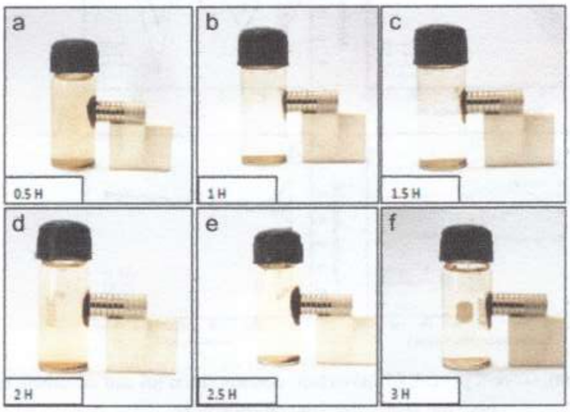


Fig. B2.1.5.6. Illustration of the magnetic properties of the synthesized iron oxide based cellulose nanocomposites.

Conclusion:

The lignocellulose rich biopolymeric sugarcane bagasse provided an effective matrix for the incorporation of nanoscaled iron oxide as observed from the TEM micrographs. This is further confirmed from the characteristic signatures of γFe_2O_3 and nanocellulose observed in the XRD diffractograms and in the FTIR spectra of the refluxed variants. The batch adsorption studies reveal the rapid removal of As by the nanocomposites which was found to be consistent throughout the pH range (4-11) and showed a mean efficiency $\geq$ 94%. The statistical optimization of the single factor and multivariate interactions between the adsorption parameters carried out using central composite design of response surface methodology showed the high adsorption efficiency to be significantly dependent on solvent pH and adsorbate (As) concentration. Additionally the magnetic separation studies carried out for the synthesized nanocomposites demonstrated a remarkably high magnetic property for all the reflux variants thus suggestive of a facile recovery approach post adsorption. The appreciable adsorption efficiency and the easy recoverability of the synthesized nanocomposites demonstrates their significant potential for possible use in the development of adsorption based novel filtration systems capable of generating arsenic free clean water for assorted uses.

B2.1.6. Remediation ready nanobiosorbents from sugarcane based second molasses: Statistical optimization of batch parameters using response surface methodology.

Abstract:

Adsorption is considered to be one of the most promising technologies for the removal of dissolved arsenic from aqueous environments on account of its simplicity, potential for regeneration, and minimization of sludge production. In the present study we report the generation of remediation ready Iron oxide impregnated nanobiosorbents using second molasses, an agrowaste based byproduct of sugar industry. Different reflux based variants were synthesized using via a facile solvothermal route and the variants were characterized for their structural and functional attributes using TEM, XRD and FTIR. The synthesized nanobiosorbents were then subjected to batch adsorption studies under different adsorbent concentrations, duration of incubation and pH conditions wherein the nanobiosorbents demonstrated a remediation efficiency in the range 85-96% against dissolved Arsenic. The single factor and multivariate interactions between the different adsorption parameters were studied using

central composite design of response surface methodology based on five level four factors. ANOVA was used to evaluate the statistical significance of the variables on the adsorption and a significant the correlation between solvent pH, adsorbate (As) concentration and adsorption efficiency was observed. The synthesized nanobiosorbents show a significant potential for use in the development of assorted devices to facilitate the removal of elemental contaminants like Arsenic from aqueous environments.

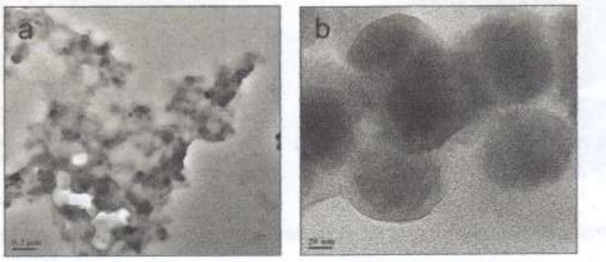


Fig. B2.1.6.1. TEM micrographs of the synthesized nanobiosorbents (a, b).

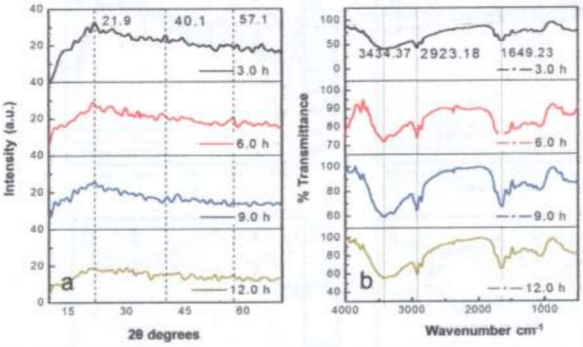


Fig. B2.1.6.2. Comparative X-ray diffractograms (a) and FTIR spectra (b) of the reflux variants 3 h, 6 h, 9 h (a) and 12 h of the synthesized nanobiosorbents

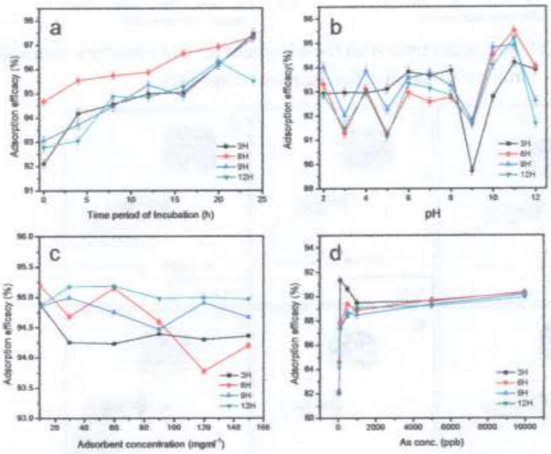


Fig. B2.1.6.3. Effect of contact time with the adsorbent (a), solvent pH (b), (d) adsorbent concentration (c) and adsorbate concentration (d) on the adsorption of Arsenic onto the synthesized nanobiosorbents.

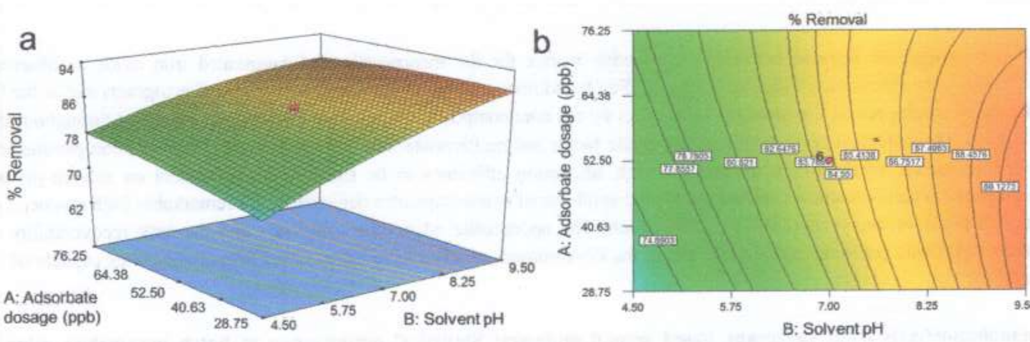


Fig. B2.1.6.4. Response surface 3D plot (a) and response surface contour plot (b) described by the central composite design model for the association between adsorbate (As) dosage and solvent pH.

Conclusion:

The TEM micrographs show the synthesized nanobiosorbents to be within the nanoscale range having an average size of ~82 nm. Moreover, the polysaccharide rich second molasses were found to provide an effective matrix for the incorporation of nanoscaled iron oxide during the solvothermal synthesis of the refluxed nanobiosorbents. This is also consistent with the results from the spectroscopic studies which show characteristic signatures of γFe_2O_3 in the XRD diffractograms and in the FTIR spectra of the refluxed variants. The batch adsorption studies show a high efficiency for the removal of dissolved Arsenic in the range 88-96% and was found to be trivially affected by the change in solvent pH and contact time with the nanobiosorbent. The statistical optimization studies for the single factor and multivariate interactions between the adsorption parameters carried out using central composite design of response surface methodology revealed a highly significant correlation between the adsorption efficiency and the adsorption parameters *viz.* solvent pH and adsorbate (As) concentration. The high adsorption efficiency of the synthesized nanobiosorbents and the economic feasibility of the low-cost second molasses precursors demonstrates their significant potential for use in the development of biosorption based filtration systems for the remediation of dissolved arsenic from aqueous environments for potable use.

B2.1.7. Synthesis and characterization of carbonized nanocellulosic Iron oxide based biosorbents from rice husk, through a pyrolytic approach and estimation of its efficiency for the removal of arsenic from aqueous environments.

Abstract:

The current study reports the generation of carbonized nanocellulosic Iron oxide based biosorbents using a pyrolytic approach. Multiple variants of the carbonized nanobiosorbents were synthesized and they were assessed for their structural and functional attributes using TEM, XRD and FTIR. Preliminary batch adsorption studies were also carried out for the pyrolyzed variants and their potential for arsenic removal was assessed. The carbonized nanobiosorbents showed an appreciable efficiency for the removal of dissolved arsenic in the preliminary investigations carried out suggesting their possible use development of filtration matrices, fillers and devices to generate arsenic free potable water for assorted uses.

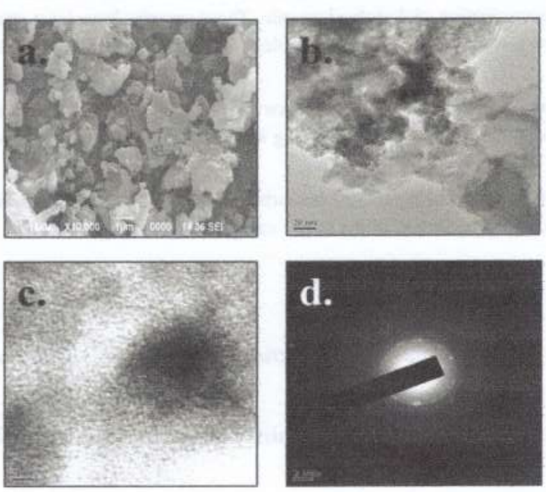


Fig. B2.1.7.1. Study of the microstructural features of the synthesized samples using Scanning electron microscopy (a) and transmission electron microscopy (b, c). Selected area electron diffraction (SAED) pattern of the synthesized sample.

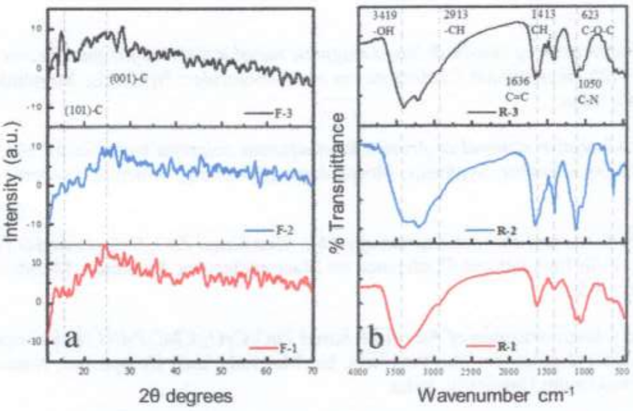


Fig. B2.1.7.2. Comparative XRD diffractograms (e) and FTIR (f) spectra of the synthesized time variants F1 (1h), F2 (2h), and F3 (3h).

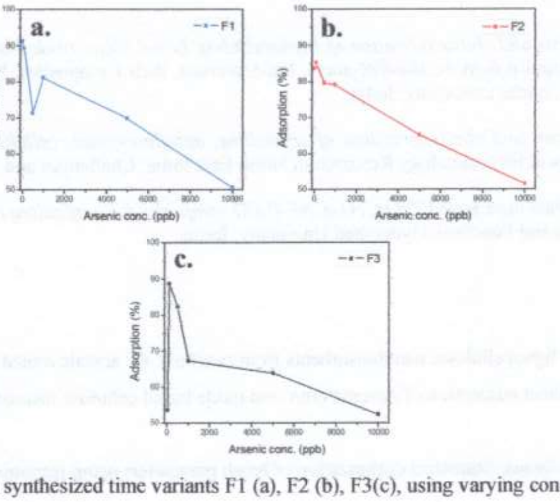


Fig. B2.1.7.1 Batch adsorption studies of the synthesized time variants F1 (a), F2 (b), F3(c), using varying concentrations of Arsenic in aqueous medium.

Conclusion:

Multiple variants of Iron oxide based carbonized nanocellulosic biosorbents was successfully synthesized via a pyrolytic approach based upon the variation of the time of pyrolysis. The micrographs obtained from the SEM, TEM microscopic studies show the synthesized nanobiosorbents to be within the nanoscale range and having an average size of ~140 nm. The SAED patterns showed the characteristic diffraction signatures for γFe_2O_3 thereby confirming the successful incorporation of the Iron oxide nanoparticles into the carbonized nanocellulose matrix. Moreover, characteristic signatures of γFe_2O_3 were also observed in the XRD diffractograms and the FTIR spectra of the synthesized biosorbents and is concurrent with the results obtained from the microscopic studies. The preliminary batch adsorption studies for the pyrolyzed variants show an initial adsorption efficiency in the range ~84-92% at an adsorbate (As) dosage of 10 ppb which was found to decline to the ~52% upon increase in the adsorbate (As) concentration to 1000 ppb. The results thus suggest the possible use of the carbonized biosorbents as remediation ready nanosorbents for the effective removal of aqueous Arsenic at low concentrations with a high associated efficiency.

B3. Details of New Leads Obtained, if any:

- A total of **200** different sampling sites were assessed by the end of the three year span of the current study which encompasses the major districts situated along the borderline of the Brahmaputra valley predicted for high contamination of dissolved arsenic. These samples have been stringently analyzed for their total arsenic content and have been collectively presented in this report. Of these samples, a total of **126** samples were found to exhibit Arsenic in the range exceeding the WHO permissible limit of **10 ppb.**
- In addition to the estimation of Arsenic, the samples were also assessed for the presence of **Iron (Fe)** and heavy metals such as **Zinc (Zn)**, **Lead (Pb)**, **Copper (Cu)**, **Cadmium (Cd)** and **Manganese (Mn)**. Of these the samples exhibiting values exceeding the desirable limit exercised by WHO, for the respective elements, have been collectively presented in this report
- The development and characterization of **twenty two (22)** different agrobased biosorbents, **three (3) carbonized biosorbents** and **one (1) synthetic biosorbent** harboring a high efficiency for arsenic removal has been achieved at the end of the three year span of the study.

B4. Manuscripts Published:

1. Kalita, E., Nath, B. K., Agan, F., More, V., & Deb, P. (2015). Isolation and characterization of crystalline, autofluorescent, cellulose nanocrystals from saw dust wastes. *Industrial Crops and Products*, *65*, 550-555.

2. Kalita, E., Nath, B. K., Deb, P., Agan, F., Islam, M. R., & Saikia, K. (2015). High quality fluorescent cellulose nanofibers from endemic rice husk: Isolation and characterization. *Carbohydrate polymers*, *122*, 308-313.

3. Nath, B. K., Chaliha, C., Kalita, E., & Kalita, M. C. (2016). Synthesis and characterization of ZnO: CeO2: nanocellulose: PANI bionanocomposite. A bimodal agent for arsenic adsorption and antibacterial action. *Carbohydrate Polymers*, *148*, 397-405.

B5. Conference Proceedings:

- Chaliha, C., Nath, B. K., Kalita, E. (2015, April). *Fabrication of rice-husk based magnetic nanobiosorbents for the efficient removal of multiple metallic contaminants from aqueous environments.* Paper presented at the Fifth International Conference on Macromolecules: Synthesis, Morphology, processing, Structure, Properties and Applications (ICM 2016), Mahatma Gandhi University, India.

- Nath, B. K., Chaliha, C., Kalita, E. (2015, April). *Adsorptive removal of Arsenic from aqueous solutions using ZnO:CeO_2:nanocellulose:PANI biocomposites.* Paper presented at the Fifth International Conference on Macromolecules: Synthesis, Morphology, processing, Structure, Properties and Applications (ICM 2016), Mahatma Gandhi University, India.

- Nath, B. K., Chaliha, C., Kalita, E. (2015, April). *Synthesis and characterization of edible films based ZnO, CeO_2 embedded cellulosic nanocomposites and their use as potential antibacterial agents.* Paper presented at the Fifth International Conference on Macromolecules: Synthesis, Morphology, processing, Structure, Properties and Applications (ICM 2016), Mahatma Gandhi University, India.

- Nath, B. K., Kalita, E. (2015, April). *Synthesis and Characterization of Rice husk based ZnO:CeO_2:CNC:PANI Nanocomposite for Antibacterial applications.* Paper presented at the Fourth International Conference on Natural polymers, Bio-Polymers, bio-Materials, their Composites, Nanocomposites, blends, IPNs, polyelectrolytes and Gels: Macro to nano Scales (ICNP-2015), Mahatma Gandhi University, India.

- Nath, B. K., Kalita, E. (2015, April). *Remediation ready nanobiosorbents from sugarcane molasses.* Paper presented at the Fourth International Conference on Natural polymers, Bio-Polymers, bio-Materials, their Composites, Nanocomposites, blends, IPNs, polyelectrolytes and Gels: Macro to nano Scales (ICNP-2015), Mahatma Gandhi University, India.

- Saikia, J. Nath, B. K., Kalita, E. (2015, April). *Synthesis and characterization of Lignocellulose based Metal oxide Nanobiosorbents from Sugarcane Bagasse.* Paper presented at the Fourth International Conference on Natural polymers, Bio-Polymers, bio-Materials, their Composites, Nanocomposites, blends, IPNs, polyelectrolytes and Gels: Macro to nano Scales (ICNP-2015), Mahatma Gandhi University, India.

- Nath, B. K. & Kalita, E. (2014, November). *Extraction and characterization of crystalline, autofluorescent, cellulose nanocrystals from Gmelina arborea.* Paper presented at the National Conference on Recent Advances in Biotechnology Research in North East India: Challenges and Prospects, Tezpur University, India.

- Nath, B. K., Kalita, E., & Deb, P. (2013, December). *Rice husk based ZnO/CeO_2/CNF/PANI composite for antifouling and antibacterial applications.* Poster presented at the International Conference on Genomics, Mechanism and Function, Hyderabad University, India.

B6. Manuscripts under preparation:

1. Synthesis and characterization Iron Oxide impregnated lignocellulosic nanobiosorbents from rice husk for arsenic remediation.
2. Statistical optimization of batch parameters for the efficient adsorption of Arsenic onto iron oxide based cellulose nanocomposites derived from sugarcane bagasse using response surface methodology.
3. Remediation ready nanobiosorbents from sugarcane molasses: Statistical optimization of batch parameters using response surface methodology.

Annexure A

Manpower Staffing Details (In the financial year wise manner)

NAME OF THE PERSON	NAME OF THE POST	DATE OF JOINING	DATE OF LEAVING	TOTAL MONTHLY SALARY	TOTAL SALARY PAID DURING THE FINANCIAL YEAR	TOTAL SALARY PAID DURING PROJECT PERIOD
Financial year 2012-13 (23rd May 2012-31st March 2013)						
Ms. Lakhirupa Devi	JRF	31.7.12	31.12.12	12000.00	60387.00	60387.00
Financial Year 2013-14 (1st April 2013-15th March 2014)						
Mr. Bikash Kar Nath	JRF (with NET and GATE)	12.7.13	Till Feb,2014	17600.00	115923.00	115923.00

27.8.14

(Signature of Principal Investigator)

PI DBT Sponsored Project
"GIS....nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

27/8/14

(Signature of Accounts Officer)

Finance Officer
Tezpur University

27/8/14

(SIGNATURE OF HEAD OF THE INSTITUTE)

REGISTRAR- I/C
TEZPUR UNIVERSITY

Annexure B

Manpower Expenditure Details (In financial year wise manner)*:

SANCTIONED POSTS	NUMBER	SCALE OF PAY	ANNUAL OUTLAY (In Rupees)	OUTLAY FOR THE ENTIRE PERIOD (In Rupees)	REVISED SCALE, IF ANY	REVISED ANNUAL OUTLAY	REVISED PROJECT OUTLAY	ACTUAL RELASES BY DBT (In Rupees)	ACTUAL EXPENDITURE (In Rupees)	BALANCE (In Rupees)
Financial Year 2012-13 (23rd May 2012-31st March 2013)										
JRF	01	12000/- plus 10% HRA	211000.00	660000.00				211000.00	60387.00	**150613.00**
Financial Year 2013-14 (1st April 2013-15th March 2014)										
JRF	01	16000/- plus 10% HRA	211000.00	660000.00				211000.00	133523.00	**17090.00**

27.8.14

(Signature of Principal Investigator)

PI DBT Sponsored Project
"GIS.......nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

27/8/14

(Signature of Accounts Officer)
Finance Officer
Tezpur University

27/8/14

(SIGNATURE OF HEAD OF THE INSTITUTE)
REGISTRAR- I/C
TEZPUR UNIVERSITY

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* Details of manpower salary/ fellowship revision alongwith due- drawn statement and arrears requested should be given separately, if applicable.

Due- Drawn Statement

Name of the Project Staff	Month and Year	Due	Drawn	Difference
Ms. Lakhirupa Devi	31.7.12 to 31.12.12	60387.00	60387.00	0.00
Mr. Bikash Kar Nath	12.7.13- till Feb 2014	133523.00	133523.00	0.00

27-8-14

(Signature of Principal Investigator)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

27/8/14

(Signature of Accounts Officer)
Finance Officer
Tezpur University

27/8/14

(SIGNATURE OF HEAD OF THE INSTITUTE)
REGISTRAR- I/C
TEZPUR UNIVERSITY

CONSOLIDATED STATEMENT FOR THE FIRST YEAR GRANT UTILIZED IN THE FINANCIAL YEARS 2012-13 and 2013-14

Item	Sanctioned outlay	Released fund by DBT		Expenditure as per latest Statement of expenditure (SOE)					
				23rd May 2012 to 31st March 2013	1st April 2013 to 31st March 2014	Total upto 31st March 2014	Balance as per released fund	Expenditure adjustments upto 31st March 2014	Required amount (In Rupees)
	Total (in lakhs)	Pages 1st`	Total (in lakhs)	Pages (in Rs.) 1st`		Rs.	Rs.	Rs.	Rs.
Equipment	5196000	5196000	5196000	346743.00	4849257.00	5196000.00	0.00	5196000.00	0
Manpower	211000	211000	211000	60387.00	133523.00	193910.00	17090.00	193910.00	0
Consumable	300000	300000	300000	145685.00	154315.00	300000.00	0.00	300000.00	0
Travel	100000	100000	100000	37910.00	77838.00	115748.00	-15748.00	115748.00	15748
Contingency	50000	50000	50000	50000.00	2884.00	52884.00	-2884.00	52884.00	2884
Overhead	100000	100000	100000	55993.00	44007.00	100000.00	0.00	100000.00	0
Total	**5957000**	**5957000**	**5957000**	**696718.00**	**5261824.00**	**5958542.00**	**-1542.00**	**5958542.00**	**18632**

09.04.2014
(Eeshan Kalita)
Principal Investigator
DBT Project
Tezpur University

PI DBT Sponsored Project
" GIS.......nanobiosorbants"

Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

11/4/14
Finance Officer
Tezpur University

11/4/2014
Registrar
Tezpur University

Appendix-A

Details of Assets acquired wholly or substantially out of Govt. grants Register to be maintained by Grantee Institution

Name of the Sanctioning Authority: DBT Govt of India

1. Sl. No. BCIL/NER-BPMC/2013/650 dated 8-6-12
2. Name of the Grantee Institution Tezpur University
3. No. & Date of sanction order BT/258/NE/TBP/2011 dated 23-4-2012
4. Amount of the sanctioned grant 79.56 lakhs
5. Brief purpose of the grant ______
6. Whether any condition regarding the right of ownership of Govt. in the Property or other assets acquired out of the grant was incorporated in the grant-in-aid sanction order. ______

*7. Particulars of assets actually credited or acquired. Please refer Appendix A1

8. Value of the assets as on Rs.59.57 lakhs Rupees
9. Purpose for which utilised at present ______
10. Encumbered or not Not applicable
11. Reasons, if encumbered Not applicable
12. Disposed of or not Not applicable
13. Reasons and authority, if any, for Disposal Not applicable
14. Amount realized on disposal Not applicable
15. Remarks Not applicable

09.04.2014

(PROJECT INVESTIGATOR)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

11/4/14

(FINANCE OFFICER)

11/4/14

(HEAD OF THE INSTITUTE)

* List of equipment purchased indicating the item wise costs may please be provided.

Sl. No.	**Name of Sanctioned Equipment**	**Total value (in Rupees)**
1	Refrigerated centrifuge (Utilized during financial year **2012-13**)	346743.00
2	Atomic Spectrophotometer and accessories (Utilized during financial year **2013-14**)	2205744.00
3	Planetary Ball Mill and accessories (Utilized during financial year **2013-14**)	2580547.00
4	Ultra-sonicator and accessories (Utilized during financial year **2013-14**)	62966.00
	Total	**5196000.00**

Item	**Total Funds sanctions in the 1st Year Grant**	**Grants received from DBT during the year 2013-14**	**Total of col (2+3)**	**Expenditure (excluding commitments) incurred during the year 2012-13**	**Expenditure (excluding commitments) incurred during the year 2013-14**	**Total Expenditure of 1st Yr Grant of 2012-13 & 2013-14**	**Balance**
1	2	3	4	5	6	7	8
Non-Recurring							
	Equipments						
	5196000	0	5196000	346743	4849257	5196000	0

09-07-2014

(PROJECT INVESTIGATOR)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"

Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

4/4/14

(FINANCE OFFICER)

4/4/14

(HEAD OF THE INSTITUTE)

Appendix-E

Utilisation Certificate

(for the financial year ending **31st March 2013.**)

(Rs. in Lakhs)

1. Title of the Project/Scheme: GIS Modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbants

2. Name of the Organisation: Tezpur University

3. Principal Investigator: Dr. Eeshan Kalita, Assistant Professor, Dept. of MBBT, TU

4. Deptt. of Biotechnology sanction order No. & date of sanctioning the project: BT/258/NE/TBP/2011 dated 23-4-2012

5. Amount brought forward from the previous financial year quoting DBT letter No. & date in which the authority to carry forward the said amount was given: Nil

6. Amount received from DBT during the financial year (*please give No. and dates of sanction orders showing the amounts paid*): 59.57 lakhs

7. Other receipts/interest earned, if any, on the DBT grants: Nil

8. Total amount that was available for expenditure during the financial year (Sl. Nos. 5,6 and 7): 59.57 lakhs

9. Actual expenditure (excluding commitments) incurred during the financial year (statement of expenditure is enclosed): Rs. 696718/-

10. Unspent balance refunded, if any (*Please give details of cheque No. etc.*):

11. Balance amount available at the end of the financial year: Rs. 5260282/-

12. Amount allowed to be carried forward to the next financial year vide letter No. & date:

1. Certified that the amount of Rs. 6,96,718/- (Rupees Sixty lakhs Ninety six thousand seven hundred eighteen only) mentioned against col. 9 has been utilised on the project/~~scheme~~ for the purpose for which it was sanctioned and that the balance of Rs. 5260282/ ____ remaining unutilized at the end of the year has been surrendered to Govt. (vide No. ____________ dated ____________)/will be adjusted towards the grants-in-aid payable during the next year.

2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilised for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. Cash Book
2. Ledgers
3. Vouchers
4. Bank Statement
5. Any Other

09.04.2014

(PROJECT INVESTIGATOR)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

11/4/14

(HEAD OF THE INSTITUTE)

Registrar
Tezpur University

B

11/4/1

(FINANCE OFFICER)

Finance Officer
Tezpur University

(To be countersigned by the DBT Officer-in-charge)

Appendix-C

Statement of Expenditure referred to in para 9 of the Utilisation Certificate

Showing grants received the Department of Biotechnology and the expenditure incurred during the period **from 1st April 2012 to 31st March 2013**.

(Rs. in lakhs)

Item	Unspent balance carried forward from Previous year	Grants received from DBT during the year 2012-13	Other receipts/ interest earned if any, on the DBT grants	Total of col (2+3+4)	Expenditure (excluding commitments) incurred during the year 2012-13	Balance	Remarks (5-6)
1	2	3	4	5	6	7	8
	1. Non-Recurring						
i)	**Equipments**						
	0	5196000		5196000	346743	4849257	
	2. Recurring						
i.	**Human Resource**						
	0	211000		211000	60387	150613	
ii.	**Consumables**						
	0	300000		300000	145685	154315	
iii.	**Travel**						
	0	100000		100000	37910	62090	
iv.	**Contingency**						
	0	50000		50000	50000	0	
v.	**Overheads**						
	0	100000		100000	55993	44007	
TOTAL							
		5957000		**5957000**	**696718**	**5260282**	

29·04·2014

(PROJECT INVESTIGATOR)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

14/4/14

(FINANCE OFFICER)

Finance Officer
Tezpur University

14/4/14

(HEAD OF THE INSTITUTE)

Appendix-B

Utilisation Certificate

(for the financial year upto **31st March 2014.**)

(Rs. in Lakhs)

1. Title of the Project/Scheme: GIS Modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbants

2. Name of the Organisation: Tezpur University

3. Principal Investigator: Dr. Eeshan Kalita, Assistant Professor, Dept. of MBBT, TU

4. Deptt. of Biotechnology sanction order No. & date of sanctioning the project: BT/258/NE/TBP/2011 dated 23-4-2012

5. Amount brought forward from the previous financial year quoting DBT letter No. & date in which the authority to carry forward the said amount was given: **Rs.5260282/-**

6. Amount received from DBT during the financial year (*please give No. and dates of sanction orders showing the amounts paid)*: Nil

7. Other receipts/interest earned, if any, on the DBT grants: Nil

8. Total amount that was available for expenditure during the financial year (Sl. Nos. 5,6 and 7): Rs.**5260282/-**

9. Actual expenditure (excluding commitments) incurred during the financial year (statement of expenditure is enclosed): Rs. **5261824/-**

10. Unspent balance refunded, if any *(Please give details of cheque No. etc.)*:

11. Balance amount available at the end of the financial year: **Rs. -1542/-(at the end of financial year 2013-14)**

12. Amount allowed to be carried forward to the next financial year vide letter No. & date:

1. Certified that the amount of Rs. **5261824/-** (Fifty two lakh sixty one thousand eight hundred and twenty four only) mentioned against col. 9 has been utilised on the project/~~scheme~~ for the purpose for which it was sanctioned and that the balance of Rs. - **1542** ____ remaining unutilized at the end of the year has been surrendered to Govt. (vide No. ____________ dated ____________)/will be adjusted towards the grants-in-aid payable during the next year.

2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilised for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. Cash Book
2. Ledgers
3. Vouchers
4. Bank Statement
5. Any Other

09.04.2014

(PROJECT INVESTIGATOR)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

B
11/4/14

(FINANCE OFFICER)

Finance Officer
Tezpur University

11/4/14

(HEAD OF THE INSTITUTE)

Registrar
Tezpur [illegible]

(To be countersigned by the DBT Officer-in-charge)

Appendix-C

Statement of Expenditure referred to in para 9 of the Utilisation Certificate

Showing grants received the Department of Biotechnology and the expenditure incurred during the period **from 1st April 2013 to 21st March 2014**.

Item	Unspent balance carried forward from Previous year 2012-13	Grants received from DBT during the year 2013-14	Other receipts/ interest earned if any, on the DBT grants	Total of col (2+3+4)	Expenditure (excluding commitments) incurred during the year 2012-13	Expenditure (excluding commitments) incurred during the year 2013-14	Total Expenditure of 1st Yr Grant of 2012-13 & 2013-14	Balance	Remarks (5-6)
1	2	3	4	5	6	7	8	9	
1.	**Non-Recurring**								
i)	**Equipments**								
	4849257	0		4849257	346743	4849257	5196000	0	
2.	**Recurring**								
i.	**Human Resource**								
	150613	0		150613	60387	133523	193910	17090	
ii.	**Consumables**								
	154315	0		154315	145685	154315	300000	0	
iii.	**Travel**								
	62090	0		62090	37910	77838	115748	-15748	
iv.	**Contingency**								
	0	0		0	50000	2884	52884	-2884	
v.	**Overheads**								
	44007	0		44007	55993	44007	100000	0	
TOTAL									
	5260282	**0**		**5260282**	**696718**	**5261824**	**5958542**	**-1542**	

09.04.2014

(PROJECT INVESTIGATOR)

PI DBT Sponsored Project
" GIS.......nanobiosorbants"

Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University

11/4/14

(FINANCE OFFICER)

Finance Officer
Tezpur University

11/4/14

(HEAD OF THE INSTITUTE)

Registrar
Tezpur University

Annexure A

Manpower Staffing Details (Financial Year 2014-15)

NAME OF THE PERSON	NAME OF THE POST	DATE OF JOINING	DATE OF LEAVING	TOTAL MONTHLY SALARY	TOTAL SALARY PAID DURING THE FINANCIAL YEAR	TOTAL SALARY PAID DURING THE PROJECT PERIOD
Mr. Bikash Kar Nath	JRF with NET LS	12.08.2013	Continuing till date (31.03.15)	₹ 17600.00	₹ 176000.00	₹ 291923.00

(Signature of the Principal Investigator) **(Signature of the Accounts Officer)**

(SIGNATURE OF THE HEAD OF THE INSTITUTE)

Annexure B

Manpower Expenditure Details (Financial Year 2014-15)

SANCTIONED POSTS	NUMBER	SCALE OF PAY	ANNUAL OUTLAY	OUTLAY FOR THE ENTIRE PERIOD	REVISED SCALE, IF ANY	REVISED ANNUAL OUTLAY (2014-15)	REVISED PROJECT OUTLAY	ACTUAL RELEASES BY DBT	ACTUAL EXPENDITURE	BALANCE
JRF	1	₹ 16000/- plus 10% HRA = ₹ 17600/- per month	₹ 2.11 lakh	₹ 6.336 lakh	₹ 25000/- plus 10% HRA = 27500/- per month (*w.e.f. 1.10.2014)	₹ 2.706 lakh	₹ 4.56 lakh	₹ 1.76 lakh	₹ 1.76 lakh	(-) ₹ 0.946 lakh

*As per Office Memorandum (O.M.) No. A-20020111197-\FD dated 31.03.2010 issued by the Department of Science and Technology, Government of India

(Signature of the Principal Investigator) **(Signature of the Accounts Officer)**

(SIGNATURE OF THE HEAD OF THE INSTITUTE)

Due-Drawn Statement

Name of the Project Staff	Month and Year	Due ₹	Drawn ₹	Difference/ Arrears ₹
Mr. Bikash Kar Nath	April 2014	17600/-	17600/-	0/-
	May 2014	17600/-	17600/-	0/-
	June 2014	17600/-	17600/-	0/-
	July 2014	17600/-	17600/-	0/-
	August 2014	17600/-	17600/-	0/-
	September 2014	17600/-	17600/-	0/-
	October 2014	27500/-*	17600/-	9900/-
	November 2014	27500/-*	17600/-	9900/-
	December 2014	27500/-*	17600/-	9900/-
	January 2015	27500/-*	17600/-	9900/-
	February 2015	27500/-*	0/-	27500/-
	March 2015	27500/-*	0/-	27500/-
			Total Due/ Arrears ₹	**94600/-**

*As per Office Memorandum (O.M.) No. A-20020111197-\FD dated 31.03.2010 issued by the Department of Science and Technology, Government of India

(Signature of the Principal Investigator) **(Signature of the Accounts Officer)**

(SIGNATURE OF THE HEAD OF THE INSTITUTE)

Appendix-E

Utilisation Certificate

(For the financial year ending 31st March 2015.)

(Rs. in Lakhs)

1. Title of the Project/Scheme: GIS Modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbants

2. Name of the Organisation: Tezpur University

3. Principal Investigator: Dr. Eeshan Kalita, Assistant Professor, Dept. of MBBT, TU

4. Deptt. of Biotechnology sanction order No. & date of sanctioning the project: BT/258/NE/TBP/2011 dated 23-4-2012

5. Amount brought forward from the previous financial year quoting DBT letter No. & date in which the authority to carry forward the said amount was given: (-) ₹ 1,542

6. Amount received from DBT during the financial year (*please give No. and dates of sanction orders showing the amounts paid)*: ₹ 9,51,000

7. Other receipts/interest earned, if any, on the DBT grants: ₹ 1,58,978

8. Total amount that was available for expenditure during the financial year (Sl. Nos. 5,6 and 7): ₹ 11,08,436

9. Actual expenditure (excluding commitments) incurred during the financial year (statement of expenditure is enclosed): ₹ 9,03,695

10. Unspent balance refunded, if any *(Please give details of cheque No. etc.)*:

11. Balance amount available at the end of the financial year: ₹ 2,04,741

12. Amount allowed to be carried forward to the next financial year vide letter No. & date:

1. Certified that the amount of **₹ 903695.00 (Rupees Nine lakhs three thousand six hundred and ninety-five only)** mentioned against col. 9 has been utilized on the project/scheme for the purpose for which it was sanctioned and that the balance of **₹ 204741.00 (Two lakhs four thousand seven hundred and forty-one only)** remaining unutilized at the end of the year ~~has been surrendered to Govt. (vide No. __________ dated __________)~~/will be adjusted towards the grants-in-aid payable during the next year.

2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilised for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. Cash Book
2. Ledgers
3. Vouchers
4. Bank Statement
5. Any Other

(PROJECT INVESTIGATOR) **(FINANCE OFFICER)**

(HEAD OF THE INSTITUTE)

(To be countersigned by the DBT Officer-in-charge)

Statement of Expenditure referred to in para 9 of the Utilisation Certificate

Showing grants received the Department of Biotechnology and the expenditure incurred during the period from **1st April 2014 to 31st March 2015.**

Sl. No.	Item	Unspent balance carried forward from Previous financial year 2013-14	Grants received from DBT during the financial year 2014-15	Other receipts/ interest earned if any, on the DBT grants (23.5.2012 to 31.03.2015)	Total of the columns (2+3+4)	Expenditure (excluding commitments) incurred during the financial year 2014-15	Balance for the financial year 2014-15 (5-7)	Remarks (5-6)
	1	2	3	4	5	6	7	8
1.	**Non-Recurring**							The documents indicating a difference in Sanctioned amount and Actual Fund Released for the Human Resource Head in the Second Year Release (FY 2013-14) are provided as Annexures
i.	**Equipment**	0.00	0.00		0.00	0.00	0.00	
2.	**Recurring**							
i.	**Human Resource***	17090.00	176000.00	158978.00	193090.00	176000.00	17090.00	
ii.	**Consumables**	0.00	600000.00		600000.00	600000.00	0.00	
iii.	**Travel**	(-) 15748.00	100000.00		84252.00	52695.00	31557.00	
iv.	**Contingency**	(-) 2884.00	25000.00		22116.00	25000.00	(-) 2884.00	
v.	**Overheads**	0.00	50000.00		50000.00	50000.00	0.00	
	TOTAL	**(-) 1542.00**	**951000.00**	**158978.00**	**1108436.00**	**903695.00**	**204741.00**	

*N.B. The original sanction for the **Human Resource** Head of the **Second Year Grant** (vide Order **No.BT/258/NE/TBP/2010 dated 08.05.2012 and 06.07.2012)** was **Rs. 2.11 lakhs.** For the **FY 2013-14,** the Human **Resource** had and unspent balance of **Rs. 0.17 lakhs.** Hence, the sanction under the manpower head for the Second **year Release** should have been **Rs. 1.94 lakh**. (Rs 2.11 lakh - Rs.0.17 lakh = Rs.1.94 lakh). However, the Second **Year Release** received vide order no **BT/258/NE/TBP/2011 dated November 5, 2014** was **Rs. 1.76 lakhs**.

(PROJECT INVESTIGATOR)

(FINANCE OFFICER)

(HEAD OF THE INSTITUTE)

Appendix-C

Statement of Expenditure referred to in para 9 of the Utilisation Certificate

Showing grants received the Department of Biotechnology and the expenditure incurred during the period from **1st April 2016 to 15th September 2017**

Sl. No.	Item	Unspent balance carried forward from Previous financial year 2015-16 (₹)	Grants received from DBT during the financial term ending 15th September 2017 (₹)	Interest earned on the DBT grants till 15th September 2017 (₹)	Total of the columns (2+3+4) (₹)	Expenditure (excluding commitments) incurred during the financial term ending15th September 2017 (₹)	Balance remaining (5-6) (₹)	Remarks
	1	2	3	4	5	6	7	
1.	**Non-Recurring**							
i.	**Equipment**	0.00	0.00		0.00	0.00	0.00	
2.	**Recurring**							
i.	**Human Resource***	128700.00	0.00	200255.00	128700.00	9800.00	118900.00	
ii.	**Consumables**	441000.00	0.00		441000.00	441001.00	-1.00	
iii.	**Travel**	77021.00	0.00		77021.00	0.00	77021.00	
iv.	**Contingency**	0.00	0.00		0.00	0.00	0.00	
v.	**Overheads**	18750.00	0.00		18750.00	18750.00	0.00	
	Sub total	**665471.00**	**0.00**	**200255.00**	**665471.00**	**469551.00**	**195920.00**	
	Grand total	**665471.00**	**0.00**	**200255.00**	**865726.00**	**469551.00**	**396175.00**	

15.09.17

PROJECT INVESTIGATOR)
(Signed and stamped)

[illegible]
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University
PI DBT Sponsored Proj.
"GIS.......[illegible]"

B

4/11/17

(FINANCE OFFICER)
(Signed and stamped)
Finance Officer
Tezpur University

(HEAD OF THE INSTITUTE)
(Signed and stamped)
Registrar
Tezpur University

1. Certified that the amount of:
   - **₹ 824449.00 (Rupees Eight lakhs twenty-four thousand four hundred and forty-nine only)** mentioned against col. 5 has been brought over from the previous financial year
   - **₹ 41277.00 (Rupees Forty-one thousand two hundred and seventy-seven only)** mentioned against col. 7 has been earned as Interest on the DBT Grants for the financial term 2015-16 and 2016-17
   - **₹ 469551.00 (Rupees Four lakhs sixty-nine thousand five hundred and fifty-one only)** mentioned against col. 9 has been utilized on the project/~~scheme~~ for the purpose for which it was sanctioned and
   - **₹ 396175.00 (Rupees Three lakhs ninety-six thousand one hundred and seventy-five only)** mentioned against col. 11 remaining as balance, unutilized at the end of the year has been surrendered to Govt. (vide No. ____________ dated ____________)/will be adjusted towards the grants-in-aid payable during the next year.

2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. Cash Book
2. Ledgers
3. Vouchers
4. Bank Statement
5. Any Other

15.09.17

(PROJECT INVESTIGATOR)
(Signed and stamped)

Dr. Eashan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University
PI DBT [illegible] Project
"GIS.......[illegible]sorbants"

B 21/11/17
(FINANCE OFFICER)
(Signed and stamped)
Finance Officer
Tezpur University

(HEAD OF THE INSTITUTE)
(Signed and stamped)
Registrar
Tezpur University

(To be countersigned by the DBT Officer-in-charge)

Appendix-C

Statement of Expenditure referred to in para 9 of the Utilisation Certificate

Showing grants received the Department of Biotechnology and the expenditure incurred during the period from **1st April 2015 to 31st March 2016**.

Sl. No.	Item	Unspent balance carried forward from Previous financial year 2014-15 (₹)	Grants received from DBT during the financial year 2015-16 (₹)	Interest earned on the DBT grants till 31st March 2015 (₹)	Total of the columns (2+3+4) (₹)	Expenditure (excluding commitments) incurred during the financial year 2015-16 (₹)	Balance for the financial year 2015-16 (5-6) (₹)	Remarks
	1	2	3	4	5	6	7	
1.	**Non-Recurring**							
i.	**Equipment**	0.00	0.00		0.00	0.00	0.00	
2.	**Recurring**							
i.	**Human Resource***	17090.00	315000.00	158978.00	332090.00	203390.00	128700.00	
ii.	**Consumables**	0.00	441000.00		441000.00	0.00	441000.00	
iii.	**Travel**	31557.00	69000.00		100557.00	23536.00	77021.00	
iv.	**Contingency**	-2884.00	25000.00		22116.00	22116.00	0.00	
v.	**Overheads**	0.00	50000.00		50000.00	31250.00	18750.00	
Sub total		**45763.00**	**900000.00**	**158978.00**	**945763.00**	**280292.00**	**665471.00**	
Grand total		**45763.00**	**900000.00**	**158978.00**	**1104741.00**	**280292.00**	**824449.00**	

15.09.17

PROJECT INVESTIGATOR)
(Signed and stamped)

Dr. Eashan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University
PI DBT Sponsored Project
" GIS.......manoliuscrbanis"

21/11/17

(FINANCE OFFICER)
(Signed and stamped)
Finance Officer
Tezpur University

(HEAD OF THE INSTITUTE)
(Signed and stamped)
Registrar
Tezpur University

Appendix-B

Utilisation Certificate

(Of the 3rd financial installment for the financial term ending 15th September 2017.)

(₹ in Lakhs)

1. Title of the Project/Scheme: GIS Modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbents.

2. Name of the Organisation: Tezpur University

3. Principal Investigator: Dr. Eeshan Kalita, Assistant Professor, Dept. of MBBT, TU

4. Deptt. of Biotechnology sanction order No. & date of sanctioning the project: **BT/258/NE/TBP/2011 dated 23-4-2012**

5. Amount brought forward from the previous financial year quoting DBT letter No. & date in which the authority to carry forward the said amount was given: **₹ 824449.00**

6. Amount received from DBT during the financial year (*please give No. and dates of sanction orders showing the amounts paid*): **NIL**

7. Interest earned on the DBT Grants for the financial term 2015-16 and 2016-17: **₹ 41277.00**

8. Total amount that was available for expenditure during the financial year (Sl. Nos. 5,6 and 7): **₹ 865726.00**

9. Actual expenditure (excluding commitments) incurred during the financial year (statement of expenditure is enclosed): **₹ 469551.00**

10. Unspent balance refunded, if any (*Please give details of cheque No. etc.)*:

11. Balance amount available at the end of the financial year: **₹ 396175.00**

12. Amount allowed to be carried forward to the next financial year vide letter No. & date:

Finance Officer
Tezpur University

Appendix-B

Utilisation Certificate

(Of the 3rd financial installment for the financial year ending 31st March 2016.)

(₹ in Lakhs)

1.	Title of the Project/Scheme:	GIS Modeling based impact assessment of ground water arsenic contamination in Brahmaputra basin and development of a remediation strategy using endemic lignocellulosic agrowaste based nanobiosorbants
2.	Name of the Organisation:	Tezpur University
3.	Principal Investigator:	Dr. Eeshan Kalita, Assistant Professor, Dept. of MBBT, TU
4.	Deptt. of Biotechnology sanction order No. & date of sanctioning the project:	**BT/258/NE/TBP/2011 dated 23-4-2012**
5.	Amount brought forward from the previous financial year quoting DBT letter No. & date in which the authority to carry forward the said amount was given:	**₹ 45763.00**
6.	Amount received from DBT during the financial year (*please give No. and dates of sanction orders showing the amounts paid*):	**₹ 900000.00**
7.	Interest earned on the DBT Grants for the period **23/05/2012/** to **31/03/2015**:	**₹ 158978.00**
8.	Total amount that was available for expenditure during the financial year (Sl. Nos. 5,6 and 7):	**₹ 1104741.00**
9.	Actual expenditure (excluding commitments) incurred during the financial year (statement of expenditure is enclosed):	**₹ 280292.00**
10.	Unspent balance refunded, if any *(Please give details of cheque No. etc.)*:	
11.	Balance amount available at the end of the financial year:	**₹ 824449.00**
12.	Amount allowed to be carried forward to the next financial year vide letter No. & date:	

Finance Officer
Tezpur University

1. Certified that the amount of:
    - **₹ 45763.00 (Rupees Forty-five thousand seven hundred and sixty-three only)** mentioned against col. 5 has been brought over from the previous financial year
    - **₹ 158978.00 (Rupees One lakh fifty-eight thousand nine hundred and seventy-eight only)** mentioned against col. 7 has been earned as Interest on the DBT Grants for the period 23/05/2012/ to 31/03/2015
    - **₹ 280292.00 (Rupees Two lakhs eighty thousand two hundred and ninety-two only)** mentioned against col. 9 has been utilized on the project/~~scheme~~ for the purpose for which it was sanctioned and
    - **₹ 824449.00 (Rupees Eight lakhs twenty-four thousand four hundred and forty-nine only)** mentioned against col. 11 remaining as balance, unutilized at the end of the year has been surrendered to Govt. (vide No. ____________ dated ____________)/will be adjusted towards the grants-in-aid payable during the next year.

2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. Cash Book
2. Ledgers
3. Vouchers
4. Bank Statement
5. Any Other

15.09.17

PROJECT INVESTIGATOR)
(Signed and stamped)
Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University
PI DBT Sponsored Project
"GIS.......nanobiosorbents"

21/11/17
(FINANCE OFFICER)
(Signed and stamped)
Finance Officer
Tezpur University

(HEAD OF THE INSTITUTE)
(Signed and stamped)
Registrar
Tezpur University
(To be countersigned by the DBT Officer-in-charge)

Annexure A

Details of Manpower engaged (Financial 1st April 2016- 30th June 2016)

Sl. No.	Name & Designation of the Manpower engaged	Pay Scale provided	Date of Appointment	Salary Due	Salary disbursed	Difference, if any	Date of leaving, if any
1.	Ms. Chayanika Chaliha	₹ 14,000/-	06.10.2015	₹ 9,800/-	₹ 9,800/-	NIL	*21.04.2016

*The official date of closing for the project titled "GIS modelling based……nanobiosorbants" under "DBT's Twinning programme for the NE" vide order no.s **BT/258/NE/TBP/2011** dated **23/04/2012** and **BT/258/NE/TBP/2011** dated **1/10/2015** accords to **23/04/2016**.

15-09.17

(Project Investigator)

(Signed and stamped)

Dr. Eashan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University
PI DBT Sponsored Project
"GIS……nanobiosorbants"

(Head of the Institute)
(Signed and stamped)
Registrar
Tezpur University

21/11/17

(Finance Officer)

(Signed and stamped)
Finance Officer
Tezpur University

Annexur

Details of Manpower engaged (Financial year ending 31st March 2016)

Sl. No.	Name & Designation of the Manpower engaged	Pay Scale provided	Date of Appointment	Salary Due	Salary disbursed	Difference, if any	Date of leaving, if any
1.	Mr. Bikash Kar Nath	₹ 25,000/- + 10 % HRA	12.08.2013	₹ 1,22,100/-	₹ 1,22,100/-	NIL	01.05.2015
2.	Ms. Chayanika Chaliha	₹ 14,000/-	06.10.2015	₹ 81,290/-	₹ 81,290/-	NIL	Continuing till date 31.03.16

15.09.17

(Project Investigator)
(Signed and stamped)

Dr. Eeshan Kalita
Asstt. Professor
Deptt. of Molecular Biology & Biotechnology
Tezpur Central University
PI DBT Sponsored Project
"GIS......nanobiosensors"

(Head of the Institute)
(Signed and stamped)
Registrar
Tezpur University

21/11/17
(Finance Officer)
(Signed and stamped)
Finance Officer
Tezpur University

Consolidated statement for the final settlement of accounts for the DBT Project "GIS......nanobiosorbents" for the financial term dated 23rd May 2012 to 15th September 2017

Sl. No.	Item	Grants received from DBT (₹)								Expenditures incurred (₹)						Balance for the financial term ending 15th September 2017(₹)
		23rd May 2012-31st March 2013	1st April 2013-31st March14	1st April 2014-31st March15	Interest gained	1st April 2015-31st March16	1st April 2016- 15th September 2017	Interest gained	Total (Grants received + Interest gained)	23rd May 2012-31st March 2013	1st April 2013-31st March14	1st April 2014-31st March15	1st April 2015-31st March16	1st April 2016- 15th September 2017	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
i.	Equipment	5196000.00	0.00	0.00	158978.00	0.00	0.00	41277.00	5196000.00	346743.00	4849257.00	0.00	0.00	0.00	5196000.00	0.00
ii.	Human Resource	211000.00	0.00	176000.00		315000.00	0.00		702000.00	60387.00	133523.00	176000.00	203390.00	9800.00	583100.00	118900.00
iii.	Consumables	300000.00	0.00	600000.00		441000.00	0.00		1341000.00	145685.00	154315.00	600000.00	0.00	441001.00	1341001.00	-1.00
iv.	Travel	100000.00	0.00	100000.00		69000.00	0.00		269000.00	37910.00	77838.00	52695.00	23536.00	0.00	191979.00	77021.00
v.	Contingency	50000.00	0.00	25000.00		25000.00	0.00		100000.00	50000.00	2884.00	25000.00	22116.00	0.00	100000.00	0.00
vi.	Overheads	100000.00	0.00	50000.00		50000.00	0.00		200000.00	55993.00	44007.00	50000.00	31250.00	18750.00	200000.00	0.00
	Sub total	5957000.00	0.00	951000.00	158978.00	900000.00	0.00	41277.00	7808000.00	696718.00	5261824.00	903695.00	280292.00	469551.00	7612080.00	195920.00
	Grand total	8008255.00								7612080.00						396175.00
	Remarks	The disbursal for the appointed JRF for the 3rd financial installment was accorded as per JRF (non NET/GATE) @ ₹ **14000.00 p.m.** thereby resulting in the unspent balance amounting to ₹ **118900.00** in the **manpower head.**														

20·10·17

(PROJECT INVESTIGATOR)
(Signed and stamped)

Dr. [illegible] Kalita
Asst. Professor
[illegible]
[illegible]

PI DBT Sponsored Project
" GIS......nanobiosorbents"

(HEAD OF THE INSTITUTE)
(Signed and stamped)

Registrar
Tezpur University

21-11-17

(FINANCE OFFICER)
(Signed and stamped)

Finance Officer
Tezpur University