Recent Developments in Chemical Sciences

Editor
Dr. Barnali Deka

Recent Developments in Chemical Sciences

Editor
Dr. Barnali Deka

PURBAYON
publication

Recent Developments in Chemical Sciences– : A collection of articles giving special emphasis on supramolecular chemistry and material chemistry edited by Dr. Barnali Deka and published by Purbayon Publication, Panbazar, Guwahati-1, Assam, India

First Edition: January, 2020 Price: 200/-

ISBN : 978-93-89940-12-1

Recent Developments in Chemical Sciences

First Edition:

January, 2020

Price: 200/-

Cover : Chitralekha

Published by:
Purbayon Publication
Jaswanta Road
Near Panbazar Aadarsha Prathamik Vidyalaya
Panbazar, Guwahati- 1, Assam, India
Email-purbayonindia21@gmail.com
website: purbayonpublication.com
Contact No. +91- 9864422157, 0361-2700969

Editorial

Over the few decades scientists and researchers have developed many important fields in chemical science. This book is designed to give an insight into the recent developments in Chemical sciences and to develop interest among new researchers on these topics.

Anion-receptor chemistry is an important area of research within the field of Supramolecular chemistry. Different types of anion-receptors have already been developed which include H-bonding, electrostatic interaction, Lewis acid-base interaction, halogen-bonding interaction, anion-π interaction etc. as a force of interaction. Out of these interactions, anion-π interaction defined as the interaction between an electron deficient aromatic system and an electron rich species (viz. anion) has recently got immense attention. Although weak, these interactions could play a significant role in anion binding and recognition process. In this connection, chapter 1 gives a brief review on design strategy of anion receptors based on anion-π interaction using representative examples.

The chemistry of dyes and intermediates had developed during the first decades of the 20th century. The major application of dyes is in coloration of substances mainly textiles. Chapter 2 gives a descriptive introduction on Dye-Surfactant Interactions in Aqueous Submicellar Medium where the formation of dye-surfactant complex, dye aggregates, ion pair etc. are observed which opens up new perspectives in understanding the role of chemical structure, chain length, charge, presence of different types of counter ions of a

surfactant on different types of dyes. In recent years the use of tailor-made dyes and surfactants has been attracted many researchers and consequently, synthetic chemists have also been involved in such research and developments.

Recently, transition metal nanoparticles have got immense attention due to their catalytic activity. The usefulness of transition metal nanoparticle is that they mimic metal surface activation and catalysis occurs at nanoscale level which brings selectivity and efficiency to catalysis mainly catalysis in organic transformation. They have broad spectrum of applications such as in biotechnology, in medicine, in targeted drug delivery and in industry. In this regard Chapter 3 gives a brief review on synthesis, characterization and catalytic application of transition metal nanoparticles with special references.

The increasing concentration of heavy metals in the environment due to several anthropogenic activities has become a threatening to living beings and environment. An Many of them have important function when present in trace amount but becomes toxic when present in excess. Some examples of trace elements are Copper (Cu), Nickel (Ni), Selenium (Se) and Zinc (Zn) which are essential to maintain the metabolism of the human body. Some of these trace metals are related to physiological function. For example Zn is present in more than 300 biologically important catalysts like alcohol dehydrogenase, carbonic anhydrase etc. and is also important in maintaining protein structure and stability. Chapter 4 is designed to highlight the Toxicity of Few Important Trace Metals and Remedial Measures. The author focus on brief introduction about trace metals, their toxic effects and various methods involved in helping to reduce or remove the trace metals. Some geological phenomena such as ore formation, leaching or degassing, weathering of rocks may lead to the occurrence of trace heavy metals in the biosphere.

Arsenic is considered as one of the most toxic metals in the environment. Out of which arsenic toxicity in the ground water is most common which may cause serious health hazards and fatal diseases like cancer and skin lesions. Thereby it needs special attention so that to avoid the toxic effects related to arsenic. Presence of microbial biome such as E. coli, Pseudomonas, and Actinobacter helps to reduce the arsenic in ground water. Arsenic Resistance Bacteria in Groundwater is found to be one of the best ways to reduce arsenic level in ground water. In Chapter 5, the author has reviewed the global arsenic contamination and presence of arsenic resistance bacteria in groundwater.

The main aim of this book is to develop interest among the upcoming researchers within the field of organic and inorganic synthesis, supramolecular chemistry, environmental chemistry and material chemistry.

Barnali Deka

Contents:

Review on Arsenic Resistance Bacteria in Groundwater

Mridul Buragohain[1], Nilakhi Kakoti[1]
Md Yamin Hassan[2]

Introduction

Arsenic pollution in our ecosystem is nowadays a severe risk effecting to human population. Millions of people across the globe unknowingly depend on arsenic contaminated groundwater for drinking purpose and facing serious health hazards. The groundwater is known to be contaminated from different xenobiotic and anthropogenic sources leading to fatal diseases as cancer and skin lesions. Arsenic in the form of arsenate, As (IV) and arsenite, As (III) is toxic in water sources. Arsenic is found naturally all over the over in ground water as a chemical of semi metal. Arsenic through contaminated water, infected soil and rock and arsenic preserved wood may put the threat of aresening poisoining in individual line. Presence of microbial biome such as E. coli, Pseudomonas, and Actinobacter helps to reduce the arsenic in ground water. This chapter aims to seek a review on global arsenic contamination and presence of arsenic resistance bacteria in groundwater.

[1]*Department of Chemistry, Lakhimpur Girls' College, North Lakhimpur, Assam, India*
[2]*Department of Chemistry, Assam down Town University, Assam, India*

Rising of urbanization, industrial pollution, burning of fossil fuels elevated the range of arsenic in the biosphere. Concentration of arsenic is found to be high in rainfall thus troubles to groundwater. In Asian countries including India arsenic polluted groundwater is being used for drinking and irrigation[1]. Estimation of fifty million population in Bangladesh depends on arsenic contaminated tube wells and suffering from severe chronic diseases including cancer[2]. Dissolution of Fe, Mn oxyhydroxide, $NaHCO_3$, DOC and high pH are the main factor of As mobilization in ground water[3]. Elevated form of arsenic in water sources results in a stress livelihood to a society including poverty and a drop of agricultural products[4]. Volcanic eruption and hydrothermal sources cause a major role in arsenic contamination to the environment[5]. In most districts of West Bengal(India), it was reported that water used for drinking and agricultural purpose were elevatedly affected by arsenic. A positive correlation of arsenic concentration between soil and water was also seen[6]. To equalized the arsenic contamination, arsenic resistance gene of bacterial species are found to remain associated with ars operon. These moiety are As(III) genes responsive regulation on (ArsR), As (III) efflux permease (ArsB or ACR3) that expel As (III) from the cell[7]. Bas1 and Bas2 two bacterial strains isolated that can convert the toxin As (III) to nontoxic As (V) and is reported to be used in bioremediation process[8]. *Bacillus* species BAR1 was also isolated from arsenic polluted groundwater which reported to be resistant to arsenic and also resitance to other Cu, Cd, Ni, Hg, Zn heavy metals.[9]. *Pseudomonas, Bacillus, Psychrobacter, Enterobacter, Vibrio* show a elevated resistance capacity for As with a minimum inhibitory concentration from 2-200Mm[10]. A study in Hetao plain, Inner Mongolia reflected the presence of Pseudomonas and Acinetobacter in a dominated pause of both high and low As groundwater[11]. High As resistant bacterial strains- *Actinobacteria, Microbacterium, Pseudomonas and Rhizobium* were localized in ground water of West Bengal (India) showing minimum inhibitory concentration of about > 10 mM[12]. Arsenate reductase activity is seen to be influenced by *Agrobacterium, Achromobacter, Rhizobium, Ochrobactrum* starins isolated from arsenic contaminated groundwater of West Bengal (India)[13].

Arsenic Mobilization

Arsenic release in environments occurs due to weathering of rocks, minerals (arsenopyrite) and anthropogenic sources. Mobilization of arsenic in ecosystem is influenced by hydrogeochemical reactions, and redox reactions carried by potential micro biomes. Elevated form of arsenic is found with high concentration of Fe oxide and pyrites[4]. Sulphate and iron reduction isolates *Deltaproteobacteria* , *Nitrospirae* were found positive in arsenic mobilization[14]. Phosphatase and siderophores play a crucial role in release of As(V) and As(III) is reduced by arsenate reductase to mobilize arsenic in groundwater[13]. Oxalic acid assemblance and As (V) reductase of *Brevundimonas,Flavobacterium, , Rhodococcus, Methyloversatilis, Methylotener, Pseudomonas* and *Polaromonas a* lead to mobilized arsenic in wide range[15]. *Acidovorax, Acinetobacter, Bosea, Bacillus, Brevundimonas, Caulobacter Herbaspirillum, Pseudomonas, Staphylococcus, Ralstonia,Rhizobiales, Rhodococcu, Undibacterium* found to use the carbon source and grow chemolithotropically enhancing the arsenic mobilization in groundwater[16]. PO_4^{3-}, SO_4^{2-},HCO_3^-, carbonate dissolution and Fe-oxyhydroxides important factor of reduction influences mobilization of arsenic[17]. Arsenic contamination in groundwater is geogenic and may triggered by Fe (III) oxides and sulphide oxidation[18].

Global Health Risk

Increasing of anthropogenic and xenobiotic activities by human, arsenic contamination in groundwater is now in elevated form. Infectious health hazards is a stressed for human population that depends mainly on natural water sources. Arsenicosis- nearby uncurable disease includes skin lesions, cancer in lungs, liver, urine and kidney is nowadays a serious issue to humans[19]. Mee lines symptom is mostly occurable in fingernails due to arsenic toxicity resulting in various cardiovascular diseases. Diabetes and pregnancy outcomes such as child mortality is an another cause factor of arsenic toxicity in drinking water. High arsenic exposure to drinking water also leads to chronic respiratory problems such as cough, breathing problem etc. Contaminated arsenic water used for irrigation purpose is passed to our nutritional crops. Cattles feeding on arsenic polluted water sources face a vulnerable death.

Conclusion

Majority of the human population is now depending on high contaminated arsenic groundwater as for drinking purposes. Lack of education regarding the toxic effect of such heavy metals present in water is one of a major cause of rise in serious health hazards. Baterial novel strains such as *Actinobacteria, Microbacterium, Pseudomonas* and *Rhizobium* can be a superior technology for bioremediation of arsenic toxicity in groundwater.

Acknowledgement

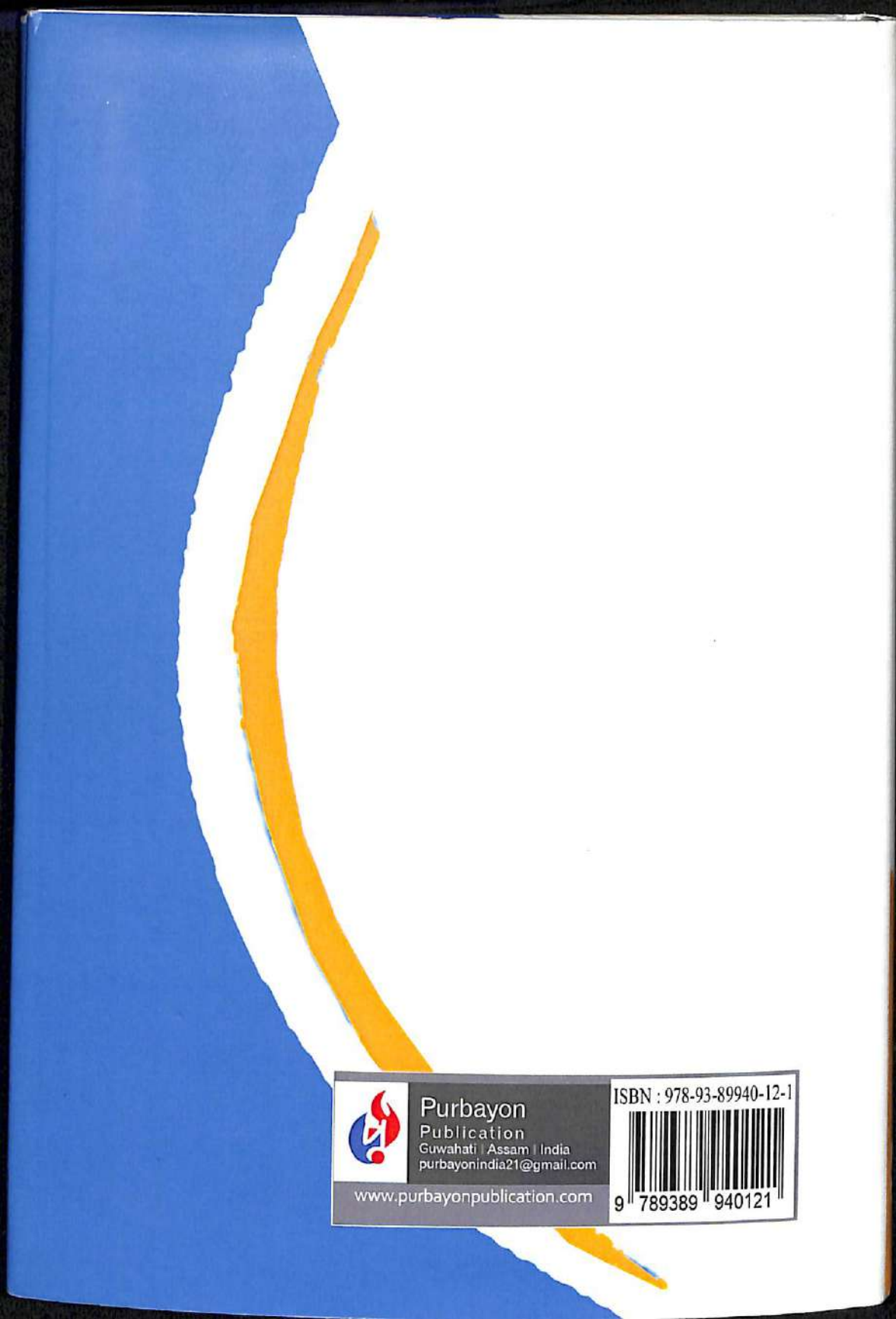
The authors are thankful to Department of Bio Technology (DBT), Govt. of India, New Delhi for financial support in the form of Major Research Project vide no. BT/IN/INDO-US/FOLDSCOPE/39/2015, dated 20th March, 2018.

Reference

1. Chakrabarti. D, Singh S.K, Rashid Md. H, Rahman M.M, (2017) Arsenic: Occurrence in groundwater, Encyclopedia of Environmental Health, Elsevier https://doi.org/10.1016/B978-0-12-409548-9.10634-7
2. Ahmad S.A, Khan M.H, Haque M, (2018) Arsenic contamination in groundwater in Bangladesh: implications and challenges for healthcare policy, Risk Management and Healthcare Policy. pp 251-261 https://doi.org/10.2147/RMHP.S153188.
3. Anwar M.H, Akai J, Komaki K, Terao H, Yoshioka T, Ishizuka T, Safiullah S, Kato K(2003) Geochemical occurrence of arsenic in groundwater of Bangladesh: sources and mobilization process(2003) , Journal of Geochemical Exploration, Elsevier.pp 109-131 https://doi.org/10.1016/S0375-6742(02)00273-X.
4. Shankar S, Shankar U, Shikha (2014) Arsenic contamination of Groundwater : A review of sources, prevelance, health risks and strategies for Mitigation, The Scientific World Journal, https:/ /doi.org/10.1155/2014/304524.
5. Dhuldhaj U.P, Yadav I.C, Singh S, Sharma N.K, (2013) Microbial Interactions in the Arsenic Cycle: Adoptive Strategies and Applications in Environmental Management, Review of

Environmental Contamination and Toxicology, https://doi.org/10.1007/978-1-4614-5882-1_1.
6. Shrivastava A, Barla A, Yadav H, Bose S (2014) Arsenic contamination in shallow groundwater and agricultural soil of Chakdaha block, West Bengal, India, Frontiers in Environmental Science, https://doi.org/10.3389/fenvs.2014.00050.
7. Yang H.C, Rosen B.P, (2015) New Mechanisms of bacterial arsenic resistance, Biomedical Journal, pp 5-13, https://doi.org/10.1016/j.bj.2015.08.003.
8. Biswas R, Sarkar A,(2018)Characterization of arsenite-oxidizing bacteria to decipher their role in arsenic bioremediation, Preparative Biochemistry and Biotechnology, https://doi.org/10.1080/10826068.2018.1476883
9. Biswas R,Majhi A.K, Sarkar A (2019) The role of arsenate reducing bacteria for their prospective application in arsenic contaminated groundwater aquifer system, Biocatalysis and Agricultural Biotechnology, Elsevier, https://doi.org/10.1016/j.bcab.2019.101218
10. Liao V H, Chu Y et.al. (2011) Arsenite-oxidizing and arsenate-reducing bacteria associated with arsenic rich groundwater in Taiwan, Elsevier, https://doi.org/10.1016/j.jconhyd.2010.12.003
11. Wang Y, Li1P et.al. (2016) Microbial community of high arsenic groundwater in agricultural irrigation area of Hetao plain, Inner Mongolia, Frontiers in Microbiology, https://doi.org/10.3389/fmicb.2016.01917
12. Paul D, Poddar S, Sar P (2014) Characterization of arsenite-oxidizing bacteria isolated from arsenic-contaminated groundwater of West Bengal, Journal of Environmental Science and Health, https://doi.org/ 10.1080/10934529.2014.937162
13. Sarkar A, Kazy S.K , Sar P (2013) Characterization of arsenic resistant bacteria from arsenic rich groundwater of West Bengal, India, Ecotoxicology, https://doi.org/10.1007/s10646-012-1031-z
14. R.E Danczak , M D Johnston, C Kenah,M Slattery ,M J Wilkins (2019)Capability for arsenic mobilization in groundwater is distributed across broad phylogenetic lineages, Plos one, https://doi.org/10.1371/journal.pone.0221694.
15. D Paul , S K Kazy , A K Gupta , T Pal , P Sar (2015) Diversity,

Metabolic Properties and Arsenic Mobilization Potential of Indigenous Bacteria in Arsenic Contaminated Groundwater of West Bengal, India, Plos one,
16. https://doi.org/10.1371/journal.pone.0118735.
17. G Soma, S Pinaki (2013) Identification and characterization of metabolic properties of bacterial populations recovered from arsenic contaminated ground water of North EastIndia (Assam), Water research,Elsevier, pp 6992-7005, https://doi.org/10.1016/j.watres.2013.08.044.
18. S Bhowmick, B Nath et.al.(2012) Arsenic mobilization in the aquifers of three physiographic settings of West Bengal, India: Understanding geogenic and anthropogenic influences , Journal of Hazardous Materials, Elsevier,
19. https://doi.org/10.1016/j.jhazmat.2012.07.014.
20. H Indica, V Meththika et al. (2016) Natural Arsenic in Global Groundwater: Distribution and Geochemical Triggers for Mobilization, Current Pollution Reports, Springer, https://doi.org/10.1007/s40726-016-0028-2.
21. Shankar S, Shanker U, Shikha (2014) Arsenic Contamination of Groundwater: A Review of Sources, Prevalence, Health Risks, and Strategies for Mitigation, The Scientic World Journal, https://doi.org/10.1155/2014/304524.



Purbayon
Publication
Guwahati | Assam | India
purbayonindia21@gmail.com
www.purbayonpublication.com

ISBN : 978-93-89940-12-1
9 789389 940121