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Appendix A

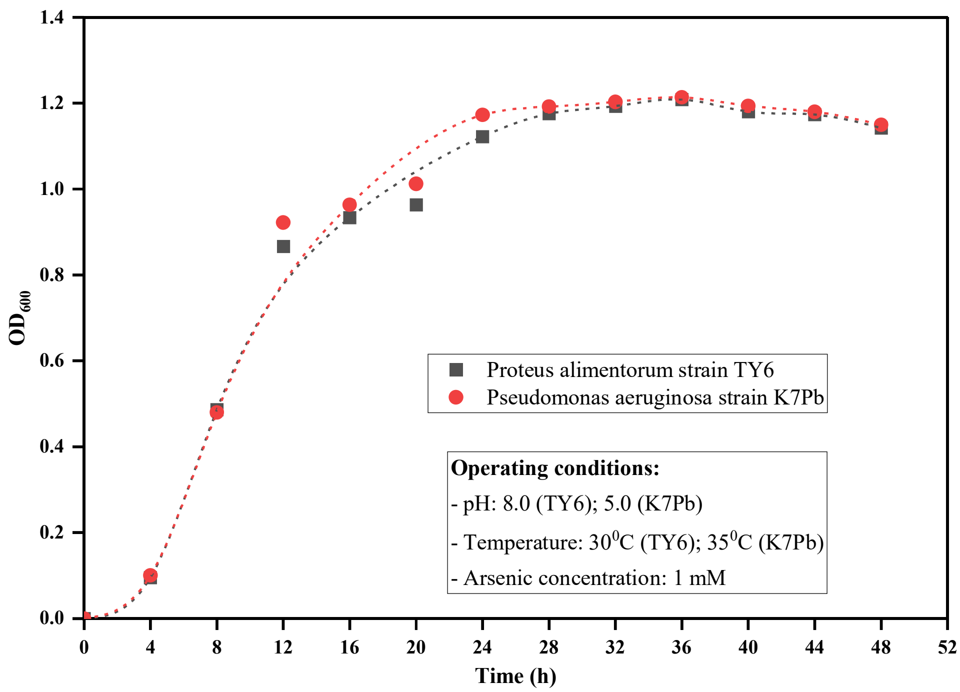


Figure A1: Growth curve of TY6 and K7Pb with time

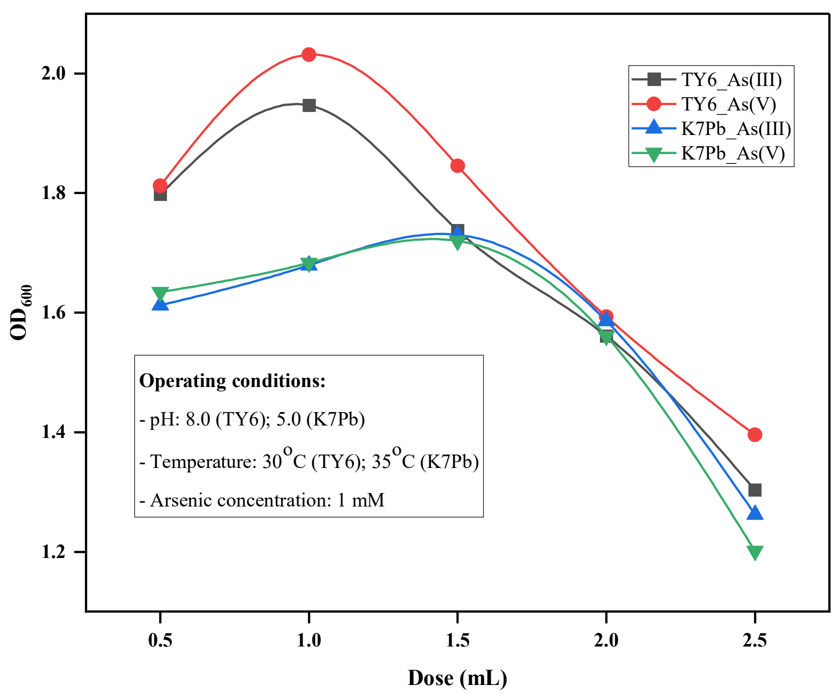


Figure A2: Effect of inoculum dose on growth of TY6 and K7Pb

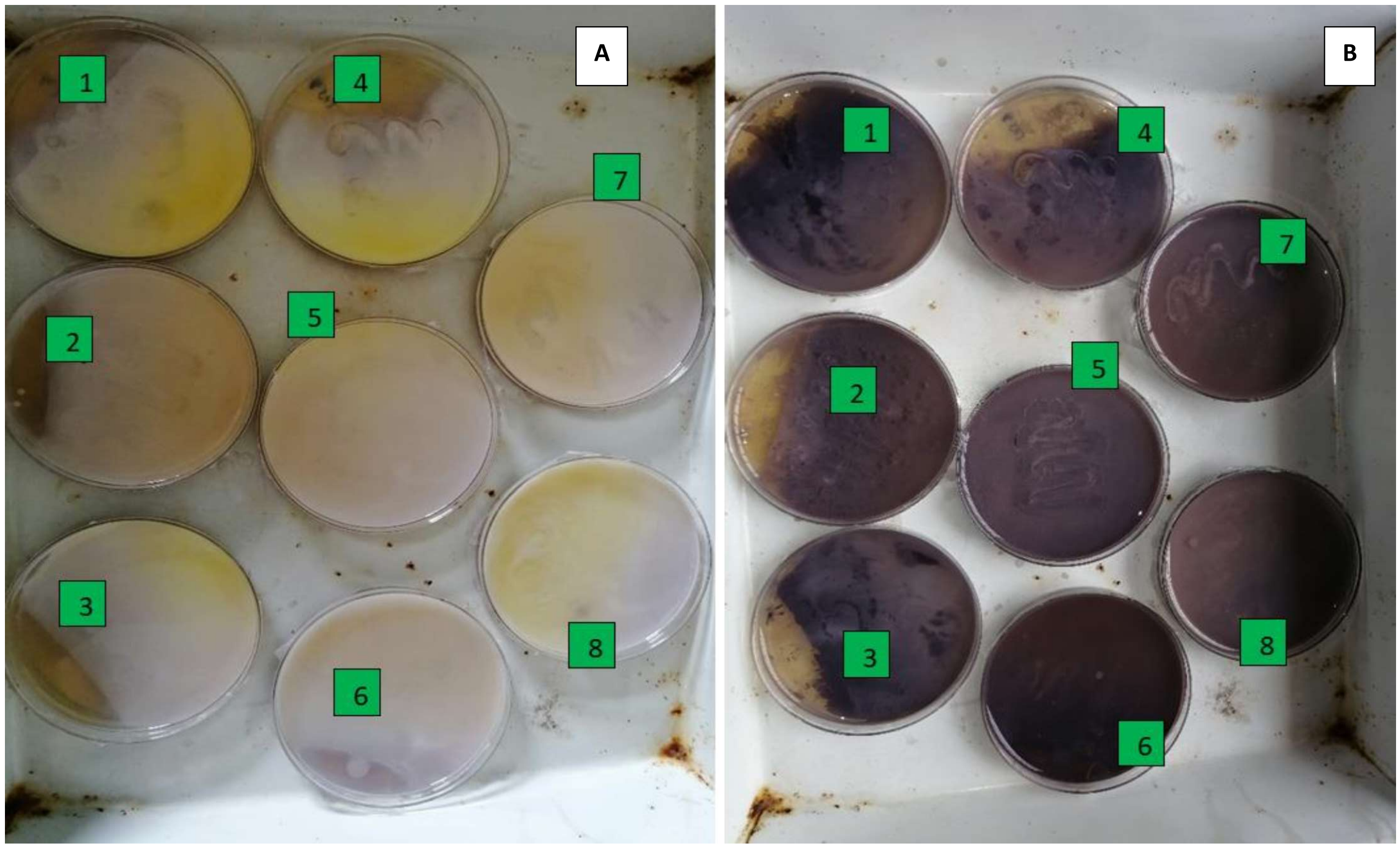


Figure A3: Biotransformation ability of the isolated strains with different combinations of arsenic and bacteria (**A**) – After 5 min; (**B**) – After 2 h [1 – As(III)_K7Pb; 2 - As(V)_TY6; 3 – As(III)+As(V)_K7Pb; 4 - As(III)+As(V)_TY6; 5 - As(III)_TY6; 6 - As(V)_K7Pb ; 7 - As(V)_K7Pb+TY6; 8 - As(III)_K7Pb+TY6]

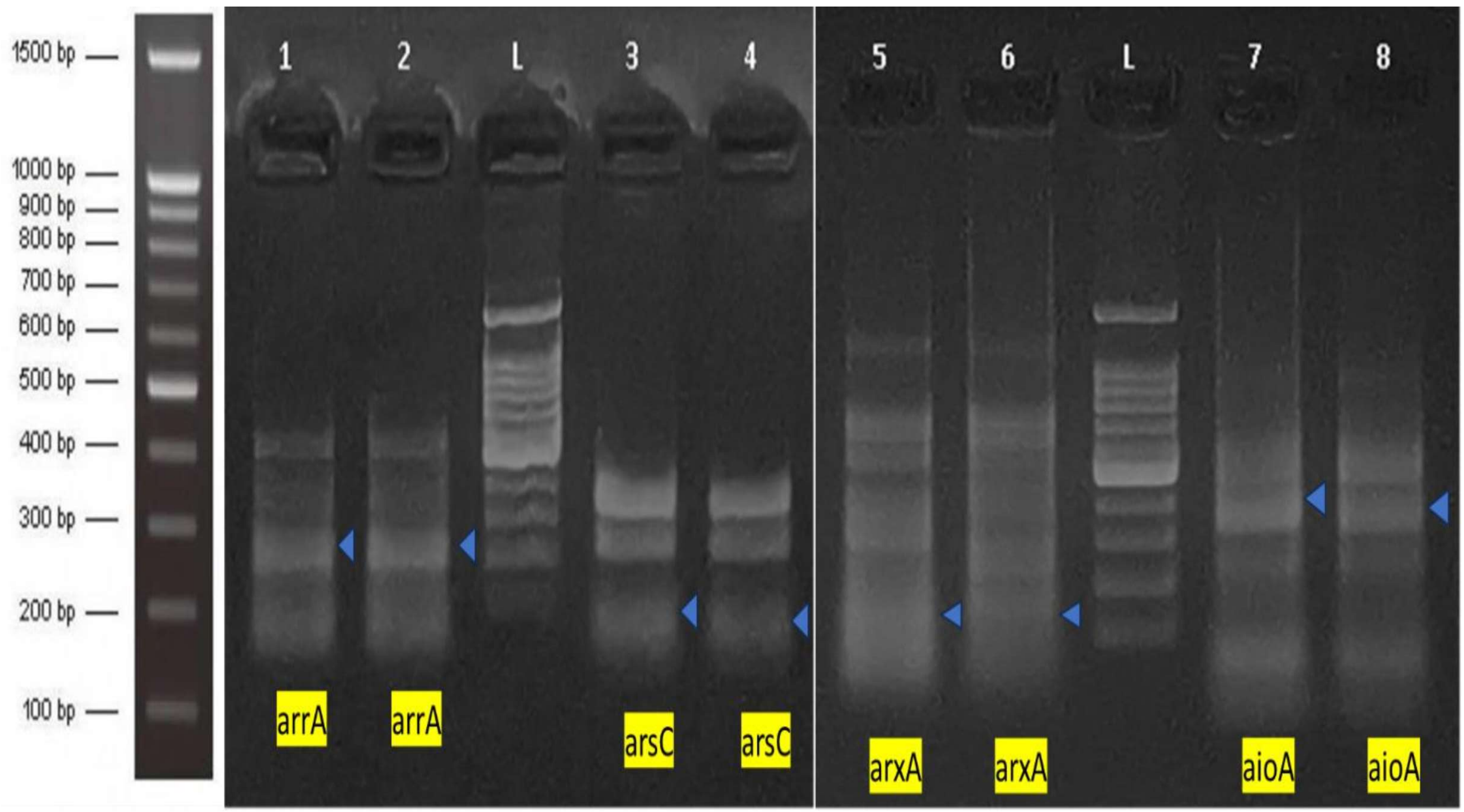


Figure A4: PCR analysis for the 16S rRNA gene, arrA (**1, 2**), arsC (**3, 4**), arxA (**5, 6**), aioA (**7, 8**) for K7Pb and TY6. The blue triangular mark represents the expected size of the genes corresponding to the bp ladder

Appendix B

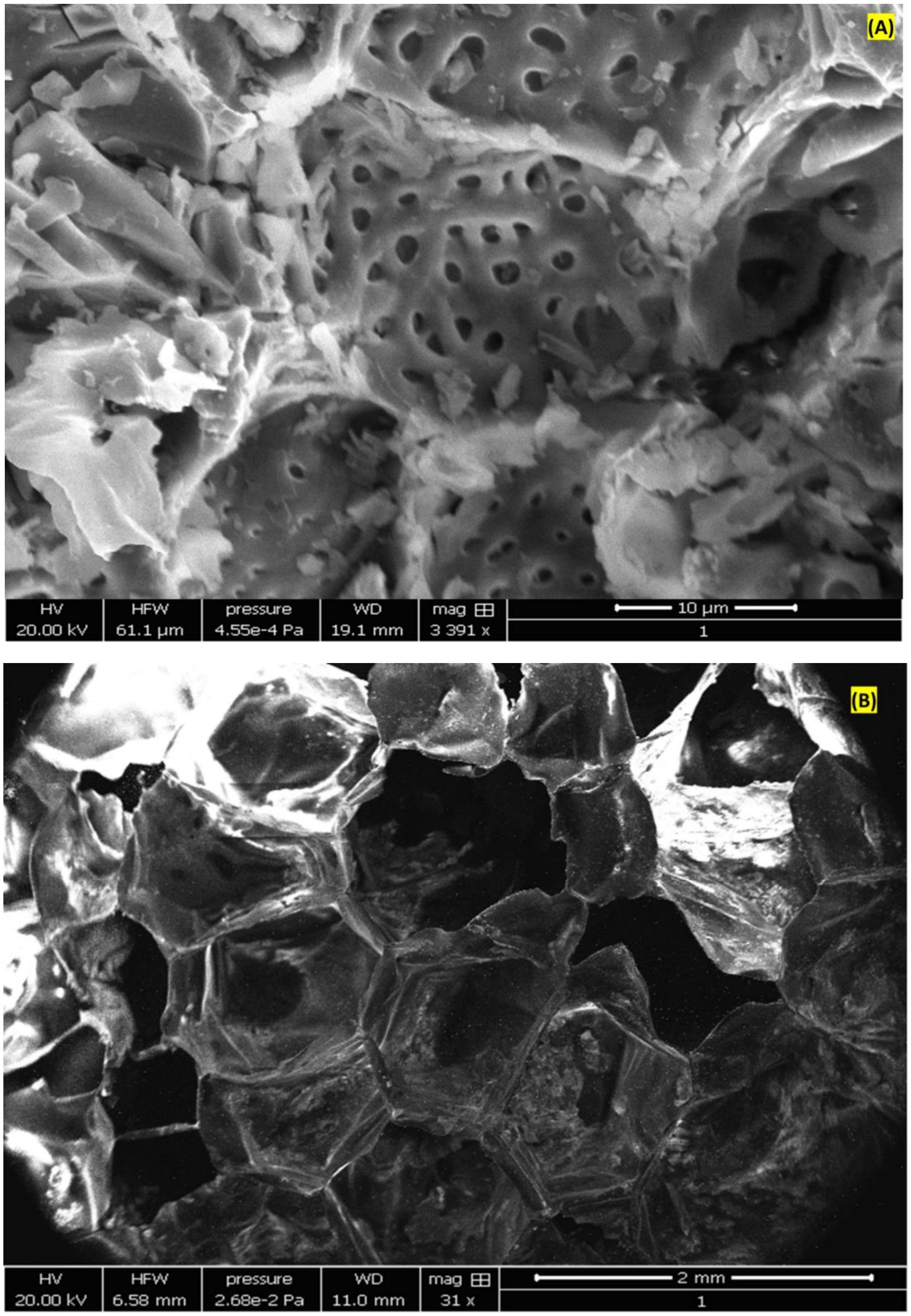


Figure B1: SEM images of carrier **(A)** before **(B)** after formation of the biofilm

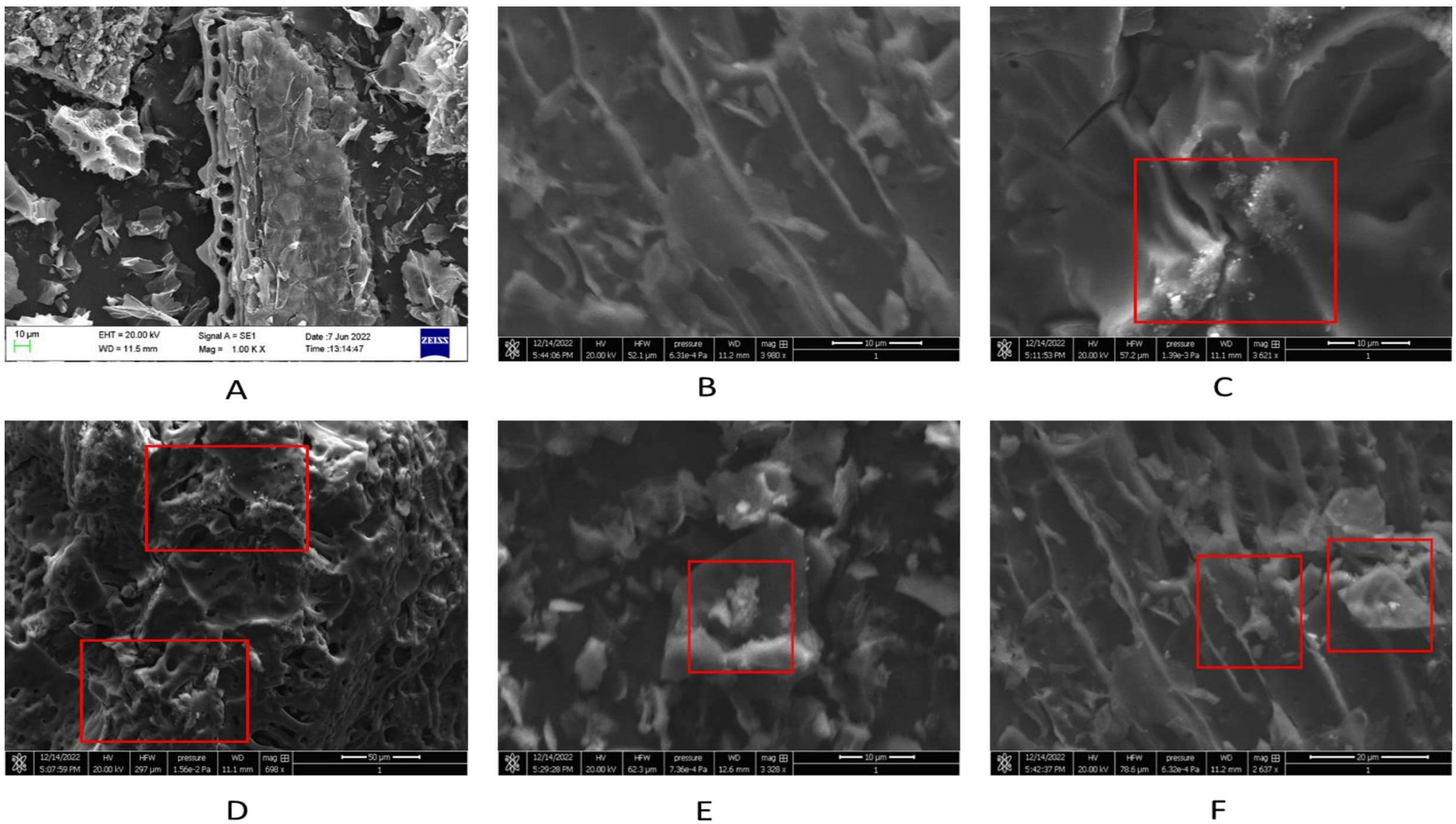


Figure B2: SEM image of **(A)** PSB before adsorption **(B)** MPSB before adsorption **(C)** PSB after adsorption of As(III) **(D)** PSB after adsorption of As(V) **(E)** MPSB after adsorption of As(III) **(F)** MPSB after adsorption of As(V)

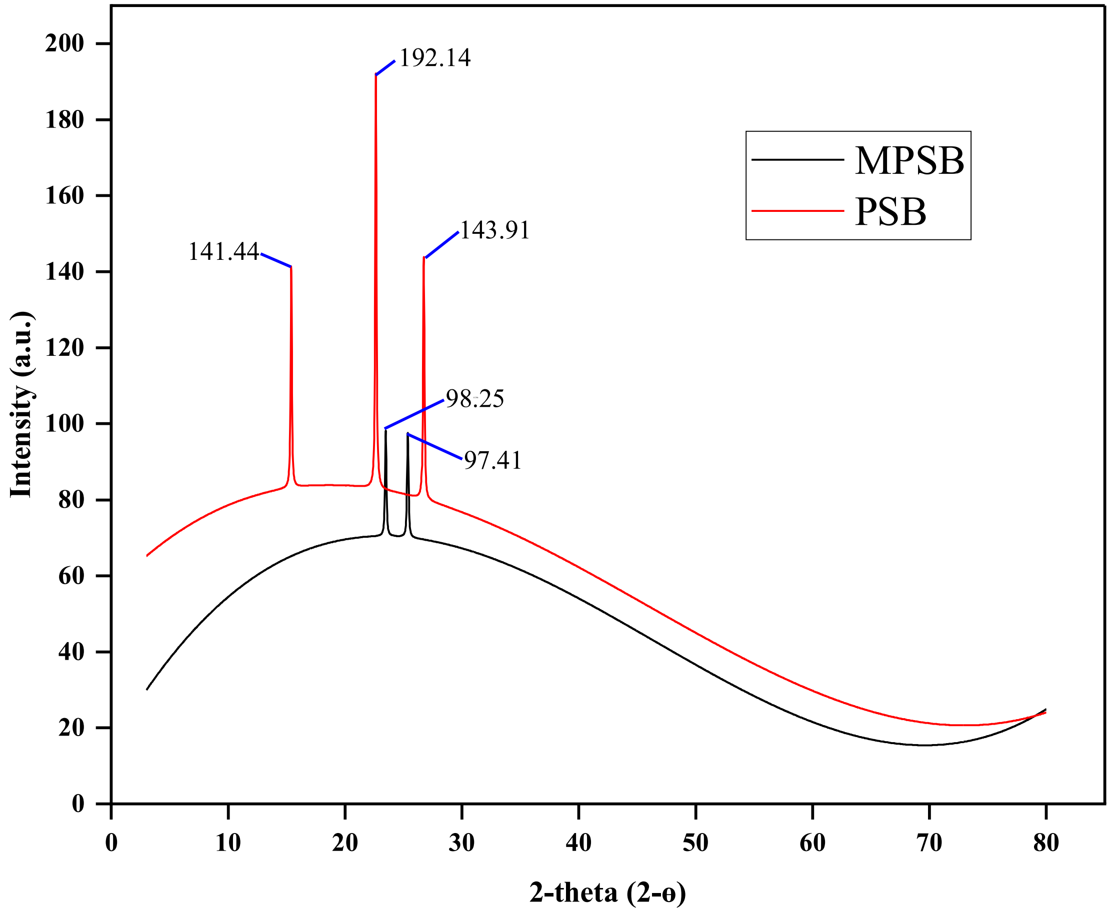
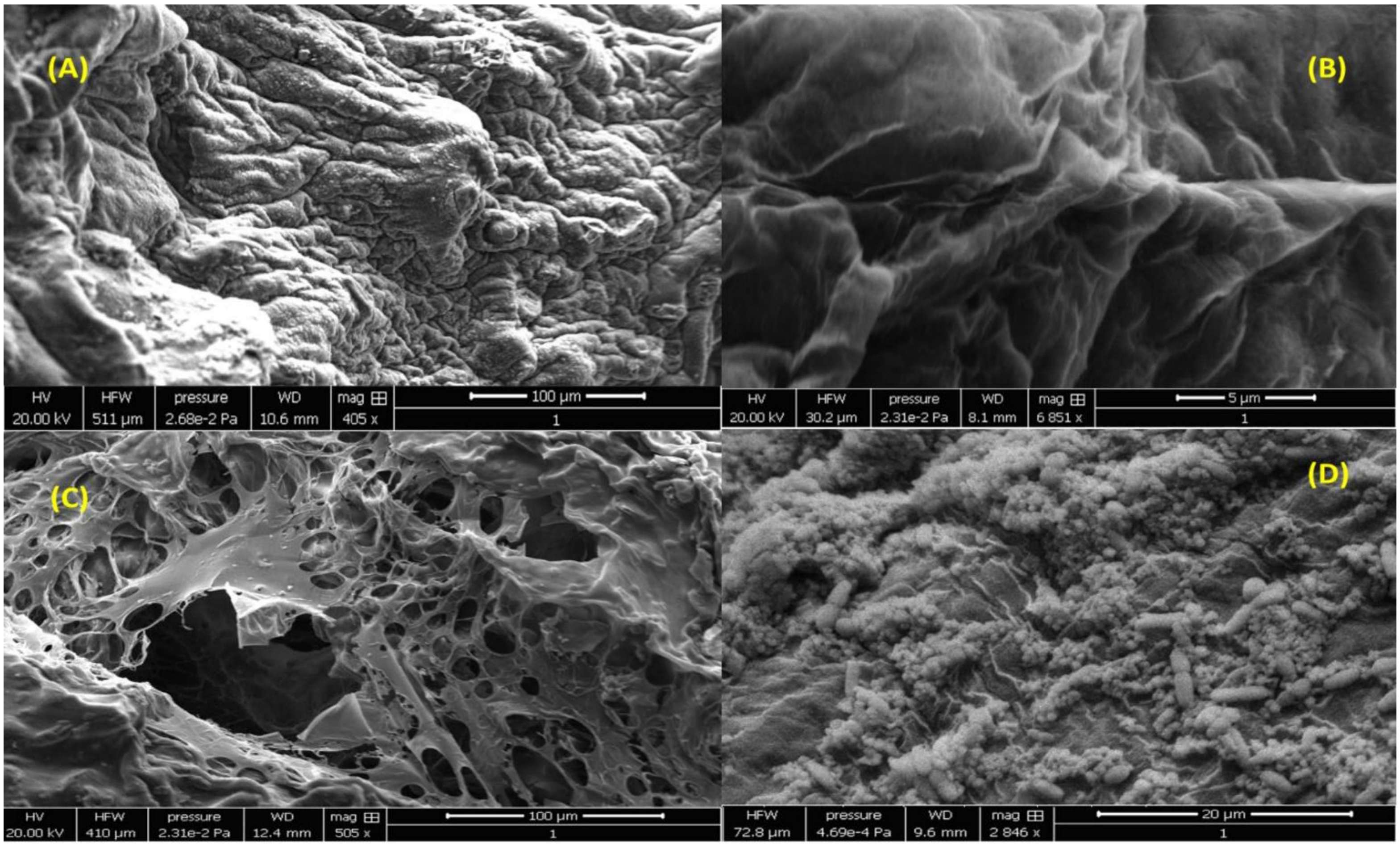


Figure B3: XRD patterns for PSB and MPSB


(A)
HV
20.00 kV
HFW
511 µm
pressure
2.68e-2 Pa
WD
10.6 mm
mag
405 x
100 µm
1
(B)
HV
20.00 kV
HFW
30.2 µm
pressure
2.31e-2 Pa
WD
8.1 mm
mag
6 851 x
5 µm
1
(C)
HV
20.00 kV
HFW
410 µm
pressure
2.31e-2 Pa
WD
12.4 mm
mag
505 x
100 µm
1
(D)
HFW
72.8 µm
pressure
4.69e-4 Pa
WD
9.6 mm
mag
2 846 x
20 µm
1

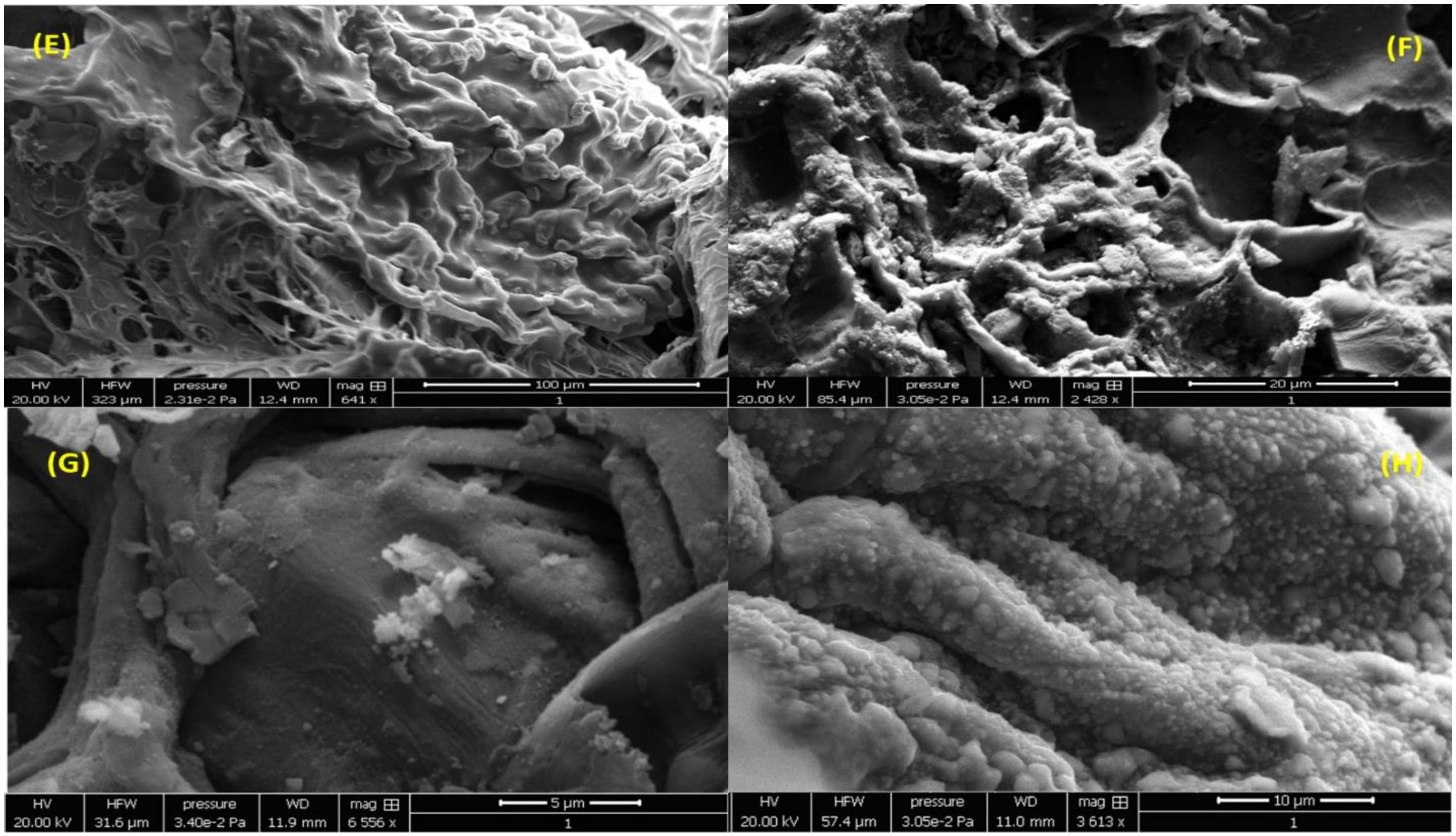
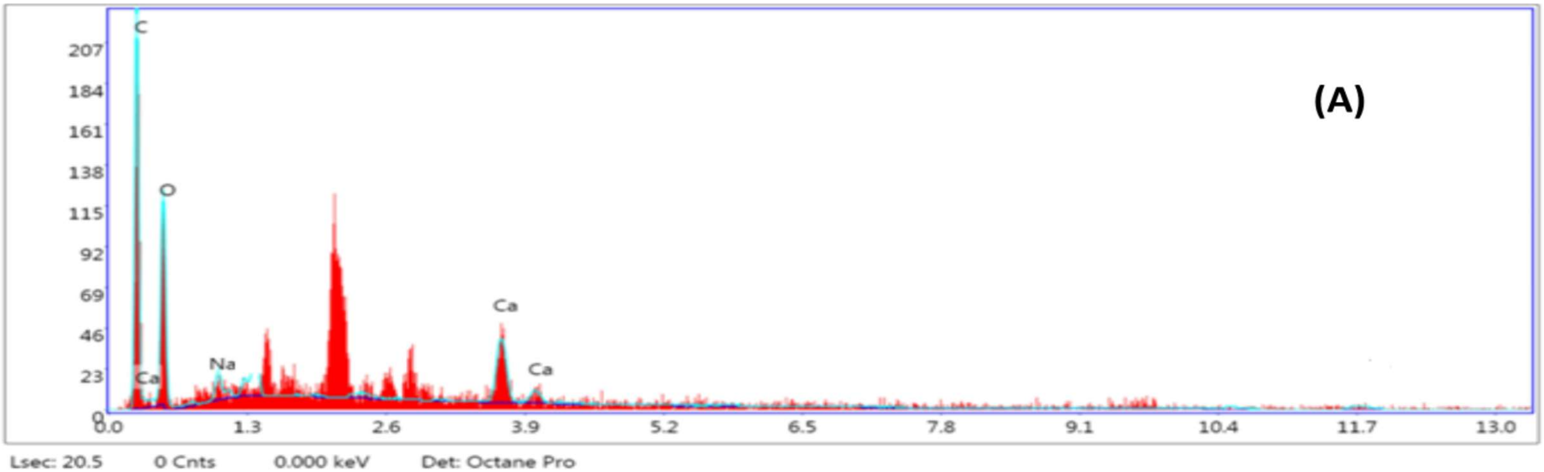
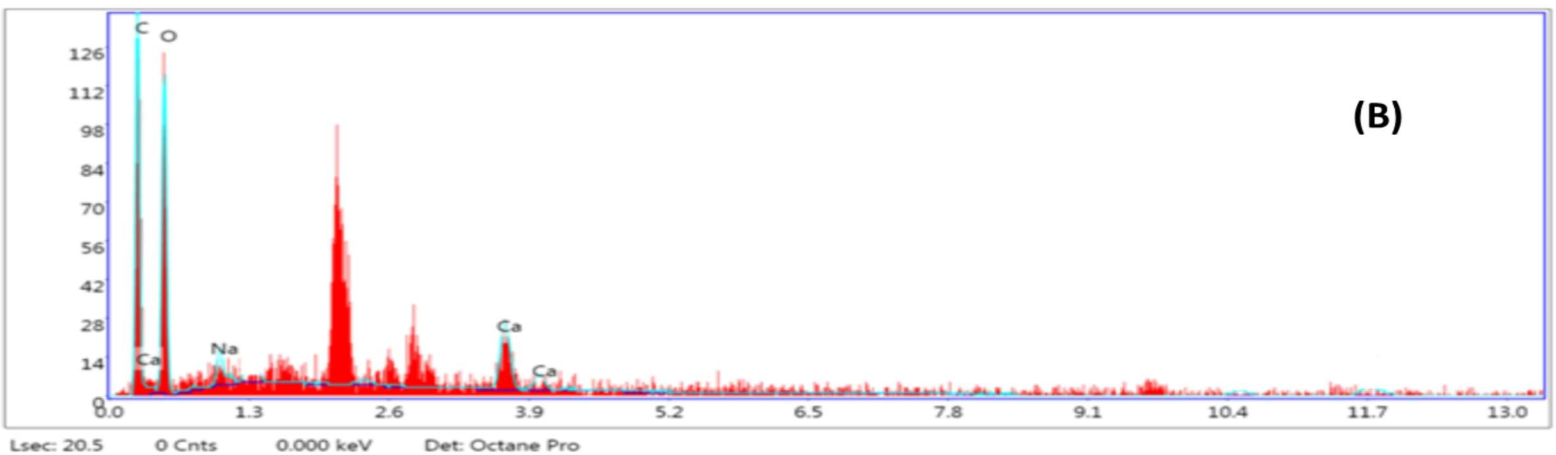


Figure B4: SEM images of immobilized bacteria encapsulated in PVA-SA beads before (A, B, C, D) and after (E, F, G, H) use


(A)
C
O
Na
Ca
Ca
Ca
207
184
161
138
115
92
69
46
23
0
0.0
1.3
2.6
3.9
5.2
6.5
7.8
9.1
10.4
11.7
13.0
Lsec: 20.5
0 Cnts
0.000 keV
Det: Octane Pro


(B)
C
O
Na
Ca
Ca
Ca
126
112
98
84
70
56
42
28
14
0
0.0
1.3
2.6
3.9
5.2
6.5
7.8
9.1
10.4
11.7
13.0
Lsec: 20.5
0 Cnts
0.000 keV
Det: Octane Pro

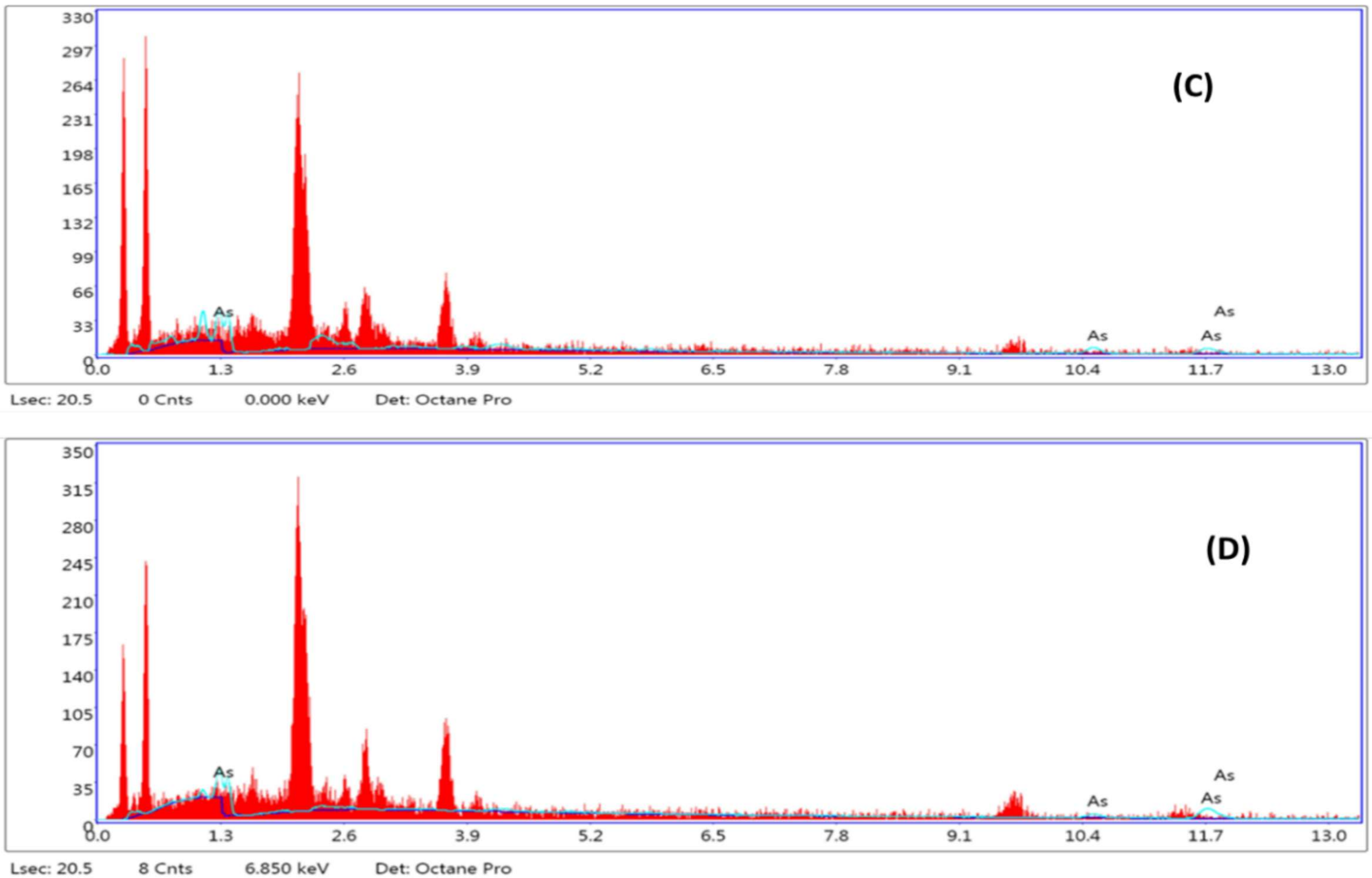


Figure B5: EDX analysis of IBT and IBK before (**A, B**) and after (**C, D**) use

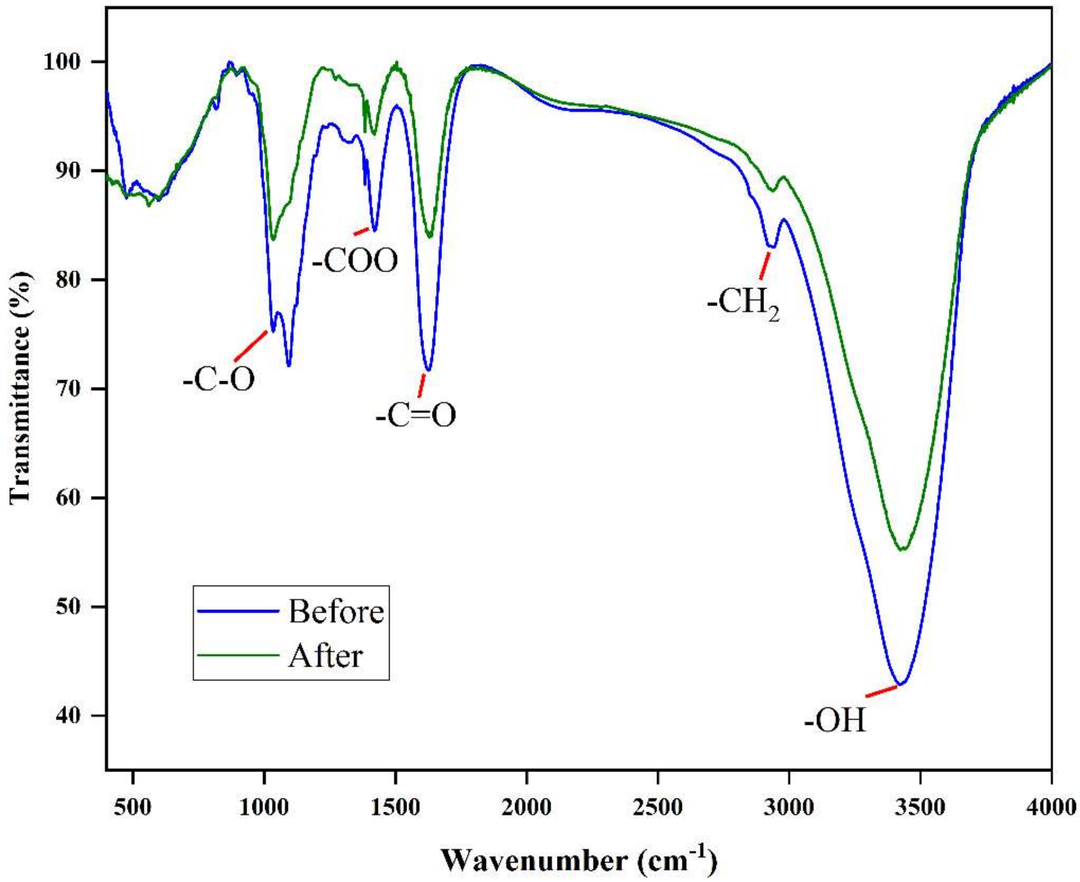


Figure B6: FTIR spectrum of beads before and after use

Appendix C

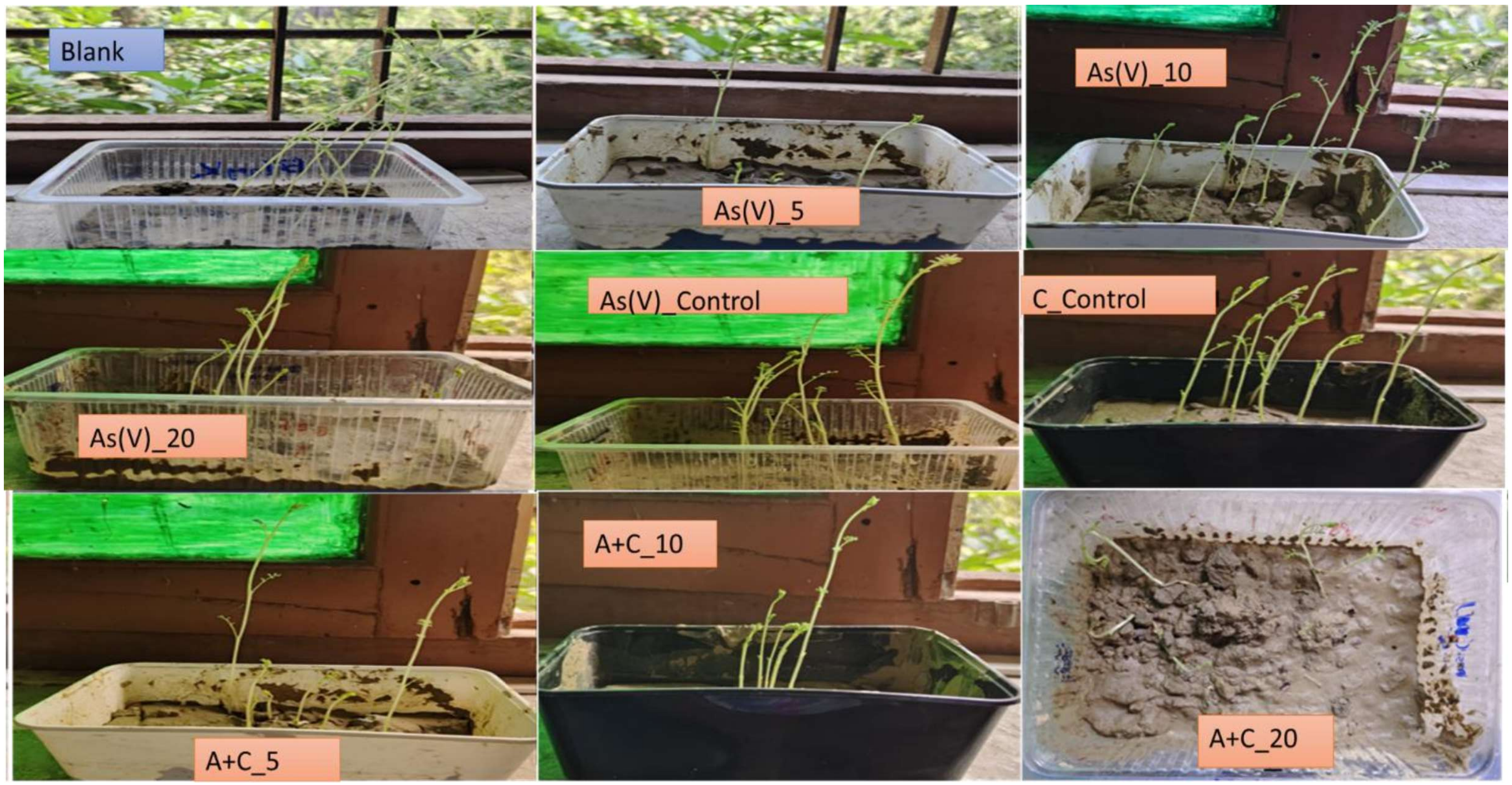


Figure C3: Growth of plants in soil treated with K7Pb after 15 days

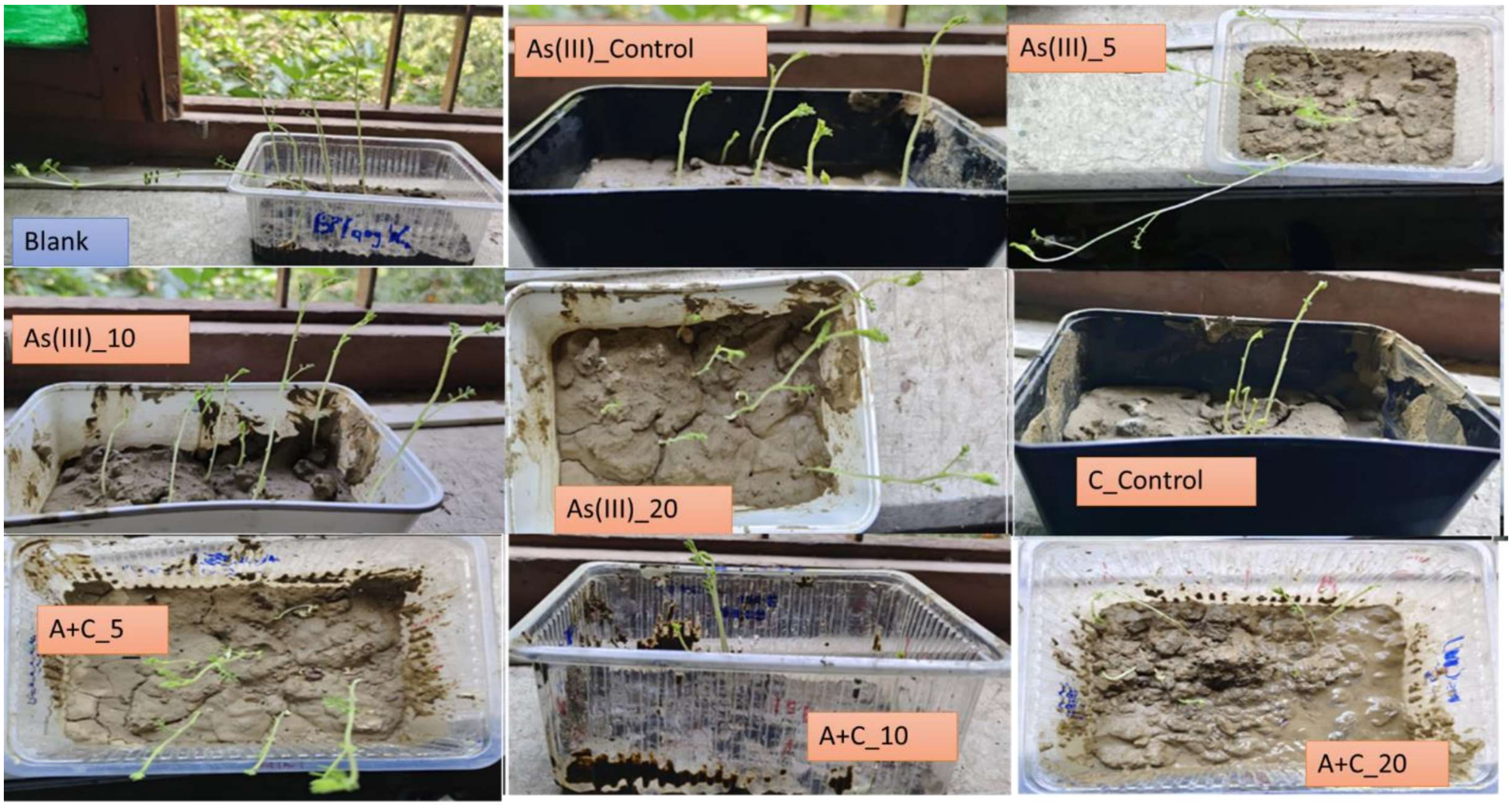


Figure C4: Growth of plants in soil treated with TY6 after 15 days

Appendix D

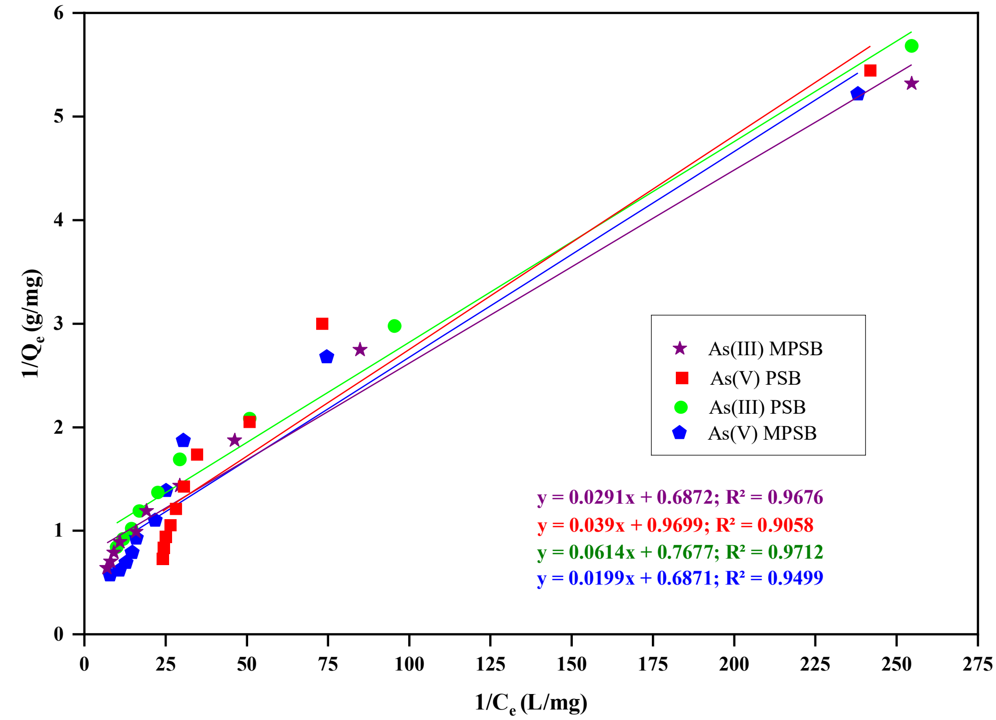


Figure D1: Langmuir isotherms for PSB and MPSB

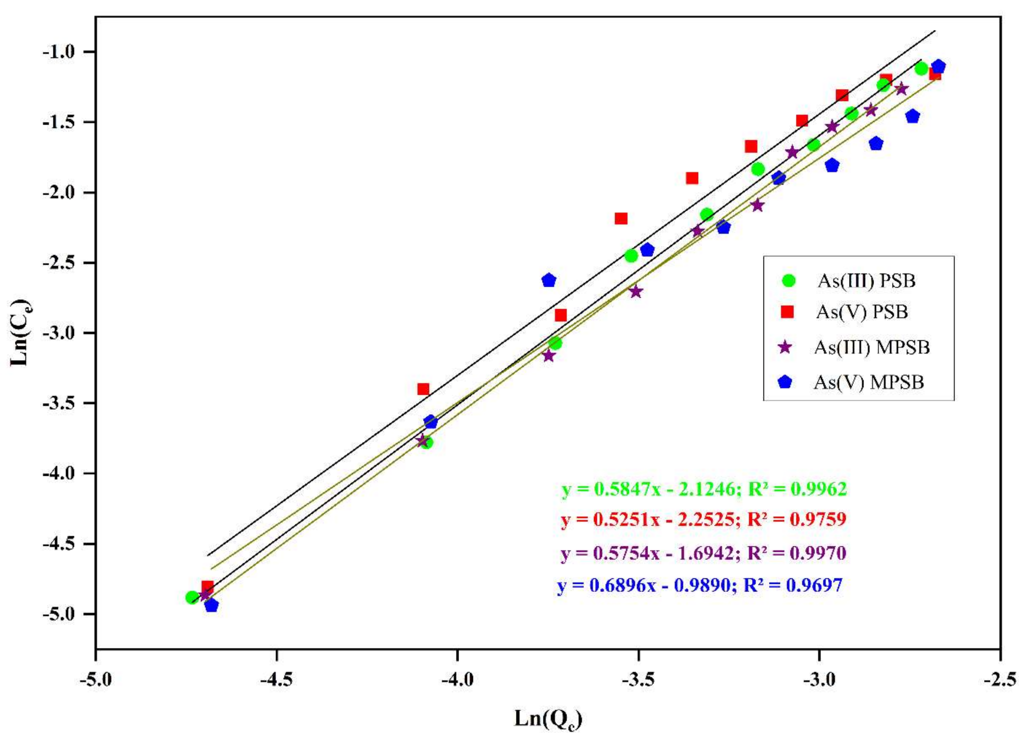


Figure D2: Freundlich isotherms for PSB and MPSB

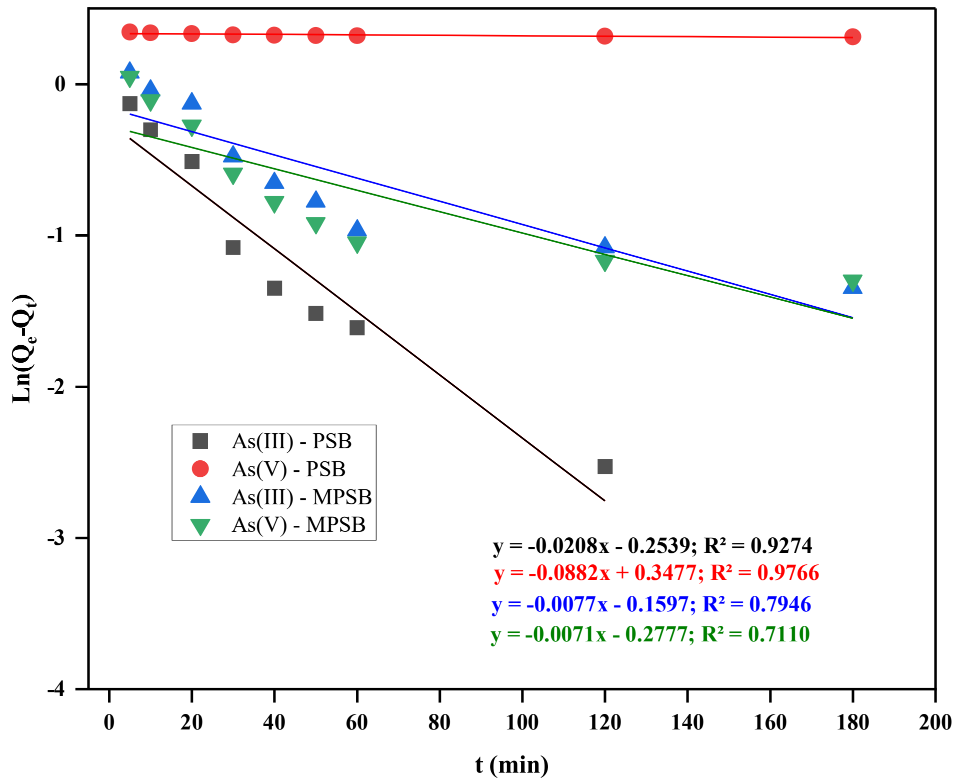


Figure D4: Pseudo-first order kinetics for PSB and MPSB

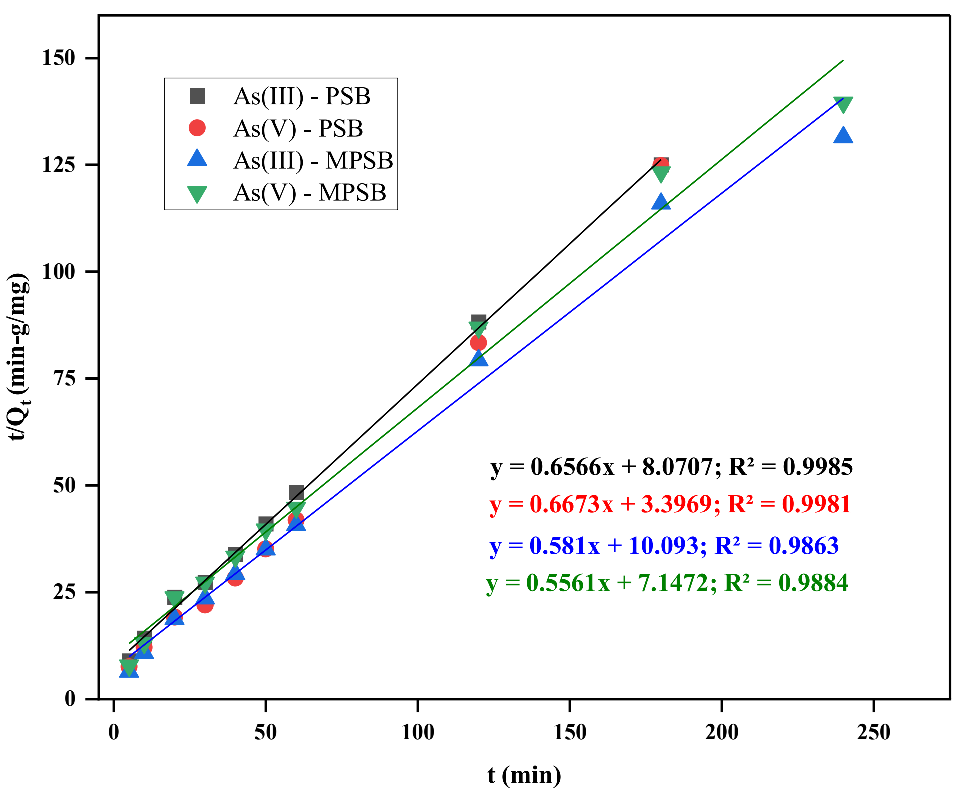


Figure D5: Pseudo-second order kinetics for PSB and MPSB

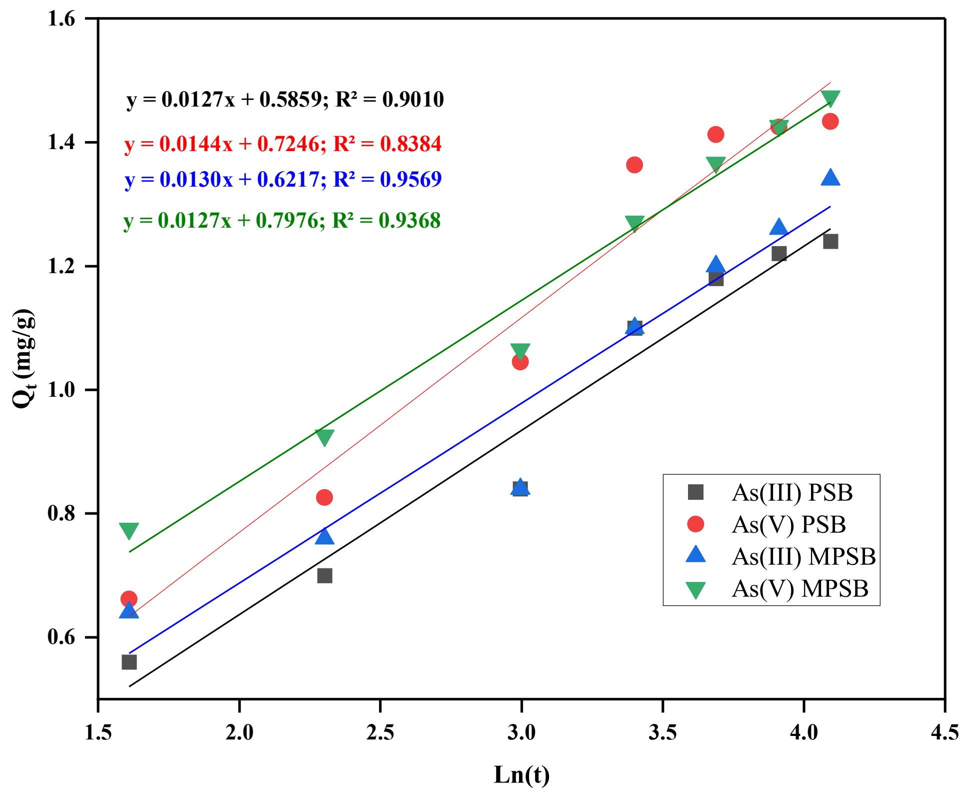


Figure D6: Elovich model for PSB and MPSB

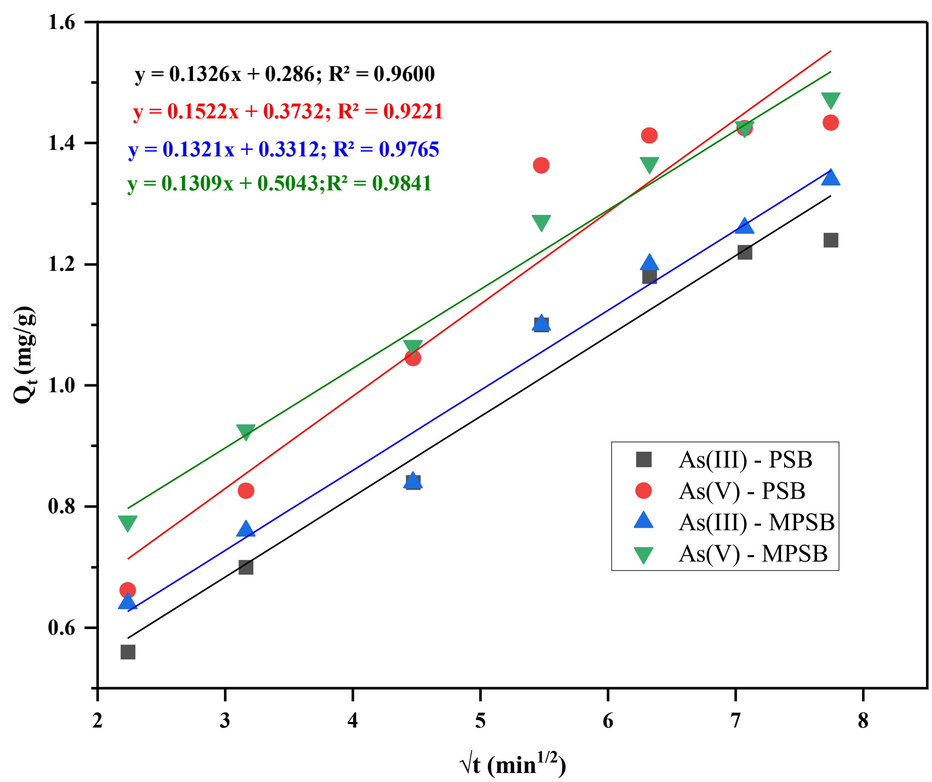


Figure D7: Intra-particle diffusion model for PSB and MPSB

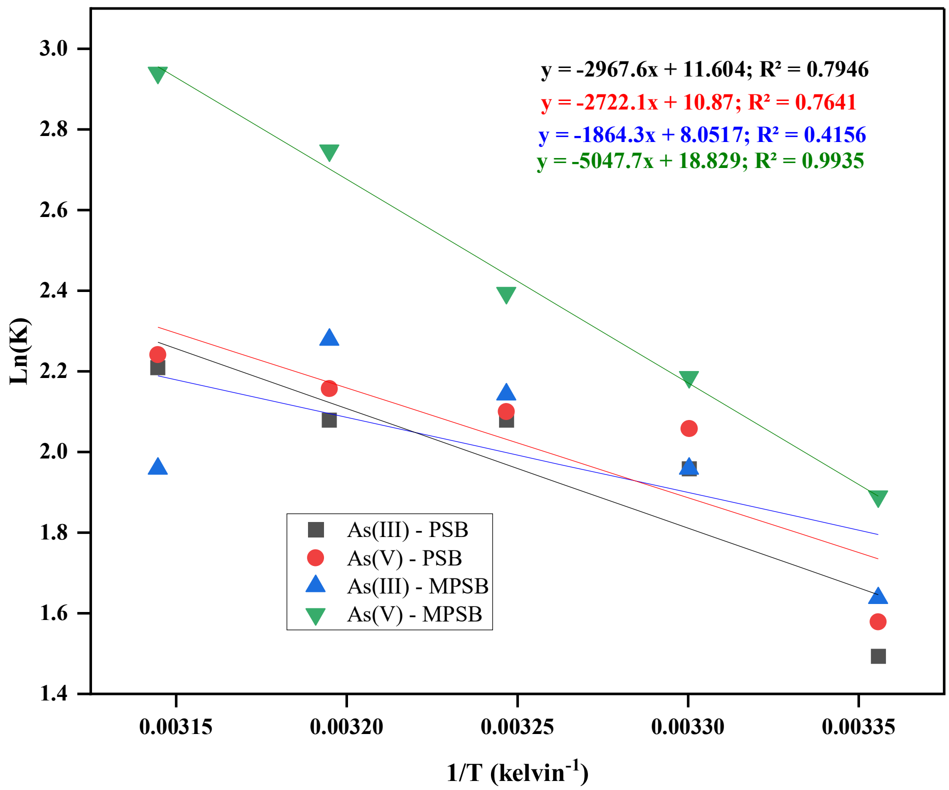


Figure D8: Ln(K) *vs* 1/T for thermodynamic study

Table D1: Properties of PSB

Parameter	Values
Specific surface area	0.904 m^2/g
Pore volume	0.0047 cm^3/g
Pore size	20.796 nm
Density	0.808 g/cm^3
pH	7.2
H/C	0.038

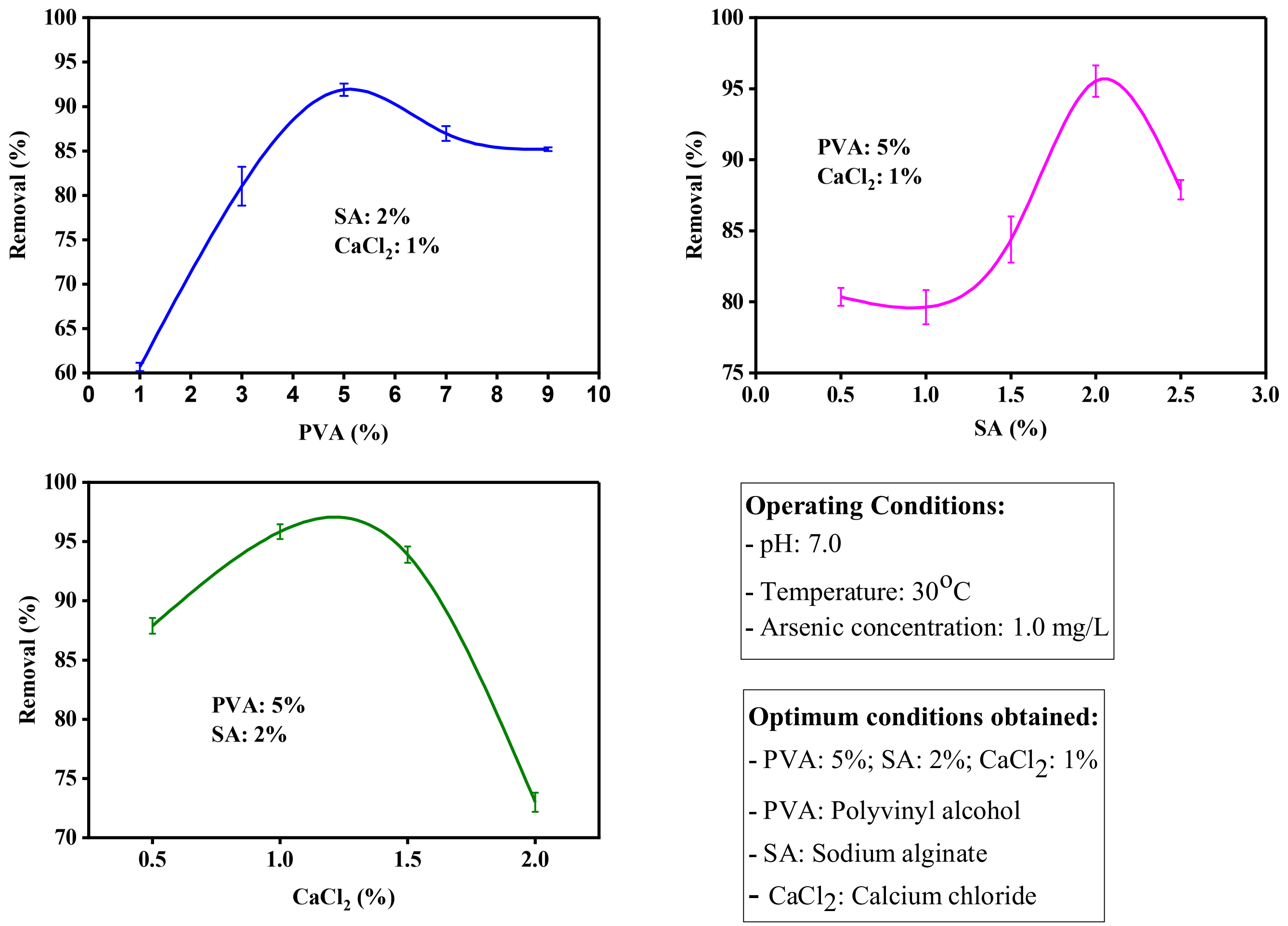


Figure D9: Parameter optimization for preparation of PVA-SA beads crosslinked with Ca^{2+}

Table D2: Water absorption capacity of beads

Day		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Water absorption (%)	IBK	0.21	0.86	1.18	5.07	5.82	5.82	5.82	5.82
	IBT	0.21	0.75	1.51	5.83	6.47	6.47	6.47	6.47

Appendix E

E1. Phylogenetic tree:

A phylogenetic tree, sometimes referred to as an evolutionary tree or cladogram, is a graphic that illustrates how a group of animals have evolved together based on similarities and differences in their morphological, genetic, or biochemical traits. To identify pollutant-degrading microorganisms, anticipate degradation routes, and optimize bioremediation procedures, phylogenetic trees are crucial in bioremediation investigations. By analyzing the evolutionary relationships and functional diversity of microbial communities, phylogenetic trees inform the selection of effective biodegrades, leading to more efficient and targeted cleanup efforts in contaminated environments.

E2. Isolate:

A single species or strain of bacteria that has been isolated using the proper media from a complex microbial community—such as soil, water, or a biological sample—is referred to as a bacterial isolate. After isolation, these bacteria can be investigated to learn more about their functions in biological processes such as bioremediation as well as potential industrial uses. Bacterial isolates are important because they can provide insightful information and practical applications in a variety of sectors and are vital for advancing scientific understanding of their use for environmental protection.

E3. Consortium:

A community of different bacterial species or strains living and interacting together in a given environment is called a bacterial consortium. This consortium is made up of various bacterial species with a range of physiological traits and metabolic capacities. Since a consortium of bacteria can remove or degrade pollutant at a faster than traditional approaches, they are essential for environmental cleanup. They offer cost-effective, environmentally friendly solutions, making them indispensable in pollution mitigation and site restoration efforts.

E4. Bioluminescence inhibition:

The production and emission of light by living things as a result of biochemical processes occurring within their cells is known as bioluminescence. Numerous animals exhibit this phenomenon, such as several types of protists, fungus, bacteria, marine invertebrates, and even terrestrial insects. An enzyme known as luciferase, oxygen, and the light-emitting chemical luciferin are all involved in the process. In the presence of oxygen, luciferin undergoes a chemical process that is catalyzed by luciferase, releasing energy in the form of light. Assays for bioluminescence inhibition provide quick toxicity evaluations for risk assessment and environmental monitoring. Bioluminescence inhibition assays are used in these investigations to quantify changes in light emission that occur after being exposed to potentially harmful chemicals. The inhibition of bioluminescence serves as an indicator of the toxicity of the test compounds. While bioluminescence itself is not directly involved in the bioremediation process, it can serve as a valuable tool for tracking and evaluating the effectiveness of bioremediation strategies.

E5. Acute toxicity:

Acute toxicity describes the harmful consequences resulting from a single or brief exposure to a material or agent, usually lasting up to 24 hours. The severity of acute toxicity can range from moderate, reversible effects to severe, perhaps fatal consequences, depending on dose, length of exposure, exposure route, and individual sensitivity. Evaluations of acute toxicity are crucial for making judgments about regulations, environmental safety, and human health. They offer vital information about the direct risks posed by chemicals, which helps to create safer goods, healthier communities, and environmentally sound activities.

E6. Chronic toxicity:

The term ‘chronic toxicity’ describes the deleterious effects of repeated or prolonged exposure to a chemical over a prolonged period of time, usually weeks, months, or years. Evaluating chronic toxicity is essential to comprehending the health hazards associated with extended exposure to hazardous materials. These studies help to improve public health outcomes, safer goods, and healthier environments by detecting long-term dangers and setting exposure limits. They play a critical role in assessing health risks, ensuring regulatory compliance, and safeguarding environmental health and biodiversity.

PUBLICATIONS

Publications in Indexed Journals

- **Kushwaha, R.,** Singh, R. S., and Mohan, D. (2024). Enhanced arsenic removal using biochar immobilized bacteria encapsulated in polyvinyl alcohol-sodium alginate beads: Fabrication, optimization and performance evaluation. *Journal of Water Process Engineering*, 64, 105569. https://doi.org/10.1016/j.jwpe.2024.105569
- **Kushwaha, R.,** Singh, R. S., and Mohan, D. (2023). Comparative study for sorption of arsenic on peanut shell biochar and modified peanut shell biochar. *Bioresource Technology*, 375, 128831. https://doi.org/10.1016/j.biortech.2023.128831
- **Kushwaha, R.,** Singh, R. S., and Mohan, D. (2023). Arsenic resistance and accumulation by two bacteria isolated from Ratanpur Village of Varanasi District, Uttar Pradesh. *Bioresource Technology Reports*, 24, 101639. https://doi.org/10.1016/j.biteb.2023.101639

Papers presented in conferences/seminars

- 'Bioremediation of arsenic in packed bed bioreactor using bacteria immobilized on polyurethane foam' in IIChe CHEMCON 2023 - An International Conference Energy Transition: Challenges and Opportunities – Heritage Institute of Technology, Kolkata (December 27-30, 2023)

- 'Comparative study for sorption of arsenic on peanut shell biochar and modified peanut shell biochar' in International Conference on Biotechnology for Sustainable Bioresources and Bioeconomy (BSBB-2022) – IIT Guwahati (December 07-11, 2022)

- 'Arsenic resistant and accumulation by two bacteria isolated form Ratanpur Village of Varanasi District' in Chem-Conflux22: International Conference on Technological Interventions for Sustainability – MNNIT Allahabad, Prayagraj (April 14-16, 2022)