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# Arsenic removal from drinking water by means of low cost biochars derived from miscanthus and coconut shell

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**Biochar: Production, Characterization and Applications**
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# ARSENIC REMOVAL FROM DRINKING WATER BY MEANS OF LOW-COST BIOCHARS DERIVED FROM MISCANTHUS AND COCONUT SHELL

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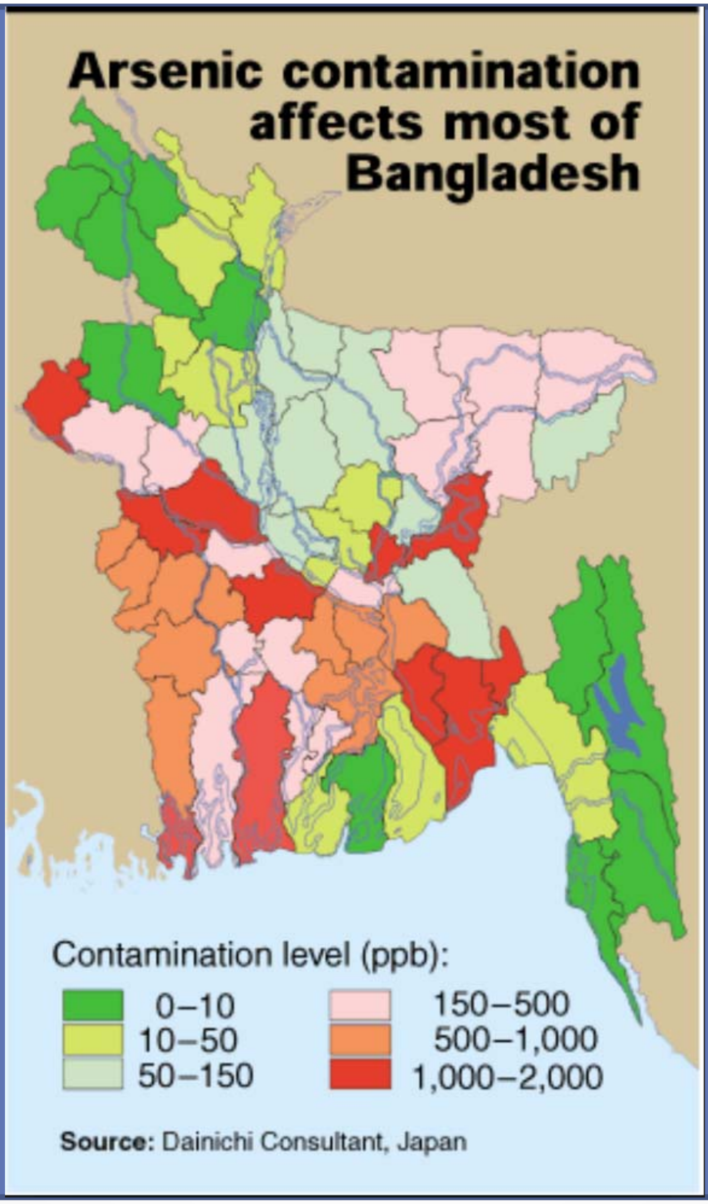
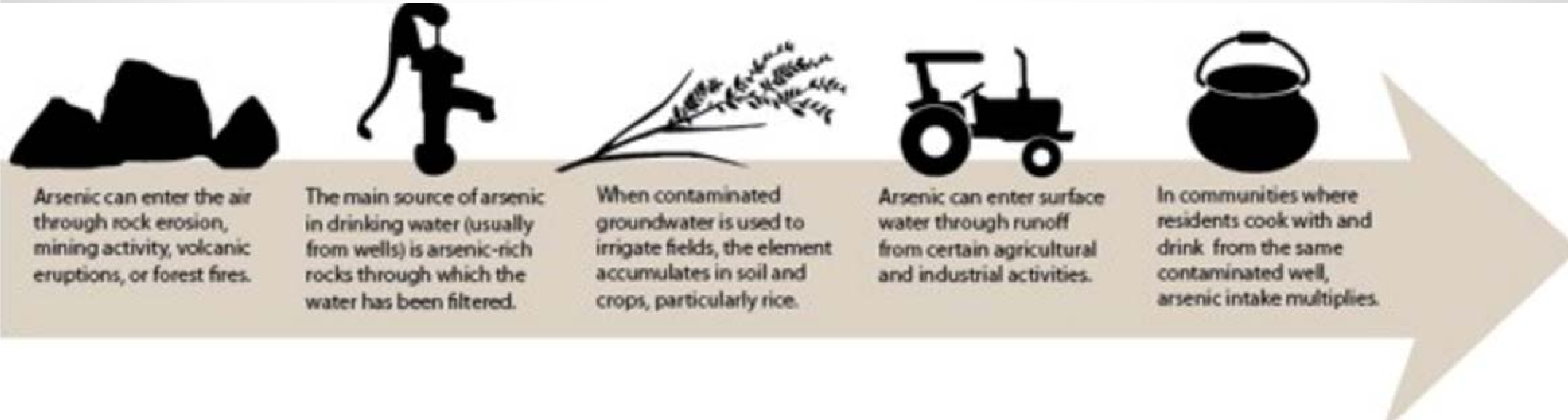
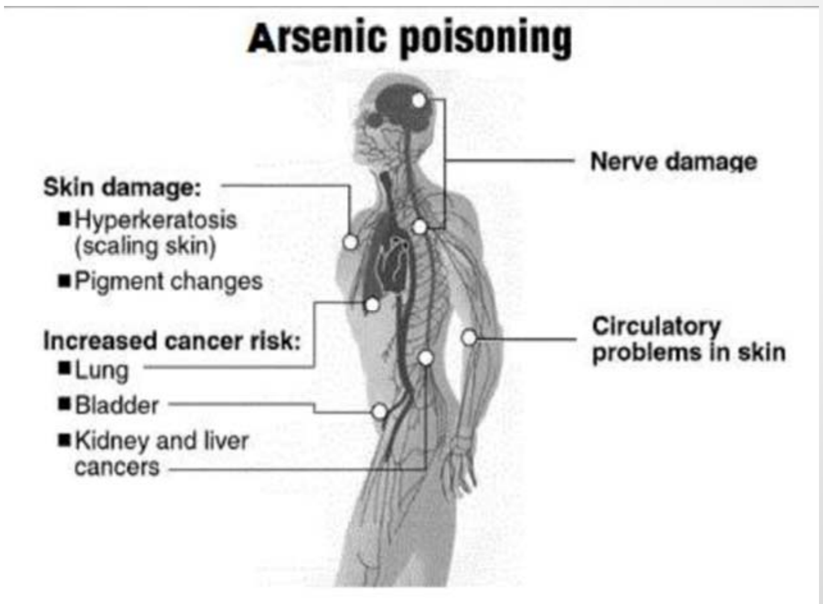
# ARSENIC POISONING OF GW (Conc >50 ppb)



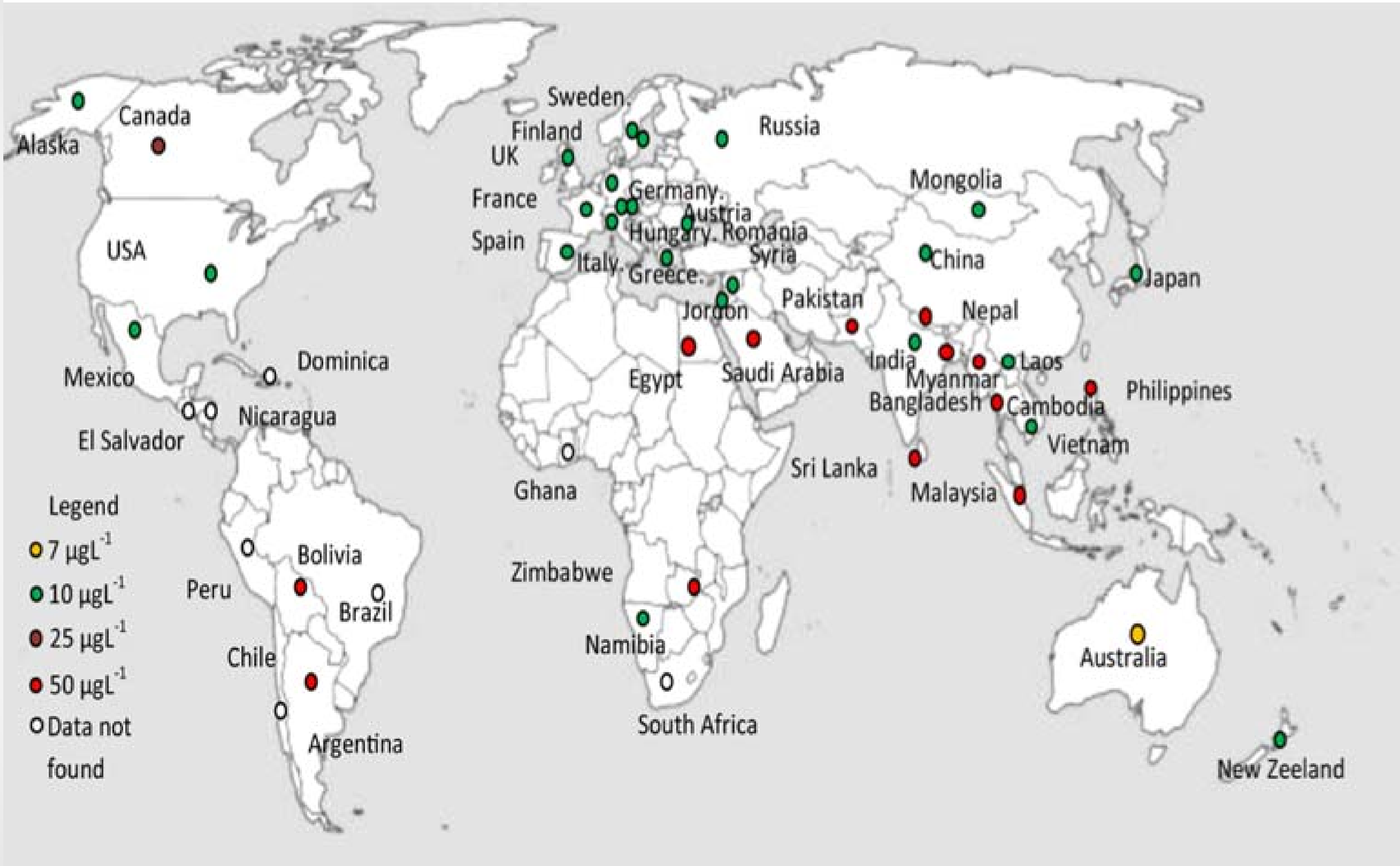
# ARSENIC toxicity and guidelines




- > 200 M people at risk of chronic poisoning
- IARC: group I
- WHO guidelines: 10 ppb



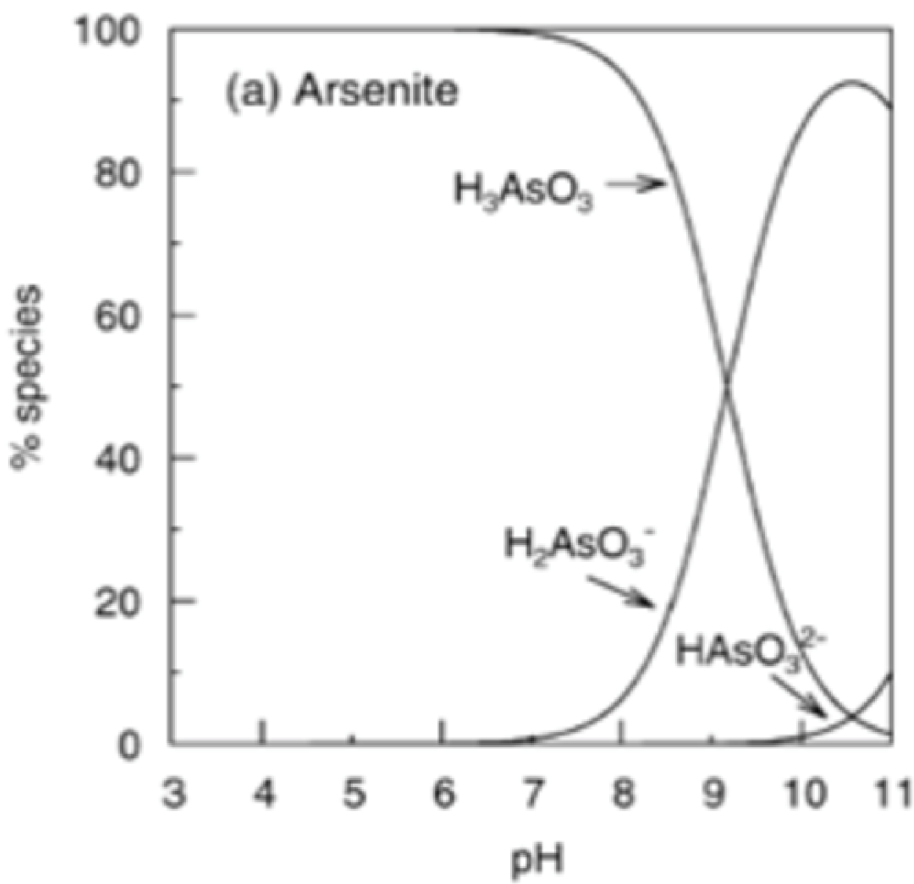
# MAXIMUM ALLOWED CONCENTRATION IN DW



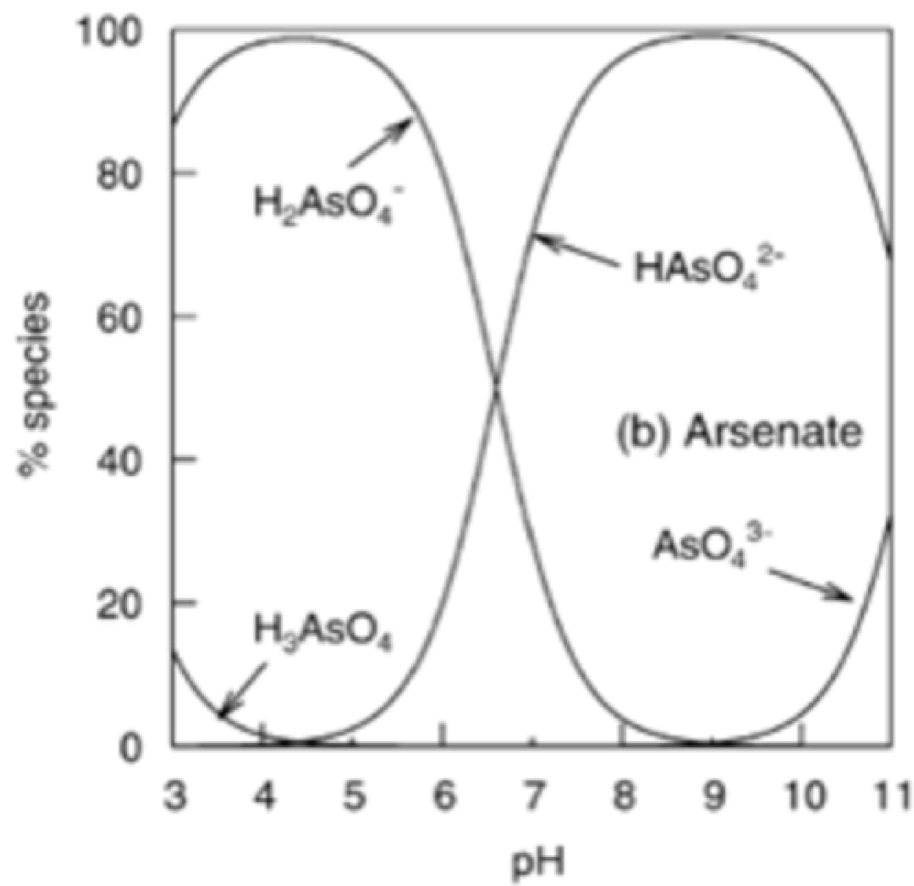
# ARSENIC SPECIATION IN WATER

TOXICITY

**As (III)** + ← - **As (V)**




a)




b)

# APPROACH AND AIM OF THE RESEARCH

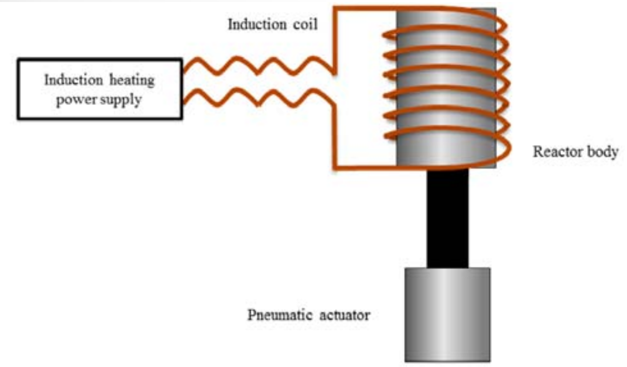
- **In Bangladesh 77 M people suffer the effect of As poisoning**

- **AIM**: find a simple and not expensive technical solution to lower As concentration below 50 ppb

- **APPROACH**: adsorption on a low-cost biochar deriving from a local biomass

# BIOCHAR PRODUCTION

Coconut shell + Miscanthus → NOT activated biochar




**Jiggled Bed Reactor (JBR)**

| feedstock | Temperature [°C] | time (h) | yield |
|---|---|---|---|
| Coconut Shell | 700 | 2 | 28 % |
| Miscanthus | 800 | 2 | 23 % |

# BIOCHAR CHARACTERIZATION

SPECIFIC SURFACE → PORES → ASHES → LEACHING

| | BET Analysis | Pores | | |
|---|---|---|---|---|
| | Specific Surface [$m^2/g$] | pore volume [$cm^3/g$] | pore dimension [Å] | ashes |
| commercial GAC | 1 339 | 0,646 | 19,310 | 2 % |
| Coconut Shell biochar | 428 | 0,212 | 19,781 | 2 % |
| Miscanthus biochar | 208 | 0,098 | 18,879 | 8 % |

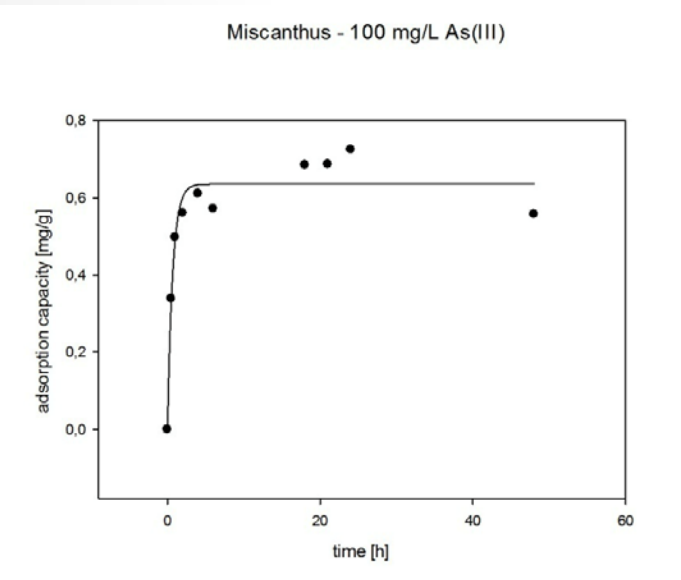
# ADSORPTION TESTS

EQUILIBRIUM TIME → ADSORPTION KINETICS → ADSORPTION ISOTHERMS → Na EFFECT

- **As (III)** - $NaAsO_2$ and $As_2O_3$
- **As (V)** - $HAsNa_2O_4$

BATCH TESTS:

- pH: **8**
- Temperature: **25 °C**
- S/L ratio: **1:10**




| $C_0$ = 100 mg/L | As | equilibrium time [h] |
|---|---|---|
| commercial GAC | III | 2 |
| Miscanthus | III | 18 |
| Coconut Shell | III | 6 |

# ADSORPTION TESTS

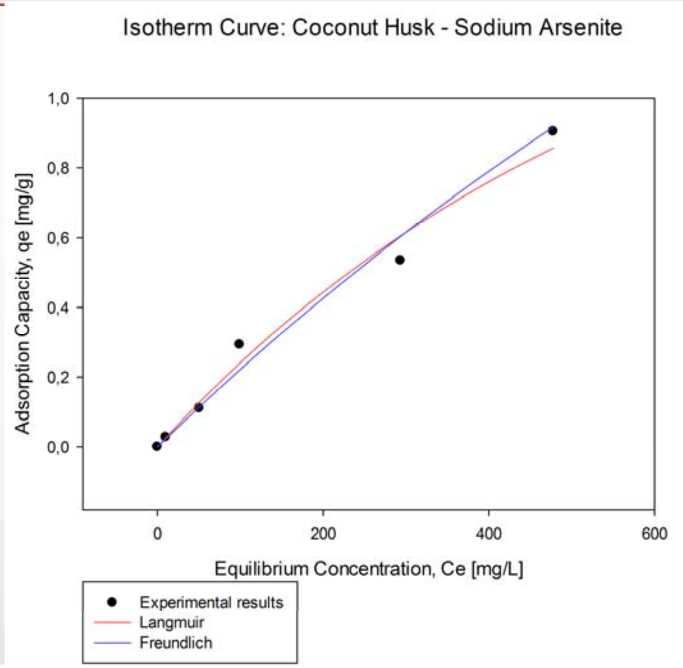
EQUILIBRIUM TIME → **ADSORPTION KINETICS** → ADSORPTION ISOTHERMS → Na EFFECT

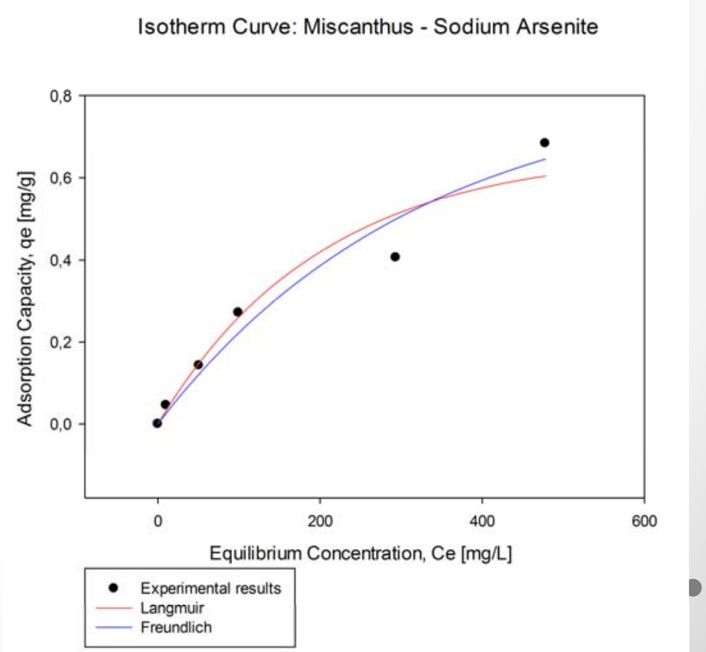
| $C_0$ = 100 mg/l<br>As(III) – $NaAsO_2$ | PSEUDO 1st ORDER | | PSEUDO 2nd ORDER | |
|---|---|---|---|---|
| | $R_I^2$ | $K_1$ [$min^{-1}$] | $R_{II}^2$ | $K_2$ [g/mg min] |
| Miscanthus biochar | 0,855 | 0,0196 | **0,994** | **0,1763** |
| Coconut Shell biochar | **0,964** | **0,0214** | 0,447 | 0,0468 |

# ADSORPTION TESTS

EQUILIBRIUM TIME → ADSORPTION KINETICS → **ADSORPTION ISOTHERMS** → Na EFFECT

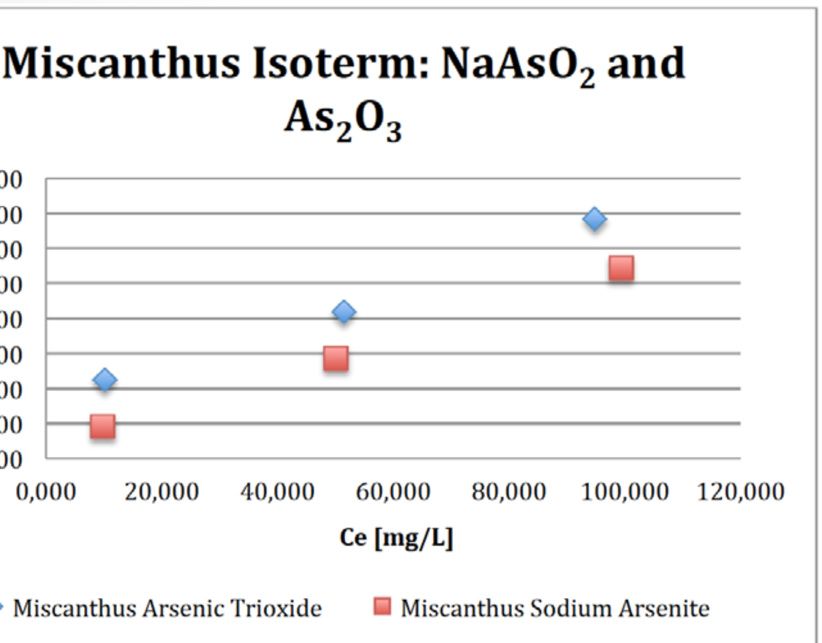
| As(III) – $NaAsO_2$ | FREUNDLICH | | | LANGMUIR | | |
|---|---|---|---|---|---|---|
| | $R^2$ | $K_F$ [mg/g] | n | $R^2$ | $K_L$ [L/mg] | $q_0$ [mg/g] |
| commercial GAC | 0,988 | 0,0036 | 1,1179 | 0,611 | 0,0010 | 2,6123 |
| Miscanthus biochar | **0,987** | **0,0102** | **1,4806** | 0,849 | 0,0039 | 0,9365 |



# ADSORPTION TESTS

EQUILIBRIUM TIME → ADSORPTION KINETICS → ADSORPTION ISOTHERMS → **Na EFFECT**




Adsorption capacities for Miscanthus and sodium arsenite and arsenic trioxide

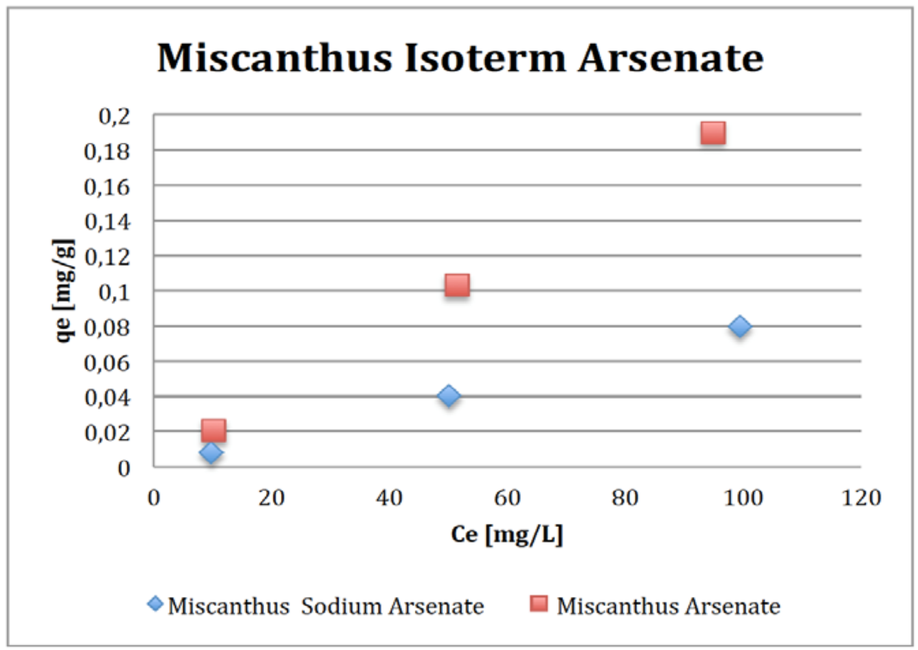



Chart 5.20 - Adsorption capacities for Miscanthus and sodium arsenate and arsenate

# CONCLUSIONS

**SORPTION** could be an interesting solution for As removal

**BUT** other biomasses should be investigated as low-cost biochar feedstocks

**Mischantus biochar** could be used as **pre-treatment** to reduce As concentration

**Sodium effect** should be quantified through further studies

**Column tests** are necessary for a reliable assessment