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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 REMOVAL FROM DRINKING WATER BY MEANS OF LOW-COST BIOCHARS DERIVED FROM MISCANTHUS AND COCONUT SHELL

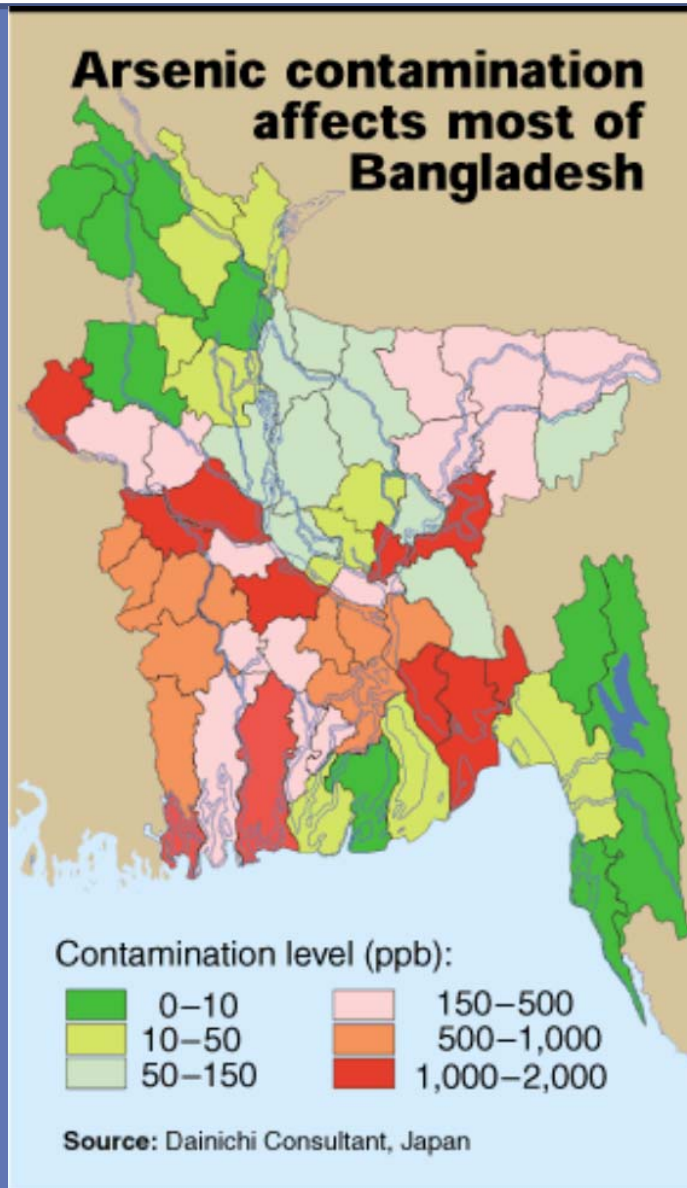
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ARSENIC POISONING OF GW (Conc >50 ppb)



ARSENIC toxicity and guidelines



Arsenic can enter the air through rock erosion, mining activity, volcanic eruptions, or forest fires.



The main source of arsenic in drinking water (usually from wells) is arsenic-rich rocks through which the water has been filtered.



When contaminated groundwater is used to irrigate fields, the element accumulates in soil and crops, particularly rice.



Arsenic can enter surface water through runoff from certain agricultural and industrial activities.

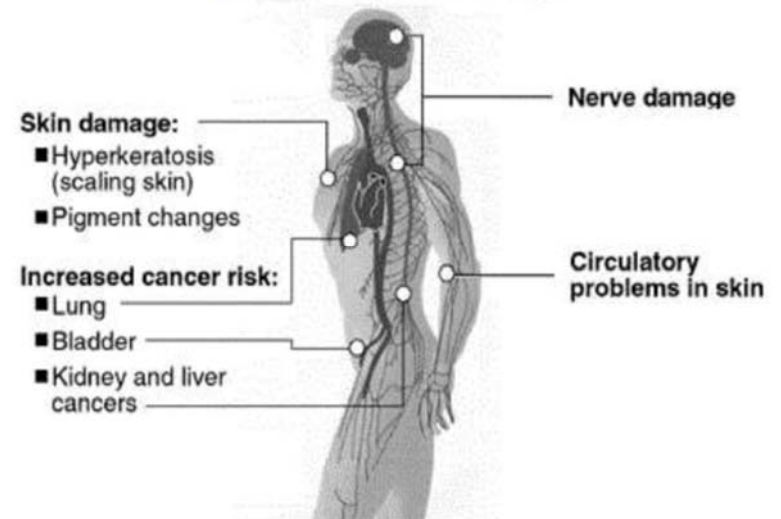


In communities where residents cook with and drink from the same contaminated well, arsenic intake multiplies.



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

Arsenic poisoning

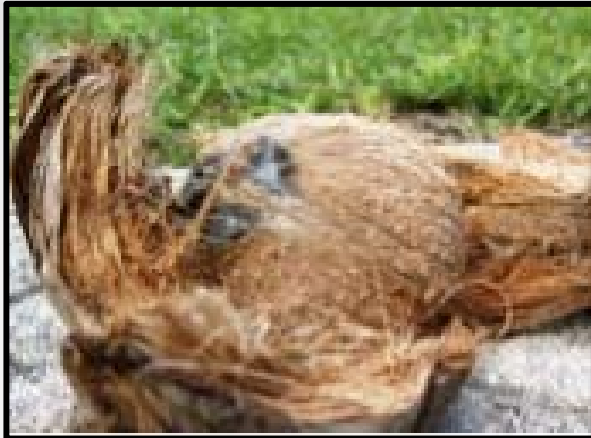


APPROACH AND AIM OF THE RESEARCH



- **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

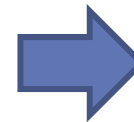
BIOCHAR PRODUCTION



Coconut shell

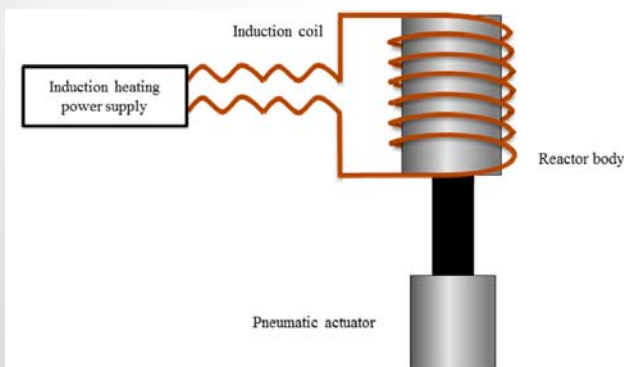


+ Miscanthus



NOT activated biochar

Jiggled Bed Reactor (JBR)



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

BIOCHAR CHARACTERIZATION



	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

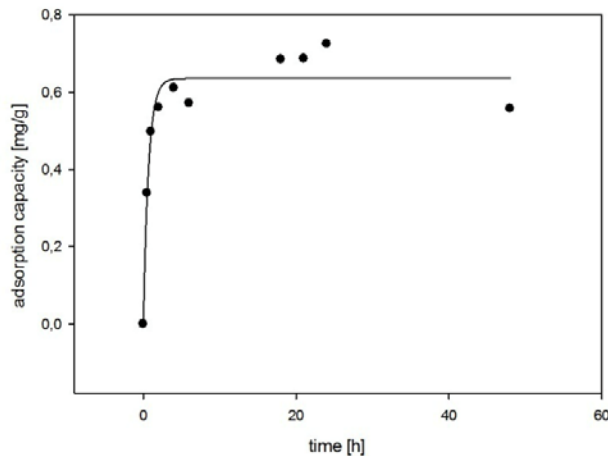
Na EFFECT

- 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

Miscanthus - 100 mg/L As(III)



$C_0 = 100 \text{ mg/L}$	As	equilibrium time [h]
commercial GAC	III	2
Miscanthus	III	18
Coconut Shell	III	6

ADSORPTION TESTS

EQUILIBRIUM
TIME

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ISOTHERMS

Na EFFECT

$C_0 = 100 \text{ mg/l}$ 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

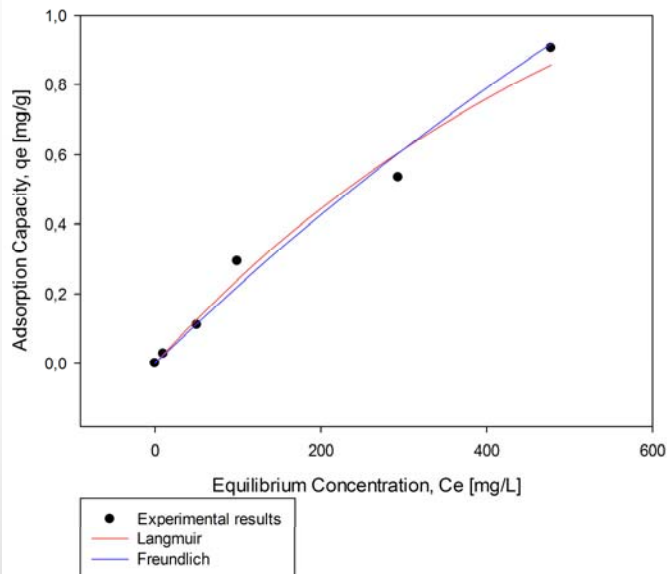
ADSORPTION
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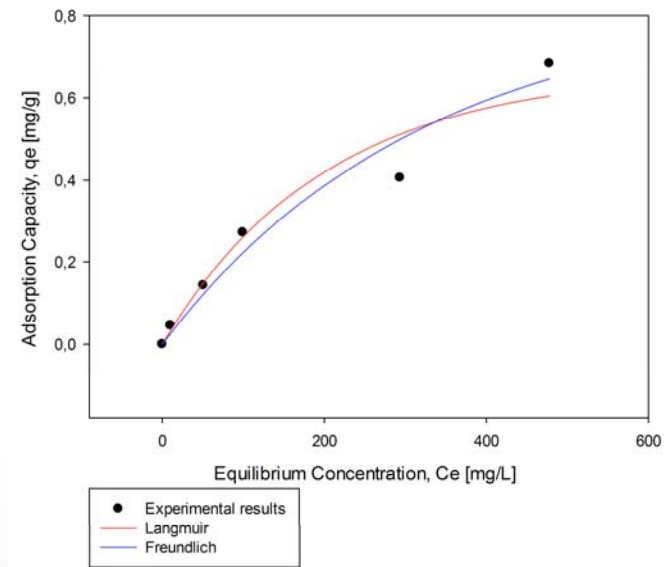
Na EFFECT

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

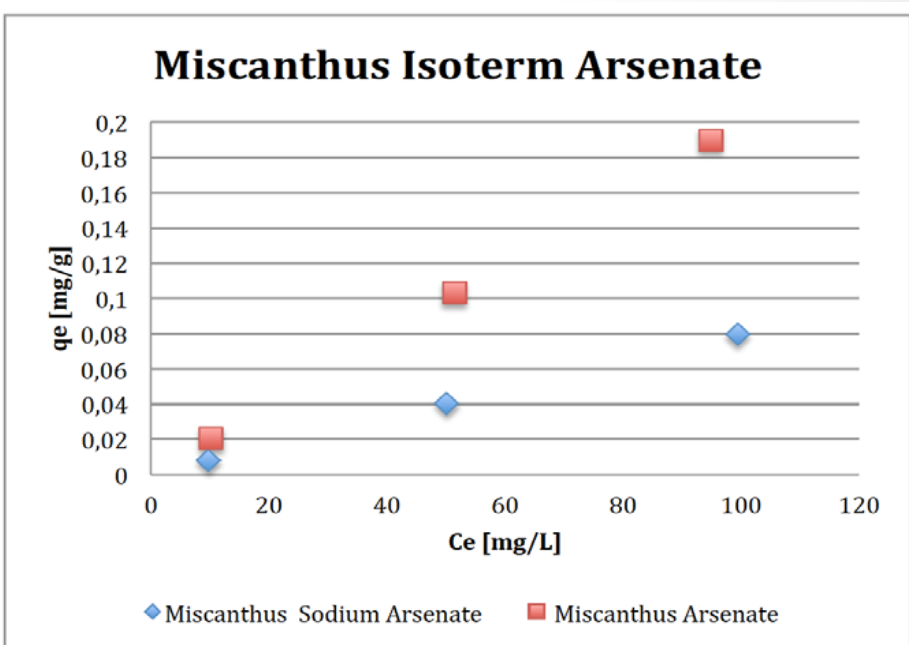
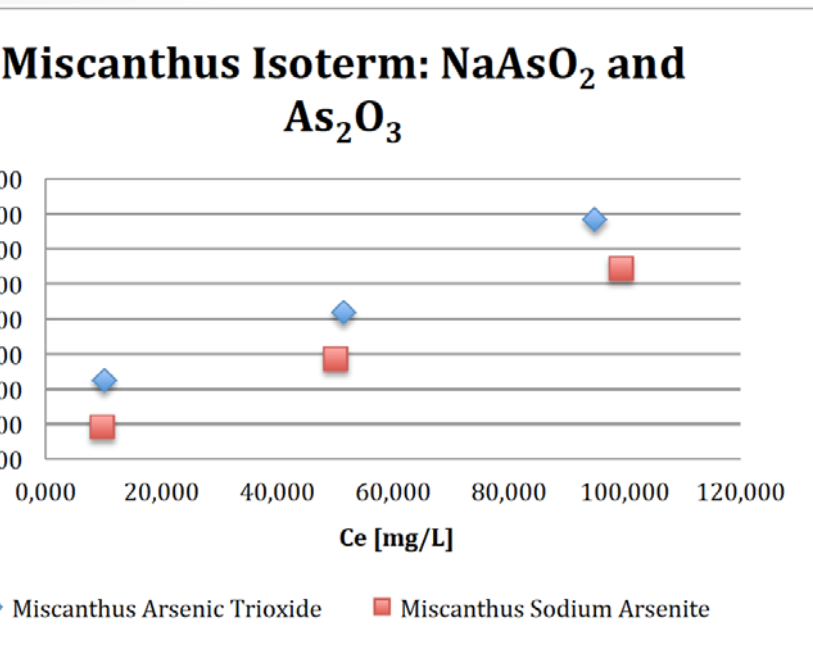
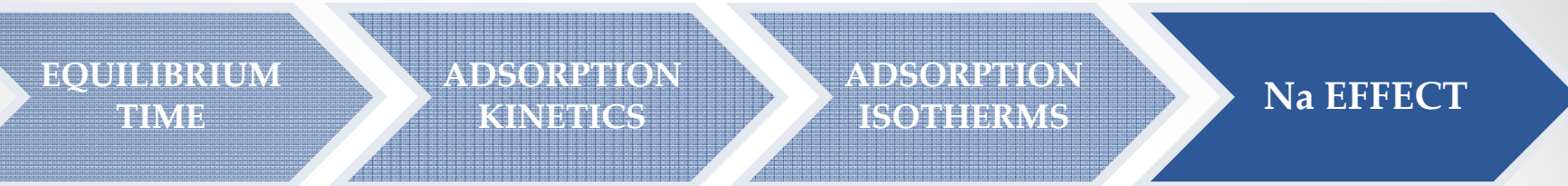
Isotherm Curve: Coconut Husk - Sodium Arsenite



Isotherm Curve: Miscanthus - Sodium Arsenite



ADSORPTION TESTS



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



DRINK