Treatment of Raw Domestic Waste Using Plant-Based Adsorbents

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Innosphere Conference, October 5th 2024

Outline

Introduction

Problem Statement

- 380 billion cubic metres of domestic wastewater is produced annually
- Only 56% is treated properly
- Untreated wastewater affects public health, water bodies, soil quality, etc.

Objective

- To use plant-based, natural adsorbents for domestic wastewater treatment
- More environmentally friendly, easily accessible to the community

Why It Matters

- Eco-friendly wastewater management → reduce reliance on chemical treatment systems
- Untreated wastewater contaminates water bodies
- Cost effective

Literature Review

Current Conventional Methods of Wastewater Treatment

- WWTPs
  - Capital intensive
  - Biological treatment & chemical coagulation
- Decentralised treatment systems
  - Smaller scale
  - Utilise constructed wetlands

Limitations of Conventional Methods of Wastewater Treatment

- High costs and maintenance fees
- Require large areas of land, unfeasible in urban areas

Materials

Plant based adsorbents: Spent tea, charcoal, sawdust

- High surface area and porosity
- Functional groups (-OH and-COOH) enhance ability to absorb
- Can act as cation exchangers
- Non-toxic & biodegradable

Typical pollutants of raw domestic wastewater

- BOD and COD → organic pollutants and matter
- Nutrients from food waste, cleaning products, etc.
- Bacteria, viruses, parasites
- FOG

Methods

Experimental Setup

- Modified plastic bottle
- Layers of adsorbent materials added
- Wastewater poured through and filtered into beaker

Analytical Technique

- The following water parameters were tested before and after treatment using JalTARA Water testing kit:
  - Physical: pH, Turbidity and Hardness
  - Chemical: Chloride, Fluoride, Iron, Nitrate

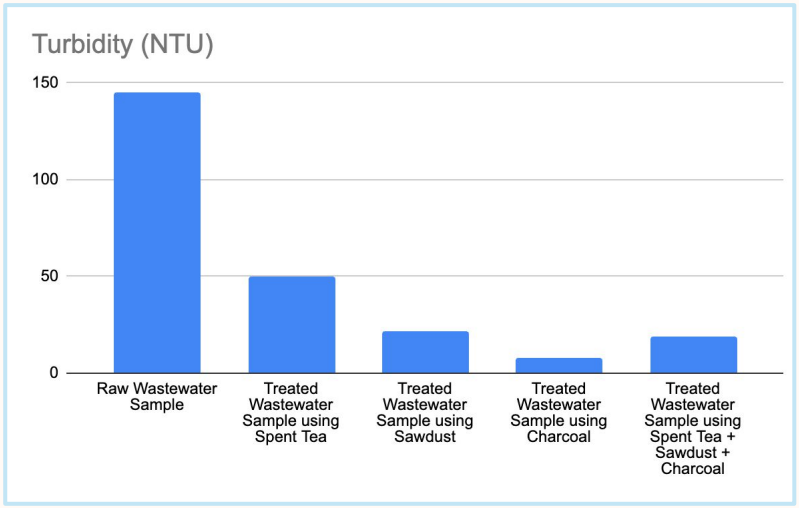

turbidity
pH

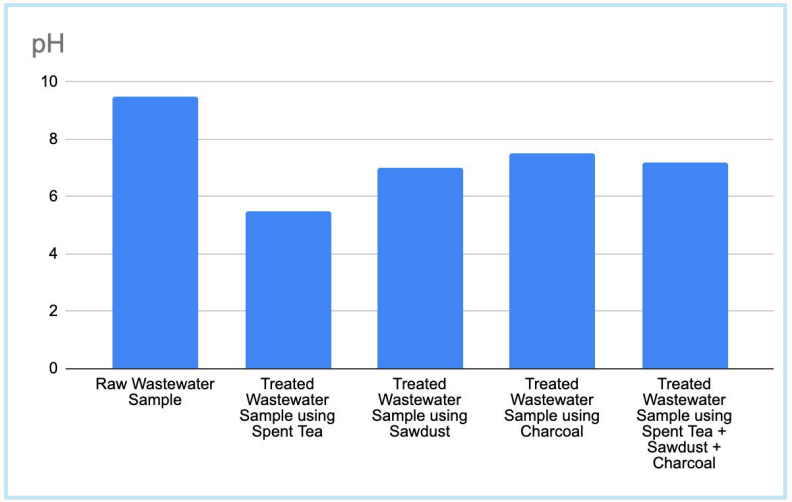

Jar water + fluoride check @ 12:18
pan fluoride check @ 12:59
charcoal fluoride check @ 12:55
milk fluoride check @ 12:53
original fluoride

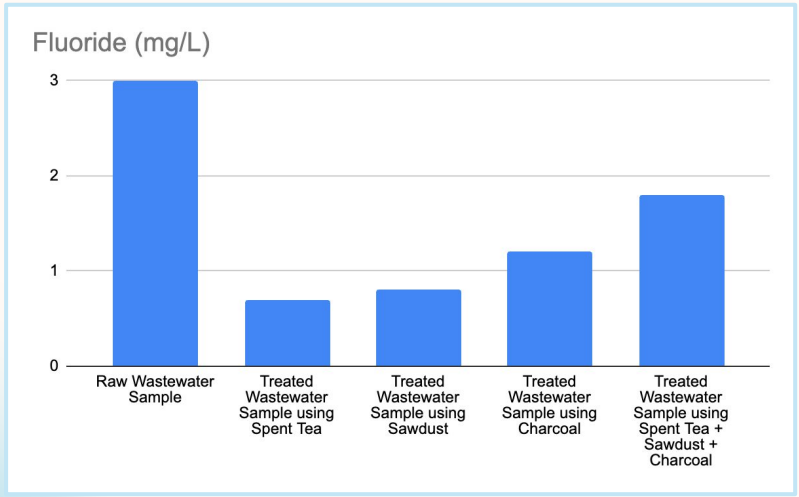

5ml

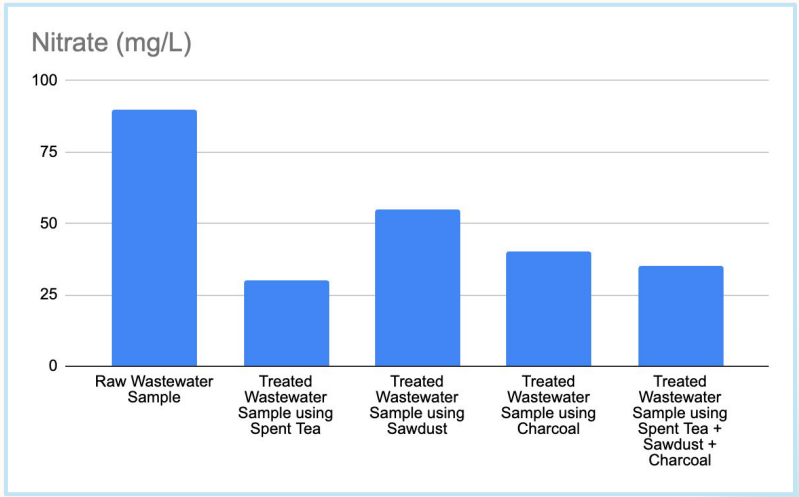
Results

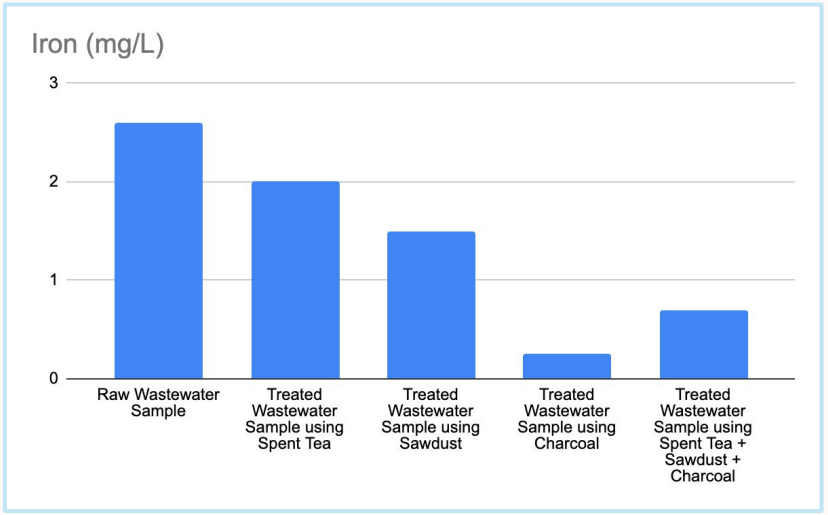
Sr. No.	Parameter	Drinking water	Raw Wastewater Sample	Treated Wastewater Sample using Spent Tea	Treated Wastewater Sample using Sawdust	Treated Wastewater Sample using Charcoal	Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal
1	pH	6.5-8.4	9.5	5.5	7	7.5	7.2
2	Turbidity (NTU)	5-10	145	50	22	8	19
3	Fluoride (mg/L)	1-1.5	3	0.7	0.8	1.2	1.8
4	Nitrate (mg/L)	45	90	30	55	40	35
5	Iron (mg/L)	0.3-1.0	2.6	2	1.5	0.25	0.7
6	Hardness (mg/L)	300-600	800	690	450	580	500
7	Chloride (mg/L)	250-1000	1200	1250	230.425	709	650

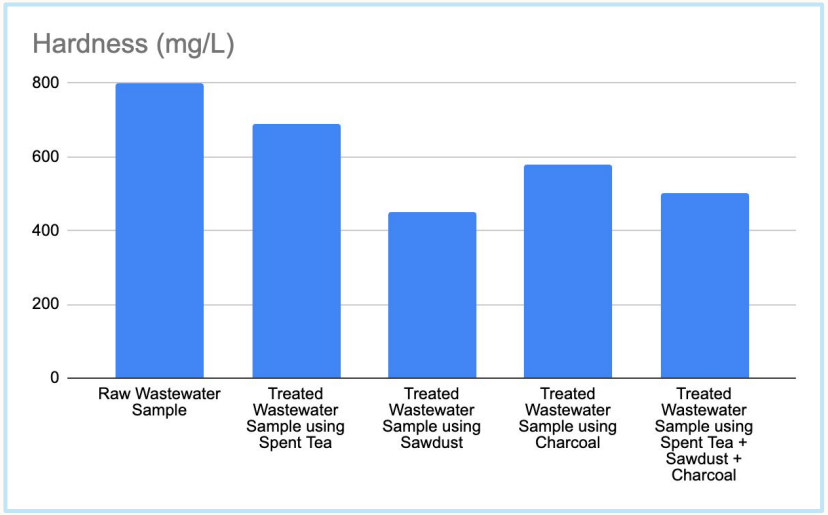

Turbidity (NTU)
150
100
50
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal

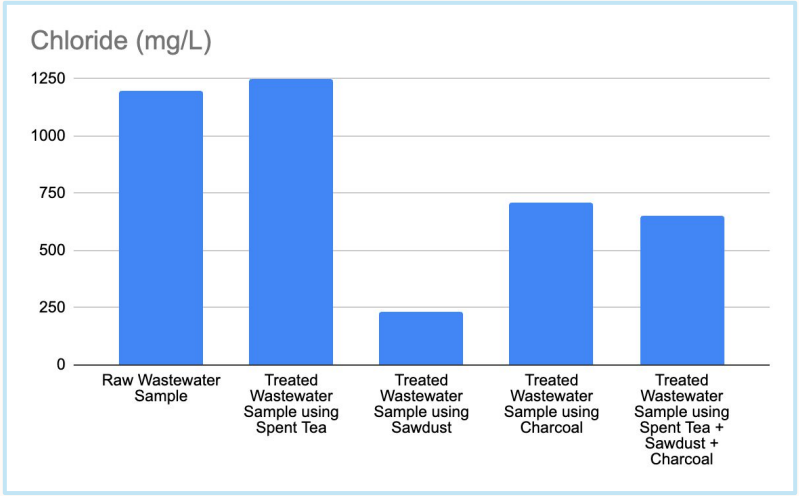

pH
10
8
6
4
2
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal


Fluoride (mg/L)
3
2
1
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal


Nitrate (mg/L)
100
75
50
25
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal


Iron (mg/L)
3
2
1
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal


Hardness (mg/L)
800
600
400
200
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal


Chloride (mg/L)
1250
1000
750
500
250
0
Raw Wastewater Sample
Treated Wastewater Sample using Spent Tea
Treated Wastewater Sample using Sawdust
Treated Wastewater Sample using Charcoal
Treated Wastewater Sample using Spent Tea + Sawdust + Charcoal

Discussion

Analysis

- Charcoal most efficiently removed turbidity (145 → 8 NTU), likely due to its porous structure which is excellent at trapping particulate matter
- Spent tea reduced pH and fluoride significantly, due to its acidic nature
- Sawdust reduced hardness, effective in adsorbing calcium and magnesium ions
- The combination of adsorbents was not always as successful as the individuals, possibly due to competition between adsorbents for active sites

Sustainability benefits

- Plant based adsorbents are eco-friendly in nature
- Renewable
- Biodegradable: ensuring minimal negative impact after use

Challenges and Limitations

Challenges

- Availability of these materials could fluctuate seasonally or be difficult to acquire in bulk
- Existing facilities may not be equipped to handle these adsorbents
- Initial startup costs and transportation costs could be high

Limitations

- Focused on three adsorbents only
- Minimal trials

Improvements

- Assessing a wide range of adsorbent materials
- Conducting long-term, more thorough experiments
- Cost-benefit analysis to truly understand viability

Conclusion

Summary

- Plant based adsorbents are effective in treating domestic wastewater
- Quantitatively, charcoal as an adsorbent was the most effective overall

Future Steps

- Large-scale testing in a lab
- Exploring different combinations of adsorbents
- Expanding scope for different industries
- More in depth research

References

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Acknowledgements

Dr. Rohan Louis D'Souza

Athena Education