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Research Article

# HEAVY METAL AND FLUORIDE REMOVAL FROM SYNTHETIC WATER TREATED WITH *DHAVA* (*ANOGEISSUS LATIFOLIA* WALL.) BARK ASH

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## ABSTRACT

Being a universal solvent, water is a major source of contamination. According to the World Summit of Sustainable Development, the major reason for lack of safe water is either scarcity of water or contamination of water sources. The quality of water is vital concern for the man kind as it is directly linked with human welfare. A**im and Objective:** To evaluate the *Jala Shodhana* properties of *Dhava* (*Anogeissus latifolia* Wall.) stem bark ash. **Material and method:** Authentification and collection of *Dhava* bark was done from renowned source. *Dhava* bark was calcinated in Muffle furnace and used for the further study. The filter was prepared by using sand, gravel and *Dhava* bark ash. Synthetic water sample prepared by adding Arsenic trioxide, lead acetate, Calcium fluoride and Mercury-II Sulfate. This synthetic water was analyzed by Atomic Absorption Spectrometry, to know the percent removal of Heavy metals and fluoride after the treatment by *Dhava* bark ash filtering apparatus. Result- The *Dhava* stem bark (filtering apparatus) shows significant result in removal of mercury (99.8%), lead (99.9%), Arsenic (34.18%) and Fluoride (57.05%) from water. **Discussion:** The present study was undertaken to assess the efficiency and pollution reduction potential of sand intermittent filtration technology in term of heavy metal. Filtration can be compared to a sieve or micro-strainer that traps suspended material between grains of filter media In this present research work efforts have been made to develop a low cost and low maintenance model of Bio-sand intermittent filtration for treatment of *Dushita Jala*. (BIO= Stem bark of *Anogessious latifolia*). **Conclusion:** This study proves the statement of *Acharya Sushruta* about *Jala shodhana* properties of *Dhava* described in *Kalpa sthana Tritiya Adhyaya.* Therefore our study will leads to the development of Bio-sand filter which is cost-effective without chemical operation and environmental friendly technology for water and waste water treatment.

## INTRODUCTION

Being a universal solvent, water is a major source of contamination. According to world health organization (WHO) 80% diseases are water borne. Drinking water in various countries does not meet WHO standards[1].

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3.1% deaths occur due to the unhygienic and poor quality of water.[2] Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water by untreated sewage in developing countries.[3]

Pollution has increased at a rapid rate in recent years due to continuous automation of today's society. Metals like lead, zinc, arsenic, copper, mercury and cadmium in industrial waste water have many adverse effects on humans and other animals like immune suppression, reproductive failure and acute as well as chronic poisoning. Beside these arsenic causes skin cancer, mercury causes mental

derangement and Minamata disease in humans and dropsy in fishes, Lead causes anemia and Burton's line on gums and Cadmium causes lung cancer and Itai-Itai disease.[4]

Traditional methods for removal of heavy metals include sedimentation, electrolysis, evaporation and solvent extraction. These methods have multiple drawbacks such as multistep procedure, high cost and use of toxic chemicals. Biosorption is an easy, environmentally friendly and efficient technique for abatement of many toxic impurities including heavy metals.

*Dhava* (*Anogeissus latifolia* Wall.) stem bark ash is a novel biosorbent material and has been reported in the literature for the purification of water (*Dushit Jala Shodhana*).[5]

**_Dhava_ Plant (_Anogeissus latifolia_ Wall.) - Botanical Description**[3]

***Dhava* (*Anogeissus latifolia* Wall.)**

A tree, upto 33.0m high, leaves elliptic-obtuse with red petiole, entire, rounded at both ends, flowers minute, greenish yellow, in globose heads on short axillary peduncles. Fruits are yellowish- brown or reddish- brown, small, shining, beaked, winged, one seeded. Seeds wedge shaped.

**Distribution**

Sub-Himalayan tract and Shiwalik hills and in the hills throughout India, ascending to 1200m.

**Parts Used:** Bark, fruit, leaf, gum, root.

**Cyclicity**[7]

**Flowering and Fruiting**

**Leaf fall –** February – May

**Flowering** – June – September

**Fruiting** – December - March

**Reproduction**

Propagation Technique

Soak seeds in cold water for 24 hours.

**Dispersal**

**Dispersers:** Wind

**Pollinators**: Bee, Insect.

Here in, we have prepared *Dhava bark* charcoal for the biosorption of heavy metals from synthetic water solution. Biosorption process variable were investigated for the highest heavy metals elimination.

**MATERIAL AND METHODS**

In the present investigation we applied an experimental method design to evaluate the effectiveness of the filter media such as different proportion of sand, gravel and *Dhava* bark ash.

The sample was analyzed on the following parameter viz., mercury, lead, arsenic and fluoride, before and after the filtration which was done using bio-sand intermittent filtration technology.

**Plant Identification**- The plant materials taken for the authentication was genuine sample of *Dhava* [*Anogeissus latifolia* Wall]. The authentication of sample was done by Dravya Guna Department of Rishikul Campus, Haridwar (DG-RC-UAU-26).

**Plant Collection-** *Dhava* [Anogeissus *latifolia* Wall] was collected from *Chandi Devi* hills *Shyampur* forest range, Haridwar (U.K)

**Preparation of Bark Ash-** The calcinations of collected plants bark done in Muffle furnace at Hans Pharmacy Pvt. Ltd Sidkul, Haridwar.

**Step 1**- *Dhava* were collected from Chandi Devi hills Shyampur forest range.

**Step 2**- They were dried in Sunlight for 7 days.

**Step 3**- Dried bark weight of *Dhava* was 4.56Kg.

**Step 4**- The calcinations of dried bark was done in muffle furnace.

**Step 5**- Bark was kept in *Sarav-samput* (earthen pot with lid) and placed in furnace.

**Step 6**- Desired temperature or set temperature of furnace was 550°C for 120 minutes.

**Step 7**- Weight of bark after Calcination was about 2.6K.g.


**Preparation of *Dhava* (*Anogeissus latifolia* Wall.) bark ash in Muffle Furnace**

**Table1: Analytical Description of *Dhava* Bark Ash**

| S.no. | Test Parameters | *Dhava* Bark ash | Method reference |
|---|---|---|---|
| 1 | Appearance | A light blackish coloured coarse bark chips | Visual |
| 2. | Odour | Odourless | Smell |
| 3. | Taste | Tasteless | Taste |
| 4. | Touch | Brittle solid | Touch |
| 5. | pH | 8.27 | API |
| 5. | Loss on drying | 2.90 | API Part II, Vol-1, Appendices-2.2.10 |
| 6. | Total ash | 23.11 | API Part II, Vol-1, Appendices-2.2.3 |
| 7. | Acid insoluble ash | 1.05 | API Part II, Vol-1, Appendices-2.2.4 |
| 8. | Water soluble extractive | 2.15 | API Part II, Vol-1, Appendices-2.2.8 |
| 9. | Alcohol soluble extractive | 0.26 | API Part II, Vol-1, Appendices-2.2.7 |

**Design of Filtering Apparatus:** The filtering apparatus was based on intermittent sand filter method. (Material required for making apparatus).

- Bark ash coarse grinded particle
- Sand
- Gravel
- Markin Cloth
- Cotton
- Bisleri Bottles (1 litre)
- Apparatus holding Stands
- Containers fitted with tap (5 lit. Capacity)

**Preparation of Layers**

**Bark Ash Layer:** Bark ash coarse grinded, sieved and washed with tap water and distil water respectively. (Size bark ash Fenugreek seed)

**Sand Layer:** Sand was sieved to separate the large particle and other impurities.

Sand was washed with water and then dried.

**Gravel Layer:** Gravel was washed with water and then dried.

**Note:** Size of sand particles was about 100-200$\mu$ (sieve size = 100 – 200), size of gravel was about 2mm.

**Method of Preparing Filtering Apparatus**

**Step-1** Filtration apparatus was made by using empty Bisleri water bottles.

**Step-2** In brief, a tiny hole was made in the cap of the bottle and bottle was cut down from the bottom.

**Step-3** Bottle was inverted upside down.

**Step-4** To fabricate the filtration apparatus, cotton was placed near the neck of bottle.

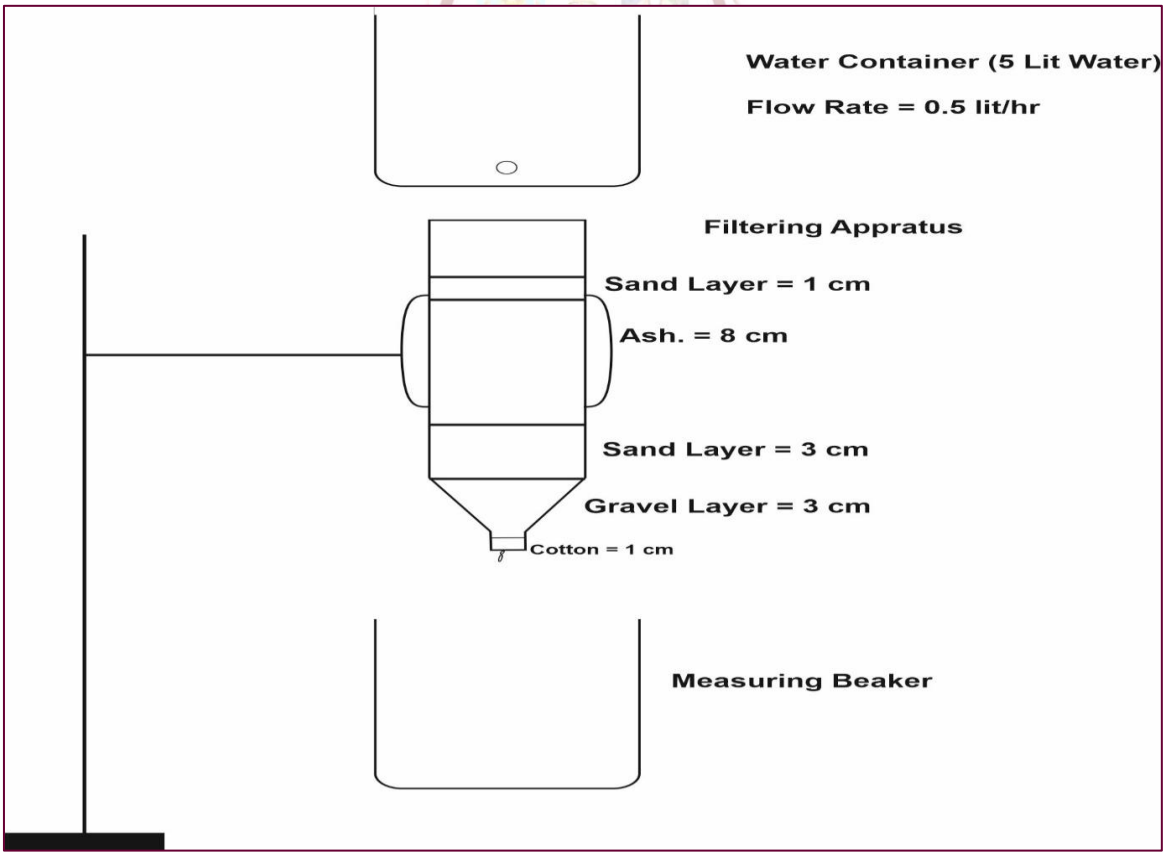
**Step-5** Afterwards, Gravel, sand, markin cloth, charcoal or bark ash, markin cloth, sand layer was filled respectively, after the cotton layer.

**Length of layers were** – (Upward down)

**Table 2: Showing Layers Arrangement in Filtering Device**

| S.no. | Layers | *Dhava* bark ash |
|---|---|---|
| 1. | Top layer | Sand layer=1cm |
| 2. | Second layer | Bark Ash= 8cm |
| 3. | Third layer | Sand layer= 3cm |
| 4. | Fourth layer | Gravel layer= 3cm |
| 5. | Cotton Layer | Diameter=1cm<br>Thickness= 1cm |

**Model of Filtering Procedure**



**Sampling Programme and Analysis**

Sampling and testing had been Carried out as per the standard methods prescribed in APHA (2011) and Trivedi and Goel (1986), Khanna and Bhutiani (2011) for the examination of the water and polluted water.

Samples was prepared by adding known amount of Mercury-II sulphate, Lead Acetate, Arsenic trioxide, Calcium fluoride in 5 litre distil water in sterile plastic canes.

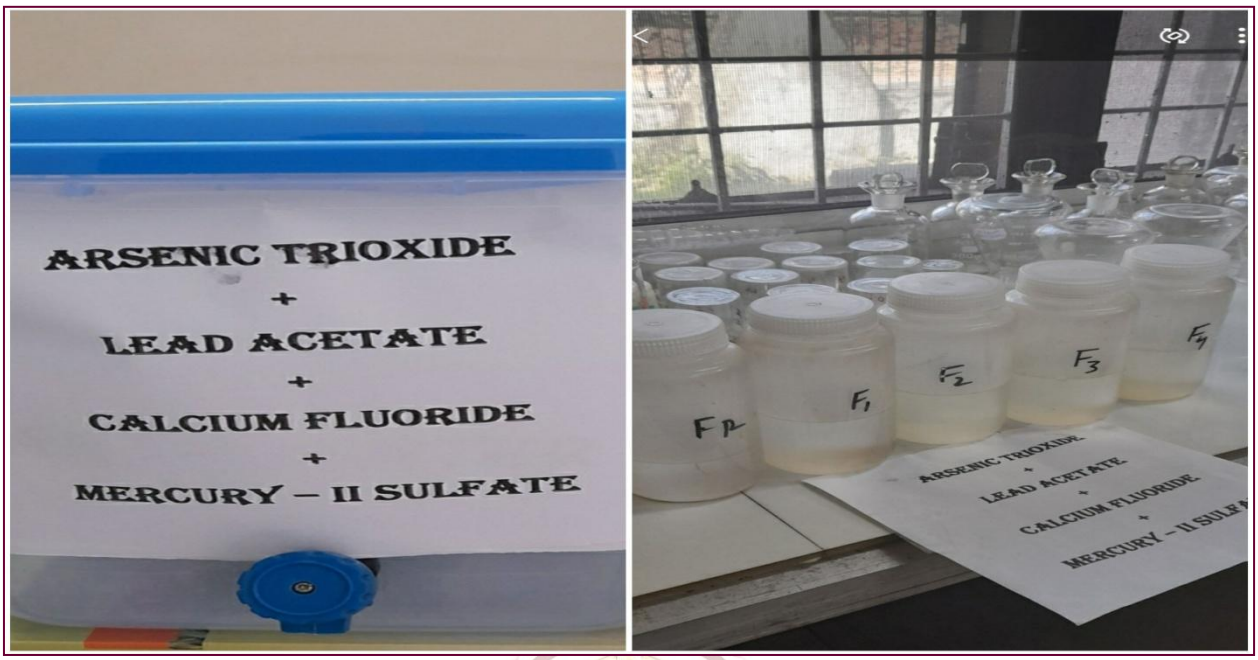



**Table 3: showing description of samples/Sampling site/ month of sampling/Analysis of sample**

| S.No. | Sample Name | Sampling Site | Month of Sampling | Analysis of Sample | Method of Analysis |
|---|---|---|---|---|---|
| 1. | Synthetic Water | Limnology lab. Enviromental Sciences, Gurukul Kangari | January 2021 | Simsa Labs, New Delhi | Atomic absorption spectrometry (AAS) |

**RESULT AND DISCUSSION**

The Bio-sand intermittent filtration system is a highly biologically active unit. The result of heavy metal percent removal was given in table given below

**Table 4: Showing Percent Removals of Metals after Treatment with *Dhava* bark filtering device**

| | Mercury | Lead | Arsenic | Fluoride |
|---|---|---|---|---|
| Untreated Synthetic water | 130.13 | 121.8 | 259.38 | 3.12 |
| Treated with *Dhava* Bark ash | 0.16 | 0.10 | 170.75 | 1.34 |
| Unit | mg/l | mg/l | mg/l | mg/l |
| % Removal | 99.8 | 99.9 | 34.18 | 57.05 |

The effects on removal of heavy metal from water are promising and encouraging.

There are organic and inorganic chemical constituents of *Dhava* bark ash might be responsible for decreased level of heavy metal like Hg, Pb, As and Fluoride.

**CONCLUSION**

*Dhava* is abundantly and easily available plants having medicinal properties. In our study, we focused its water purifying potential. *Acharya Sushrut* described 9 plants and much other process for purification of *Dhushita Jala, Dhava* is one of them.

The effect of *Dhava* bark ash has excellent potential to remove heavy metals from water.

The study about chelating property of *Dhava* can be carried out because of good results in heavy metal reduction especially in Hg, Pb and As.

This study also proves the statement of *Acharya Sushruta* about *Jala Shodhana* properties of *Dhava.*

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