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# Utilization of Lapsi seed stone (*Choerospondias Axillaris*) as source of activated charcoal for removal of arsenic

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*People inhabited in Terai region of Nepal use ground water as the main source of drinking water that are contaminated with arsenic at concentration level higher than guide line value set by WHO. The arsenic in the ground water is originated from the dissolution of naturally occurring arsenic containing minerals. Nepal, being a poor country, cannot afford to adopt costly and sophisticated technology to remove arsenic. Adsorptive removal of arsenic utilizing the activated charcoal prepared from the locally available Lapsi (chorespondias axillaris,* Roxb*) seed stone is presented. Tons of Lapsi seed stones are generated as waste which can be carbonized to activated charcoal. The adsorption capacity for arsenic is quite low for raw charcoal but activation followed by iron impregnation greatly enhances it. The low cost activated charcoal prepared from locally available Lapsi seed stones can be used in community level at point- of- use treatment for arsenic contaminated ground water of Terai region of Nepal.*

## Introduction and objectives

The presence of Arsenic above WHO guideline value in ground drinking water of Terai region of Nepal became a major health concern (Panthi, 2006). Long term exposure to arsenic can cause cancer of the bladder, lungs, skin, and kidney, liver and prostate. In natural water, arsenic is primarily present in arsenate (As (V)) and arsenites (As (III)). Pentavalent species predominate and are stable in oxygen rich aerobic environment. Trivalent arsenites predominate in moderately reducing anaerobic environments such as groundwater (Smedley et al., 2002).

Arsenic contamination and its mitigation measurements came into light in 1980s when alarmingly high concentration of arsenic was found in the tube wells of West Bengal of India and Bangladesh which had created a great havoc, and was also considered as world's biggest environment disaster. Department of water Supply and Sewerage (DWSS) with assistant from WHO /Nepal conducted a systematic study on the contamination of arsenic in ground water of Terai region of Nepal. (Panthi, 2006) In all the six districts of Terai region of Nepal, water from the tube wells (TW) are contaminated with arsenic in a level higher than the safe limit set by WHO for drinking purpose (NASC/UNICEF, 2007) [**Figure 1**]. Different technologies have been used for the mitigation of arsenic from water like coagulation, co-precipitation, use of synthetic ion exchanger, electro dialysis, biological treatment etc. But all arsenic removal technologies suffer from one or more draw backs, and limitations. Removing arsenic in drinking water by using adsorbent is evolving as a front line defense in recent year. The adsorbent utilized are biological materials, mineral oxides, polymer resins, iron oxides coated sand (Vaishya et al., 2003), cement (Kundu et al., 2005), activated alumina and activated carbon (Reed et al., 2000) Modifications of the known adsorbent are necessary for enhancing the efficiency of removing arsenic from arsenic contaminated ground water. For wide spread use removal of arsenic by adsorption, the cost of the adsorbent should be low. Such a low cost adsorbent could only be produced from the locally available resources. Among many types of adsorbent materials, activated carbons are the most widely used for water treatment owing to their versatile adsorption capacity and low cost. Preparation of activated carbons involves two steps: the carbonization of raw carbonaceous materials and the activation of the product. Activated carbon can serve as ideal support media for iron impregnation, and iron impregnated material is known to be most effective adsorbent for arsenic (Kundu et al, 2005; Reed et al, 2000). The adsorption capacity of activated carbon depends upon pore volumes and specific surface area which in turn also depends upon the carbon precursor. The selection of the precursor for the preparation of activated charcoal depends upon availability, cost, carbon content, and ease of activation. Considering all these facts Lapsi (*choerospondias axillaris,* Roxb.) seed stone is selected as a precursor for preparing activated carbon in the present study. The photograph of Lapsi seed stone is shown in **Figure 2**. Lapsi tree is native to Nepal. (Paudel, 2002) It is a wild large deciduous and dioecious plant belonging to the family Anacardiaceae. Lapsi tree is reported in three hundred village development community of Nepal, forty thousand trees has been producing fruits and five hundred thousand new plants has been planted. The edible part of the fruit (skin and pulp) comprises 71 % and seed stone of 29%.(Paudel 2002) Every year tons of Lapsi seed stone are generated as agricultural waste matter and are use only as fuel in brick kilns. The objective of the present investigation is therefore to prepare activated carbon from Lapsi seed stones and impregnate with iron and study adsorption of arsenic from ground water.

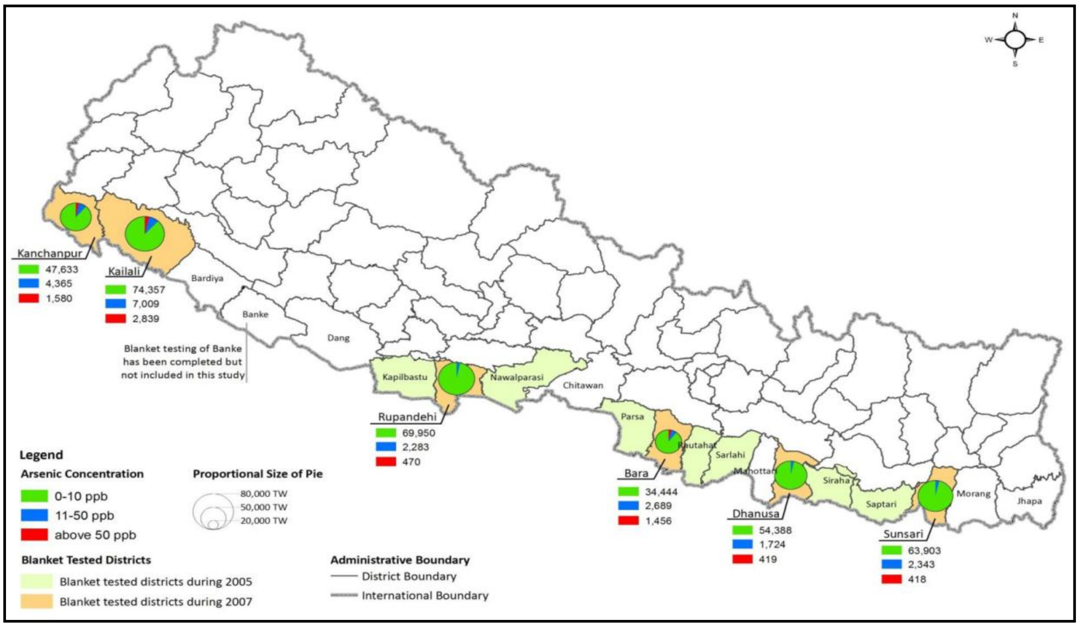


**Figure 1. Arsenic contaminations in tube wells of six districts of Terai region of Nepal**

**Figure 2. Lapsi Seeds (*Choerospondias axillaris* )**

**Figure 3. SEM image of activated charcoal**

## Preparation of activated carbon from Lapsi seed stone

Lapsi fruits are collected from vegetable market at Kalimati, Kathmandu. The fleshly part is removed and the seed stones are washed several times with distilled water. These seed stones are dried in sun light for a week, and then in electric oven for three hours at $110^{o}$ C. The seed stone is grinded in electric grinder and grinded seed are carbonized under nitrogen atmosphere at $400^{o}$C for three hours. For chemical activation the granular seed stone is immersed in zinc chloride for 24 hours and carbonized in nitrogen atmosphere. The carbonized material is washed with distilled water and dried. The dried materials are used with and without iron impregnation to study the adsorption capacity for arsenic. The characteristics of activated charcoal prepared from Lapsi seed stone is given in **Table 1**.

**Table 1. Characteristics of activated charcoal derived from Lapsi seed stones**

| Characteristics | Value |
|---|---|
| Surface area,$m^2$/g | 800 |
| Ash content (%) | 3.5 |
| Mosture (%) | 0.2 |
| Iodine no.(mg/gm) | 630 |
| **Surface Functional Groups** | |
| Carboxylic (meq $g^{-1}$) | 0.45 |
| Lactones (meq $g^{-1}$) | 0.30 |
| Phenol (meq $g^{-1}$) | 0.50 |
| Adsorption Capacity( mg/g) | |
| Cd(II) | 12.5 |
| Cr(VI) | 58 |

## Results and discussion

The characteristics of activated charcoal prepared from the Lapsi seed stones are given in **Table 1** and SEM picture at magnificence of 500 is shown in **Figure 3**. The activated charcoal prepared from Lapsi seed stones is highly porous and has sufficiently high surface area. The porous surface morphology of the prepared charcoal is a positive point for adsorption of pollutants. The high value of iodine number clearly indicates the presence of sufficient porous sites for effective adsorption. The activated charcoal without iron impregnation is found to be a good adsorbent for Cr (VI) and Cd (II) ions (Lamsal, 2009). But its adsorption capacity for arsenic is quite low. It is reported that the coating of iron on sand has a positive role in adsorptive removal of arsenic from drinking water (Kundu et.al, 2005; and Vaishya et.al, 2003) The presence of oxygen containing surface functional groups in the charcoal from *choerospondias axillaris* seeds can act as a site for iron loading. Hence charcoal is impregnated with iron (III). The iron impregnation activated charcoal has a quite high adsorption capacity for arsenic. When iron impregnated charcoal of dose 2 g/L was used, the concentration of arsenic in water decreased drastically. (**Table 2**).

**Table 2. Adsorptoion of arsenic by iron impregnated charcoal**

| Initial [As] in ppb | [As] after adsorption in ppb | % adsorption |
|---|---|---|

| | | |
|---|---|---|
| 200 | 9.9 | 95.0 |
| 400 | 15.0 | 96.2 |
| 800 | 27.1 | 96.6 |

If initial concentration of arsenic in water is 200 ppb, after adsorptive removal, the concentration of arsenic decreased to below WHO guideline value, while if initial concentration is as high as 800 ppb, the treated water contain less than 50 ppb, the limit set by Nepal for arsenic in drinking water.

## Conclusion

The Lapsi stones, the waste seed, can be carbonized and activated to obtain activated charcoal which can be used for removing As, Cd and Cr from water. Iron impregnation greatly enhances the adsorption efficiency for the adsorption of As from ground water and this low cost adsorbent prepared locally can be used by community at the point of use to get rid of arsenic pollution in ground water.

### Keywords
Activated charcoal, arsenic removal, adsorption, Choerospondias axillaris.

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