

**Interim report**

**On**

**Research on granular activated charcoal to  
remove/reduce organic contaminants and dissolved  
mineral elements in drinking water**

**For:**

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**By:**

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## Background

The Nakuru Defluoridation Company Ltd. (NDC) and Mr. Graeme BoydMoss have been evaluating Activated Charcoal (AC) produced by custom made “Jikos”. The objective has

been to see how useful the AC can be especially as a bactericide. It is hoped that the study will help identify commercial as well as functional uses for the AC.

Activated Charcoal filtration can generally be used to improve visually objectionable water. AC filtration is effective for some contaminants and not effective for others. **Not All Charcoal is alike:** Each type of AC can have different adsorptive capacities. Different source materials and manufacturing procedures give each brand of activated charcoal its own pore diameters and internal volume that determine its adsorption capacity. The type of household water purifier applied in this research typically contains granular activated carbon. The two most important factors affecting the efficiency of activated carbon filtration are the amount of AC in the unit and the amount of time the contaminant spends in contact with it, the more carbon the better. Similarly, the lower the flow rate of the water, the more time those contaminants will be in contact with the carbon, and the more absorption that will take place. Particle size also affects removal rates.

**Important information:** The data used to make conclusions and recommendations in this report is by activated charcoal from one type of tree species. More research is needed to establish the decontamination properties on different types of tree species and possibly different water sources.

## **Objective**

The primary objective of the research project was to test a simple, inexpensive system for removal/addition of dissolved mineral elements and organic contaminants in drinking water using activated charcoal derived from a local wooden stove to benefit the local community working in tea plantations in Kericho region and later use the waste by product as fertilizers.

## Methodology used

### Lab scale tests



Figure 1: Apparatus for bench scale research

### **Series A: Bacterial removal Set up**

A ratio of 3:1 coarse to fine granules of activated charcoal was used i.e. 75g of fine and 225 g of coarse granules.

2 liters of highly contaminated water was passed every day except weekends.

Bacteriological analysis was done before and after filtration and results recorded as follows:-

Date	Accumulative Vol. of water passed	Fecal coliform Raw water	Fecal coliform Treated water	% removal
11/5/11	2	654	0	100%
12/5/11	4	702	0	100%
13/5/11	6	824	0	100%
16/5/11	8	756	0	100%
17/5/11	10	1023	0	100%
18/5/11	12	845	0	100%
19/5/11	14	678	0	100%
20/5/11	16	902	0	100%
23/5/11	18	864	0	100%
24/5/11	20	1523	0	100%
25/5/11	22	872	0	100%
26/5/11	24	758	0	100%
27/5/11	26	1029	0	100%

30/5/11	28	752	1	99%
31/2/11	30			

**Table 1: microbes removal**

### Interpretation

There were no microbes in the filtered water for the first 26 liters of water passed. After passing 28 th liter of contaminated water there was presence of fecal coliform in the outlet. Ideally water for human consumption should be free from bacterial contamination.

### Series B: Ions removal

#### Set up

Same ratio as above

2 liters of water with known concentration of dissolved ions analyzed before filtration was passed through the media.

Tests of the same were undertaken to evaluate whether there was reduction or addition of the chemical elements in the filtered water.

Date	Accm. Vol. passed	Nitrates		Iron		Calcium		Sodium	
		Before	After	Before	After	Before	After	Before	After
11/5/11	2	1.77	0.58	0.19	0.07	3.77	4.48	147	79
12/5/11	4	-	0.92	-	0.07	-	4.92	-	109
13/5/11	6	-	1.12	-	0.08	-	5.45	-	113
16/5/11	8	1.78	1.26	0.20	0.15	3.80	5.65	145	117
17/5/11	10	-	1.48	-	0.17	-	6.12	-	123
18/5/11	12	-	1.62	-	0.2	-	6.67	-	138
19/5/11	14	1.77	1.76	0.2	0.2	3.78	6.53	146	142
20/5/11	16	-	1.77			-	5.73	-	147
23/5/11	18					-	5.61	-	147
24/5/11	20					-	5.29		
25/5/11	22					3.80	4.8		
26/5/11	24					-	4.23		
27/5/11	26					-	3.9		
						3.80	3.8		

**Table 2: Ions Removal**

### Interpretation

According to the above results there was slight/insignificant reduction of nitrates, iron and sodium initially which then increased as more water was passed through until there was equilibrium between raw and treated water.

Calcium levels were seen to increase above the raw water concentrations from the start and also as more water was being added this probably suggests that there was addition of Calcium ions from the activated charcoal, but later decreased to concentration same as raw water. The addition of Calcium ions might be because of wood ash which is mainly comprised of Calcium carbonate.

### **Series C: Color and turbidity removal**

#### **Set up**

Same ratio as above

Turbid water with high levels of color, turbidity and iron concentrations was passed through the media. Analysis was done to determine whether the media can remove/reduce the above. Iron measurements were included to determine whether iron content trapped in particulate matter is also reduced as turbidity is reduced.

Date	Acc.Vol. Passed	Color		Turbidity		Iron	
		Before	After	Before	After	Before	After
11/5/11	2	463	0	68	0	4.36	0.08
12/5/11	4	461	0	65	0	4.02	0.05
13/5/11	6	393	0	62	0	3.21	0.05
16/5/11	8	356	0	45	0	2.86	0.04
17/5/11	10	396	0	49	0		
18/5/11	12	796	0	106	0		
19/5/11	14	831	0	87	0		
20/5/11	16	784	0	112	0		
23/5/11	18	802	0	90	1		
24/5/11	20	666	3	98	1		
25/5/11	22	1012	16	127	3		
26/5/11	24	958	23	94	5		
27/5/11	26	962	25	124	7		
30/5/11	28	810	28	110	8		

**Table 3: Color and Turbidity**

#### **Interpretation**

The media reduced color and turbidity levels to zero after passing the first 16 liters of water. After the 22<sup>nd</sup> liter the color and turbidity levels had reached the maximum recommended guideline value of 15 Color units/l and 3 mg/l respectively.

From the above results Iron concentrations were also reduced.

### **Conclusions and recommendations**



From the above data, the Activated Charcoal filters are NOT successful at removing dissolved inorganic contaminants (metals & non-metals). Removing these contaminants requires other types of purification filters/processes. However, AC filtration does remove microbes initially but not for long. AC filtration reduces color and particulate matter significantly.

The consumer should assume that the AC filter as currently composed is not effective enough in removing microbes and dissolved inorganic elements and should only use it to purify visual organic matter. It is recommended that the activated charcoal be impregnated with a bactericide such as silver nitrate which is effective at inactivating such water residing bacteria as *Escherichia Coli*. The results of this study also indicate that there is potential for multiple uses for the AC. The study recommends that further studies be conducted with AC from other tree species as well as alternating water qualities.

### **References:**

The conclusions are based on WHO permissible guideline values for drinking water. The Procedures used for water testing are adapted from 'Standards methods for the examination of water and wastewater' published by APHA and AWWA.