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Efficacy of Hibiscus Cannabinus L. (kenaf) Crude Seed Powder and its Methanol Extract in Water Purification

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Abstract

The efficiencies of hibiscus cannabinus (kenaf) powder and methanol extract were studied in water purification. Two turbidity levels namely, high (160NTU) and low (49NTU) were considered. The water samples were taken from an open pond used for irrigation farming in Custom area of Maiduguri, Nigeria. In this study, the powdered cannabinus was discovered to be more effective in removing high turbidity water, with an efficiency of 96.0% against the extract with 85.6%. However, in low turbidity water, the methanol extract performed better, with a turbidity removal efficiency of 89.4% compared to 84.4%, if the cannabinus powder is used. Another parameter studied was the pH of the water which remains unaffected after the treatment at 7.0. The outcome of the performance of this natural coagulant and alum when compared indicated that alum also performed better on high turbidity water than low turbid water with a removal efficiency of 98.8% and 95.7% respectively. Alum slightly affected the pH of the water from original value of 7.0 to 5.5, which makes the water more acidic after treatment. It appears that natural coagulants of plant origin remain the best option engineers are left with, if the current emphasis on millennium development goal on clean water supply for all is to be achieved.

Keywords: , Cannabinus, Coagulation, Water Purification

1. Introduction

Despite the technological advancement in water treatment and supply, one major challenge facing many developing countries today is lack of clean and safe drinking water to its citizens. It has been estimated that, 1.2 billion people do not have clean and safe drinking water (Pritchard et al., 2009). In Nigeria for instance, some municipalities are spending around 50% of their annual recurrent cost on water supply (Muyibi and Okufu 1995). In third world countries, many communities depend to a large extent on pond and other surface water sources for their domestic water supply. This could be an open borrow pit left during/after road construction or a river. River water drawn for consumption or general household use is highly turbid, especially in the rainy season. Studies have shown that, one major problem with the treatment of surface water is the large seasonal variation in turbidity (McConnachie et al., 1999). Turbidity in water is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, planktons, and other microscopic organisms (American Public Health Association/American Water Works Association 1989, Nwaiwu and Lingmu 2011). Turbidity can provide food and shelter for pathogens and if not removed can provide a condition for re-growth of pathogens in the distribution system (Nwaiwu and Lingmu 2011). The consumption of high turbid water may lead to water borne disease outbreak. Water and water related diseases such as diarrhea, typhoid, cholera, and drancunculiasis are fast becoming endemic in certain parts of Africa (Yongabi, 2004; Prichard et al., 2009). To control these diseases, water needs to be purified in order to make it safe for human consumption. However, for many developing countries, coagulation, flocculation and sedimentation are expensive processes of water treatment because of high cost involved to import chemicals in hard currency, leading to high pricing for treated water and the difficulties in accessing the chemicals (Ghebremichael, 2004; Kebreab et al., 2005). Chemical disinfectants like chlorine are not only expensive but have general health effects and environmental problems. Its usage generally resulted in production of trihalomethane, a cancer precursor (Yongabi, 2004) while alum is linked to Alzheimer disease (Zhang et al., 2006). In view of the above, quite a number of natural materials of plant origin have long been used by local communities in many developing countries in water treatment. Some of the effective coagulants have been identified: Nirmali, Okra, Red beans, Sugar and Red maize (Gunaratna et al., 2007), and also Moringa oleifera (Jahn, 1988). Several extensive studies have been done on the use of these indigenous natural coagulants. Yongabi et al. (2011) studied the phytodisinfective and phytocoagulative activities of some plants in rural Cameroon which revealed that, H. sabdariffa seed and its calyx, M. oleifera, J. curcas and Pleurotus tuberregium scherotum lowered the turbidity of the water and the coliform count. The limited knowledge on the exact dosage and mechanism for usage renders them ineffective to compete favorably

with the widely known synthetic chemicals. Also, the use of these plants in folk medicine and as a food makes them unlikely that they may contain any toxic substances (Jahn and Hamid, 1979). Plant coagulants can perform well if fully explored. The relationship between the botanical type and a content of coagulants (chemotaxonomy) could be detected for several plants genera and families. One of such families is the Hibiscus (malvaceae) family and a member of this family is hibiscus cannibinus Linn (kenaf). This study is therefore intended to investigate the use of crude seed powder and methanol extracts of Hibiscus Cannabinus in water purification.

2. Methodology

A seed of hibiscus cannibinus was obtained from Custom market in Maiduguri, Borno state – Nigeria. The seed was identified in both the Department of Biological Science and Crop Science both at the University of Maiduguri. The seeds were dried and pulverized using a commercial grinding machine, weighed and stored in a plastic container which was properly labeled in preparation for the test. The method of extraction adopted for the study was soxhlet apparatus using methanol. The raw water sample was collected from an existing pond used for irrigation farming located at custom area (Bakin Kogi) in Maiduguri, Borno State. The water was collected in the middle of the pond by immersing a plastic container (25 litre jerry can) completely until it was full. The cap was inserted while the container was under the water. The water was taken to the laboratory and stored under a room temperature of 25^{o}C. The appearance/cloudiness of the samples was noted by visual observation (Burns and Van, 1974). The turbidity of the water was measured before and after the coagulation process. A graded weight of the seed powder and the methanol extract were mixed with distilled water separately in a conical flask to form a paste. The content of the flask was shaken for 2 minutes in order to activate the active ingredient present in the plant specimen and was then filtered through a sieve. Water with two turbidity levels, namely; high (160NTU) and low (49NTU) were considered. The amount of coagulant solution to be used was measured between 10 to 100mg/l. The coagulants were added simultaneously in five different beakers each containing 1 liter of the water sample to be tested. The stirring paddle was lowered into each beaker and the apparatus was started at a speed of 200rpm for 1min to ensure effective mixing and then 15min at a speed of 30rpm to effect flocculation (Folkard et al. 1987). At the end of the stirring period, the turbidity and the pH of the supernatant were determined using a photometer and a universal indicator respectively after a settling time of 30min, 1hr, 6hr and 24hrs. The universal indicator was used with the comparative chart in the laboratory for pH determination.

3. Results and Discussion

The results of the jar test was performed using Hibiscus Cannabinus as a coagulant material, which revealed the following efficiencies of the powder and the methanol extract with alum as a control, as shown on figs. 1 and 2.

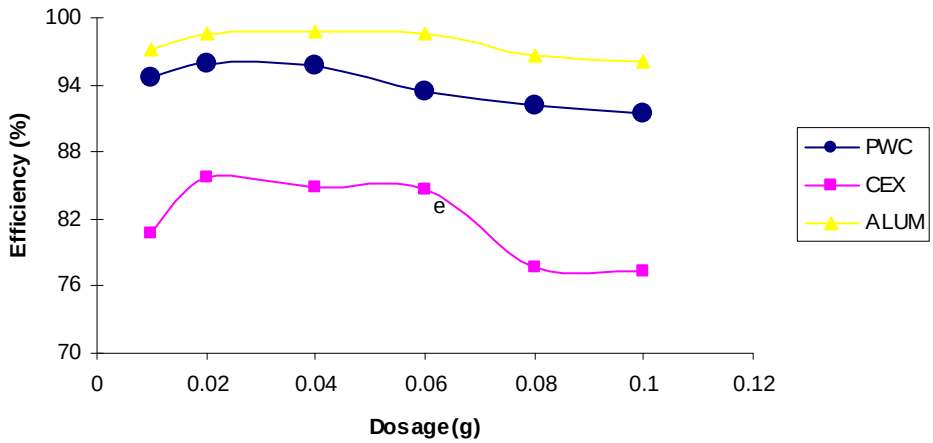

Figure1. Efficiency of Hibiscus Cannibinus on High Turbidity Water (160NTU) Note: PWC = Cannibinus Powder, CEX = Cannibinus Extract

Findings from this study indicated that, Hibiscus Cannabinus powder coagulates well on high turbid water than the extract because it formed larger flocs which facilitated settling and as a result, clear supernatant was produced. The removal efficiency showed that, after 24hr settling time of the crude powder, the high turbid

water was reduced from 160NTU to 8.44, 6.63, 6.98, 10.19, 12.75 and 13.64NTU corresponding to 10, 20, 40, 60, 80 and 100 mg/l respectively. This resulted in removal efficiency of about 96% at 20mg/l. On the contrary, the removal efficiency of the methanol seed extract using the same water sample and dosages as above indicated that, turbidity was reduced from 160NTU to 30.74, 23.00, 24.33, 24.63, 35.75 and 36.25NTU which correspond to 10, 20, 40, 60, 80 and 100 mg/l respectively. Hence Cannabinus extract has a turbidity removal efficiency of 85.6% at 20mg/l as well. It could be deduced from this experiment that, an increase in coagulant dose from 20mg/l reduces the removal efficiencies of both the Cannabinus powder and the extract. It appeared that, an increase in cannabinus dosage led to an increase in turbidity of the water.

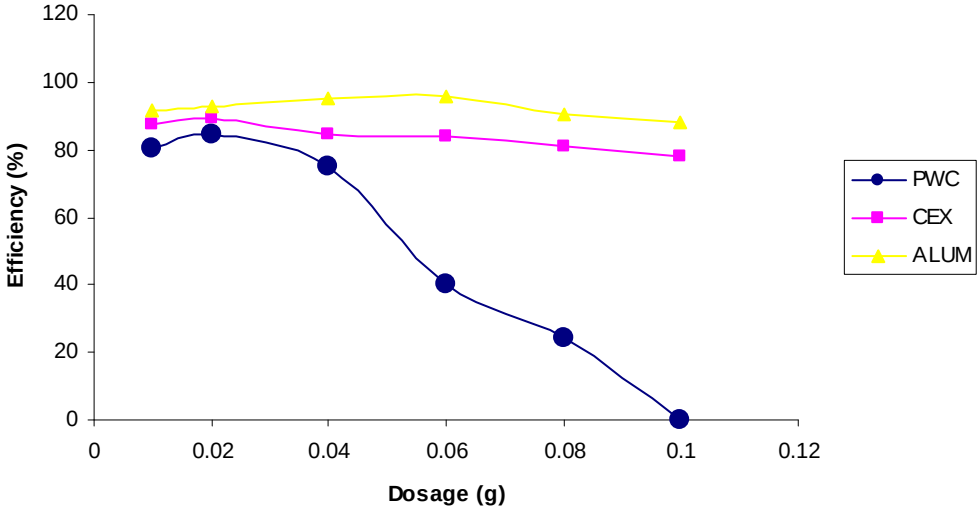

Figure 2. Efficiency of Hibiscus Cannabinus on Low Turbidity Water (49 NTU)
Note: PWC = Cannabinus Powder, CEX = Cannibinus Extract

Considering the results from fig. 2, it appeared that when the extract was used to treat the low turbidity water, it reduces the turbidity from 49NTU to 6.26, 5.21, 7.48, 7.78, 9.45 and 10.89. This however corresponds to 10, 20, 40, 60, 80 and 100mg/l dosage respectively after 24hr settling time. Here, the maximum removal efficiency was again noted at 20mg/l which is 89.4%. However, when the result was compared with the crude powder on low turbidity water, it showed that, the removal efficiency was lower than that of the extract. This is because the cannabinus powder reduces the turbidity from 49NTU to between (7.7 and 37.1NTU) thus, a maximum efficiency removal of 84.35% at 20mg/1 and with no reduction in turbidity at 100mg/l dosage. Similarly, an increase in coagulants dosage resulted in a reduction in the removal efficiency of the coagulants. This therefore followed the same trend as that of the study on high turbidity water. It revealed that cannabinus works better on high turbidity than on low turbidity waters. The performance of powdered cannabinus was observed to be better than the extract in treating high turbidity water while the extract seems to coagulate well above the powder when using it on low turbidity water. Another good remark that could be said about the study is that, all the coagulants performed best at 20mg/l dosage. This means that the hibiscus cannabinus seeds can be considered to be more economical to use because of the small quantities that may be required to treat a given volume of water. In all the tests, the initial pH of the water was not altered after the treatment and remains within the WHO stipulated value of 6.5 – 8.5. This finding quite agrees with the findings of Ndabigengesere and Narasiah (1998), and Nwaiwu and Lingman (2011) on moringa oleifera seed, when compared to the use of chemical base coagulants. This is also supported by a study conducted by Fatoki and Ogunfowakan (2002) which consist of coagulating inland river water by means of alum and ferric chloride which that a 10mg/l dose of any of the chemical resulted in an increased pH value by at least 0.4. However, when comparing the performance of alum on high and low turbidity waters as indicated on Tables 1 and 2, it showed that alum also performed well on high turbidity than on low turbidity water similar to the results reported on the performance of the plants coagulant.

4. Conclusion and Recommendations

More attention is now geared towards the study of phyto-coagulants in order to reduce the cost of using the so called synthetic chemical coagulants. One of such plants is the hibiscus cannabinus , which was used in this

study. The turbidity removal efficiency of the plant powder and the methanol extract gave promising results on both high and low turbidity waters. The powder works far better than the extract on high turbidity water with a removal efficiency of about 96% compare to 85.6% of the extract whereas, the extract performed well above the powder with a turbidity reduction efficiency of 89.4 % against 84.4% when cannabinus powder was used. On the pH, cannabinus coagulates well without affecting the pH of the final treated water, unlike alum which was discovered to have affected the pH of the final water from an initial value of 7.0 to 5.5 which makes the water to be more acidic. This indeed is one major advantage plant coagulants have over the well acclaimed synthetic coagulants. It is because of these advantages highlighted above that, this study recommends the use of coagulants of plants origin, because it is more economical and environmentally friendly to use. Secondly, the antimicrobial properties of such plants would also need to be studied in order to identify their disinfection properties.

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