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COAGULATION EFFICIENCY OF *HIBISCUS SABDARIFFA* SEED EXTRACT IN TURBID WATER OF CHALLAWA GORGE DAM AND KANO RIVER, NIGERIA

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ABSTRACT

The study assessed the potential of using Hibiscus Sabdariffa seed extract (HSSE) as a coagulant in water treatment. The seeds were winnowed, ground and sieved to175µm. A stock solution was prepared from the seed powder and Jar test was run on surface water samples obtained from Challawa Gorge dam and Kano River to determine the required dose of HSSE to meet acceptable drinking water standard. The pH and turbidity of both raw and treated water were noted. The pH of treated water with HSSE was within the range of 6.2-7.9. The study also revealed that Hibiscus Sabdariffa seed extract was relatively good in turbidity removal with percentage efficiency of 62.80% and performs better in highly turbid water at an optimum of 1.5 mg/l.

1. INTRODUCTION

Water covers more than 70% of the earth surface. Organisms survive longer without food than without water and it is an incredibly important resource in our daily lives. Everyday, water is used for cooking, bathing, and many other activities. With the importance of water in our lives, many of us know very little about the water we use each day. We drink tap water, enjoying the convenience and cost-effectiveness of this practice, yet, we fail to recognize the serious threat this water may pose to our health if polluted or contaminated.

The demand for water is increasing rapidly with our growing population. Already there is acute shortage of both surface and groundwater in many parts of the world (WHO, 2011). Pollution and contamination of the available water sources has greatly affected water quality. Pollution might result from indiscriminate disposal of wastes or unsafe discharges into the environment (WHO, 2011). Globally, the provision of safe drinking water has remained a great challenge. About eighty million (80 000 000) people have no access to safe drinking water, especially in rural areas and semi urban settlement in under developed countries of Sub-Sahara Africa (WHO, 2011). Only about 16% have access to safe and adequate drinking water via improved pipe system (WHO/UNICEF, 2012). According to United Nations estimates, by the year 2025, up to 20% of the world's population could live in countries where water is in short supply (WWDR, 2003).

A good step towards boosting water supply is the involvement of stakeholders in the design and implementation of a safe and affordable drinking water supply that can be effectively incorporate into overall water resource management (Amatobi, 2010). Water supply systems need to be based on convenient and adequate supply of drinking water to the populace. Good water supply reflects on the health and economic life of people, by reducing water-borne disease. The source of water supply is very essential in the design and implementation of safe drinking water for all. It also reduces the chances of contamination, thereby reducing the cost of treatment. (Venugopala, 2002). Consequently, for most people, the only available source of water is the contaminated source, containing harmful bacteria, yielding illness to millions of children and families. However, available means of purifying water in Nigeria is expensive and not affordable especially by individuals.

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 (Jones and Bridgeman, 2017). Hence, this study is aimed at evaluating the efficiency of *Hibiscus sabdariffa* seed extract (*Roselle* in English or *yakuwa* in Hausa) and its optimum amount that would yield minimum acceptable quality of water with respect to turbidity.

2. MATERIALS AND METHODS

Raw water samples from Challawa Gorge Dam and Kano River were collected and stored in a 15 litres container (the container was rinsed with distilled water and again rinsed with the raw water). The samples were collected in the morning and analyzed same day for pH, temperature, turbidity and Jar test to determine the optimum amount of *Hibiscus sabdariffa* linn seed extract required for the study. For the Jar test, a 15g of *Hibiscus sabdariffa* Linn seed powder was weighed and mixed with 500 ml of distilled water to make a stock solution. The stock solution was placed on a magnetic stirrer for one hour so as to activate the active ingredient present. The solution was then sieved using muslin cloth. The stock solution was added to six beakers containing 250 ml of raw water sample in volumes of 2ml, 4ml, 6ml, 8ml, 10ml and 12ml using a pipet. The content in the beaker (raw water and stock solution) was stirred at 150 rpm for 2 minutes for effective mixing and 50 rpm for 15 minutes so as to effect flocculation. The mixture was left undisturbed for 30 min, 1 hour, 6 hour and 24 hours. Fragile flocs formation was observed and the flocs settled gradually at the bottom of the beakers and leaving a brownish water sample. The water sample was allowed to settle and filtered by decanting into conical flask and stored in a refrigerator for coliform analysis. The turbidity and pH of the water samples were recorded both before and after the process. The analyses were carried out in the Civil Engineering Laboratory, Bayero University, Kano and National Research Institute for Chemical Technology, Zaria.

3. RESULTS AND DISCUSSION

The results of laboratory determination of turbidity and pH with respect to dosage of *Hibiscus sabdariffa* seed extract for Challawa Gorge Dam and Kano River were presented in Table 1 and Table 2 respectively.

Table 1: Variation of turbidity and pH with respect to *Hibiscus Sabdariffa* seed extract dosage for Challawa dam

Settling time	30 minutes		1 hour		6 hours		24 hours	
Dosage (mg/l)	Turbidity (NTU)	pH	Turbidity (NTU)	pH	Turbidity (NTU)	pH	Turbidity (NTU)	pH
0.0	546.0	7.5	544.0	7.4	542.0	7.4	540.0	7.5
0.5	328.0	7.4	300.0	7.1	290.0	7.9	271.0	7.2
1.0	310.0	7.3	280.0	6.6	275.0	7.7	258.0	7.4
1.5	305.0	7.2	270.0	6.6	250.0	7.4	203.0	7.3
2.0	325.0	7.2	305.0	6.3	245.0	7.3	225.0	7.2
2.5	330.0	7.2	310.0	6.2	251.0	7.2	240.0	7.2
3.0	338.0	7.1	315.0	6.2	259.0	6.9	257.0	7.2

It could be inferred from Table 1, that *Hibiscus sabdariffa* seed extract coagulate relatively well on Challawa Gorge dam water which has an initial turbidity of 546 NTU. The turbidity decreased when treated with *Hibiscus sabdariffa* seed extract as the settling time increased and also decreased when the dosage did not exceed 1.5 mg/l otherwise the water became more turbid. The occurrence of little floc could be as a result of alkalinity of the treated samples not enough to allow the formation of flocs. Bina (2009), in a study, viewed that the presence of bivalent cations such as Ca^{+2} and Mg^{+2} increases the ion strength of the solution and the destabilization of the colloidal particles and this is in conformity with the present research. The turbidity of the sample is far above the WHO's recommended value for good quality drinking water. A great difference in turbidity decrease was seen at the dose of 1.5mg/l, which decreased the turbidity from 546 NTU to 203 NTU. The removal efficiency was calculated using Equation 1:

$$Efficiency = \frac{(C_1 - C_2)}{C_1} \times 100 \quad (1)$$

Where: C_1 = initial turbidity; C_2 = final turbidity

Maximum removal efficiency of 62.80% was recorded for Challawa gorge dam at a settling time of 24 hours for a dose of 1.5mg/l. It was observed from Table 1, that as the doses of the extract increase, the pH decreased. Although the initial pH was 7.5, slight variation was noted at a settling time of 6 hours for a dose of 0.5 to 1.0mg/1. Thus, the pH decreased with respect to the dose and remained relatively unstable with respect to settling time. This was in accordance with the study conducted by Mangale *et al.* (2012), which after treatment with *Moringa Oleifera* seed powder, the pH decreased at 0.5 and 1mg/l dose but at 1.5mg/l it increased. Therefore, the pH in this sample was 6.2 to 7.9 which was within the recommended acceptable range for drinking water as specified by WHO (2006) which is between 6.0 and 8.0. Although higher pH was obtained from the result, the study concurred with a study conducted by Madhavi (2014), who opined that optimum coagulation occurred at pH 8.

Table 2: Variation of turbidity and pH with respect to *Hibiscus sabdariffa* seed extract dosage for Kano River

Settling time	30 minutes		1 hour		6 hours		24 hours	
Dosage (mg/l)	Turbidity (NTU)	pH	Turbidity (NTU)	pH	Turbidity (NTU)	pH	Turbidity (NTU)	pH
0.0	97.9	7.9	97.7	7.4	97.4	7.4	97.2	7.5
0.5	85.2	6.7	72.1	6.7	60.2	6.9	45.2	6.9
1.0	87.1	6.2	75.1	6.2	63.1	6.7	48.1	6.8
1.5	89.2	6.3	80.1	6.3	65.1	6.6	51.1	6.7
2.0	95.0	6.3	81.3	6.3	67.0	6.5	54.0	6.7
2.5	96.4	6.3	83.2	6.3	69.0	6.5	56.0	6.5
3.0	97.2	6.3	84.6	6.3	70.0	6.4	59.0	6.6

Similarly, Kano River originated from the rocky area of plateau with low turbid water, and as such the water had less turbidity from source when compared to the Challawa gorge Dam. From Table 2, the reduction in turbidity was achieved at a dose of 0.5mg/l to 2.5mg/l, but above 2.5mg/l, the water became turbid for settling time of 30 mins. However, Table 2 also showed that *Hibiscus sabdariffa* seed extract performed slightly well on medium turbid water. This is in conformity with a study conducted by Jones and Sangodoyin (2013) in which it was opined that, an increase in coagulant dose from 20 mg/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.

The use of *Hibiscus Sabdariffa* Linn seed extract on Kano River also showed that the pH decreased as the dose increased. The pH at 30 minutes and 1 hour remained fairly constant. At 6 hours and 24 hours there was slight variation in all the pH except for 2.5mg/l, (Table 2). This could be attributed to the fact that as the dose increased the pH tended to be stable towards acidity which is as result of the presence of tannin and saponin in its phytochemical constituent. Consequently, the pH in this sample was 6.2 to 7.9 which was within the recommended acceptable range for drinking water as specified by WHO (2006) which is between 6.0 and 8.0. The observation on pH made in this present analysis were in accordance with previous studies on coagulation and flocculation ability of some seeds (Ndabigengesere *et al.*, 1995).

4. CONCLUSION

Hibiscus sabdariffa seed extract could be relatively effective in removing the turbidity of water as observed at 3mg/l dosage. However, the turbidity of Challawa Gorge Dam and Kano River water samples were drastically reduced from 546NTU to 203NTU and 97.9NTU to 45.2NTU respectively. Thus, if the dosage could be further increased, the turbidity might meet the WHO minimum requirement of 5NTU for drinking water. The findings also showed that the pH value of the treated water was within the specified range. However, the pH maintained a stable value with longer settling time. Based on the outcome of this study, *Hibiscus sabdariffa* seed extract is recommended to be used as a coagulant with other plants so as to improve its coagulation ability.

5. ACKNOWLEDGMENT

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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