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COAGULATION POTENTIALS OF THE LEAVES OF DESERT DATES, GUIERA, JUJUBE TREE, KAMEL'S FOOT AND MAHOGANY

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Abstract

Coagulation activity in water and waste water treatment tends to reduce turbidity by agglomerating the dissolved and suspended particles thereby making them dense enough to settle. Alluminium phosphate is the common solution that is used to achieve coagulation. In case of lacking aluminum phosphate, an alternative has to be considered. In this study, leaves of five trees are considered. The trees include Jujube Tree (Prunus Domestica), Desert dates (Balanites Eagyptiaca), Kamel's Foot (Piliostigma reticulatum; P. Thonningii), Guiera (Guiera Senegalensis) and Mahogany (Khaya Senegalensis). Leaves of these trees were dried and grinded to powder before they were dissolved in water. Extract of these solution were used for coagulation potentialities with a concentration of 2 ml per liter. Turbidity of the water was tested before coagulation and was found to be 233 NTU. The results of the turbidity after coagulation showed that the water has 53 NTU, 69 NTU, 70 NTU, 74 NTU and 700 NTU for Mahogany, Jujube, Guiera, Desert Dates and Kamel's Foot respectively. Drinking water limit of 5NTU for turbidity in accordance to W.H.O has not been achieved in all the tests made

Keywords: Water, Coagulation, Turbidity, Leaves

Introduction

Majority of living organism and Humans in particular depend on water for their survival. Generally, water is becoming an issue of discussion in many developing nations due to an undergoing radical transformation of ecology. There is much water crisis both in rural and urban areas where research has shown that 1.2 billion people lack access to safe and affordable water for their domestic use (Sulaiman et al., 2017). The detrimental bone of contention is that larger population of the world are living in rural areas and lack access to quality water for their livelihoods (Mcmichael, 2000). However, this problem of access to quality water has major negative impacts on people's well-being such as; massive health effect, poor personal hygiene and a problem of sanitation.

The scarcity of the natural source of fresh water supply correlates with the increased in global social economic growth and activities, force to use domestic and industrial wastewater. However, these water require numerous

purification methods which include integrating coagulation along with filtration, sedimentation or flotation have been well-known for treatment of water and wastewater (WHO, 2011).

Coagulation is the water treatment process used to remove solids from water, by manipulating electrostatic charges of particles suspended in water. This process introduces small, highly charged molecules into water to destabilize the charges on particles, colloids, or oily materials in suspension. Selecting the right coagulant for a system will enhance overall system performance, and particularly improve solids removal efficiency by enhancing filter and clarifier performance.

Treatment of both water and wastewater has coagulation as one of the pillars in the treatment process. Coagulation is always aimed at bringing together the suspended particles present in the water in question to enable the particles to settle down. Settling of the particles improves the turbidity of water. Turbidity in general, is a measure of water cloudiness induced by such colloidal and suspended matters and is also one of the major criteria in raw water monitoring to meet the stipulated water quality (Choy et al, 2014).

There are many coagulants available for wastewater treatment, but majority are chemical substance. In conventional processes, the most common coagulant is the Aluminum sulfate ($Al_2(SO_4).14H_2O$). Aluminum Sulfate, popularly known as 'alum' is the most common inorganic coagulant used for coagulation in water and waste water treatment. Other chemical coagulants include Ferric Chloride, Ferric Sulfate, Sodium Aluminate, Ferrous Sulfate and Aluminum Chloride. Despite the superiority of chemical coagulants in treating turbid water, they are still lacking in terms of green chemistry. In the 1960s, detrimental effects of chemical coagulants on the human health were published (Simate et al., 2011). Residual aluminum in alum treated water has been the center of debate as it is linked to serious health issues such as the development of Alzheimer's disease (AD) (Walton, 2013).

Chemical coagulation is the most common and traditional coagulation process in water and wastewater treatment. Water treatment using the chemical coagulants has side effects to the health (neurological problems) of humans and their existing environment (Saleem & Bachmann, 2019).

To provide alternatives to chemical coagulants, scientists have considered testing other natural materials to replace the chemical ones. Coagulation using plant materials has attracted the attention of researchers in both past and present. Before the scientific research, in rural areas of tropical regions, coagulants of plants origin have been put into use to improve its turbidity for domestic use (Fuglie, 2001). Raghuwanshi et al., 2002 used Nirmali seeds, Surjana seeds and Maize to serve as coagulants in conjunction with alum. Their research showed that combination of Nirmali seed and maize as coagulants reduced turbidity to less than 1 NTU. In another effort to obtain plant oriented coagulants, Cactus latifaria and the seeds of Prosopis juliflora were experimented using Standard Jar Test Measurement. Their ability to coagulate drinking water was found to produce water of about 5 NTU on turbid water that was about 200 NTU (Diaz et al 1999). Similarly, the performance of Cassia angustifolia seed gum in comparison to Poly Aluminum chloride (PAC) in coagulation activity on acid dye solution were carried out by Sanghi, et al, 2002. Their results indicated that Cassia angustifolia (CA) seed gum was in favour compared to Polyaluminium chloride (PAC). It was also observed that the used of Moringa Oleifera seeds as coagulants reduced turbidity of water by 98% (Desta and Bote, 2021). Banana stem juice was also found to be effective as coagulant in primary treatment of waste water (Alwi et al, 2013). According to Anju and Mophin-Kani, 2016, the Neem and orange seeds reduced turbidity by 4 NTU and 8 NTU respectively.

The experiments of Asrafuzzaman, 2011 showed that Moringa oleifera, Cicer arietinum, and Dolichos lablab reduced turbidity to 5.9, 3.9, and 11.1 NTU, respectively, from 100 NTU. It was also found that these natural coagulants reduced about 89–96% of total coliforms. Carvalho et al, 2016. Tested coagulation using

Moringa oleifera as coagulant and found it to be removing cells even in low turbid waters .Treatment of turbid water with banana pith removed up to 98.5, 54.3, 96.03, 98.9, 88.7, 100, 100, 92, 81, 100 and 60% of turbidity, COD, suspended solids, sulphates, nitrates, copper, chromium, iron, zinc, lead and manganese, respectively, at a banana pith dosage of 0.1 kg/m^3 and initial pH of 4 (Kakai et al, 2016). (Šćiban et al., 2009) experimented the use extracts obtained from seeds of European chestnut and common oak acorn and found them to be good for coagulation. Their effectiveness at 0.5ml/L were observed to be 80% and 70%, respectively. The concentration of 1.0mg/l extract of Strychnos potatorum was found to reduce turbidity by 99% while 16 mg/l of Hibiscus sabdariffa extract reduced turbidity of water by 89% (Swati and Govindan, 2005).

Jujube Tree, Desert dates, Kamel's Foot and Guiera are widely available in northern Nigeria. Mahogany is scarcely available in Northern Nigeria but abundantly found in Southern part of the Country.

Methodology

Leaves of the under listed trees were studied and all were obtained within the premises of the locality and almost found in all Northern parts of Nigeria

Table 1: Names of Trees Used in the Study

S/N	English Name	Botanical Name
1	Kamel's Foot	Piliostigma reticulatum
2	Guiera	Guiera Senegalensis
3	Mahogany	Khaya Senegalensis
4	Desert dates	Balanites eagyptiaca
5	Jujube Tree	Prunus domestica

The Leaves were dried and grounded into powder as shown in Figure 1. The grounded powders are soaked into water for 24 hours to make them pastes.

Figure 1: Picture of the Grinded Powder of the leaves.

The pastes were filtered to produce extracts. The pastes were then filtered to produce extracts. The extracts were used in a ratio of 1:500 (1ml of extract in 500ml of the water sample). Flocculation period of 30 minutes was used in the flocculation machine. The solutions were allowed to coagulate for 24 hours. Turbidity of the coagulated and uncoagulated water were measured using a turbidity meter. Results of the turbidity before and after treatment is shown in Table 2.

Table 2: Turbidity of water before and after coagulation

S/N	English Name	Botanical Name	Turbidity (NTU)
1	Kamel's Foot	(Piliostigma reticulatum; P. thonningii),	700
2	Guiera	Guiera Senegalensis	70
3	Mahogany	Khaya Senegalensis	53
4	Desert dates	Balanites eagyptiaca	74
5	Jujube Tree	Prunus domestica	69
6	Turbidity before coagulation		233

Results and Discussions

From Table 2, it can be observed that the sample turbidity was 233 NTU before being subjected to coagulation trials using extracts of different the five trees. Extracts from Mahogany, Jujube, Guiera and Desert Dates trees have reduce the turbidity by 77.3%, 70.4%, 70.0%, 68.2% respectively. However, extracts from Kamel' foot tree increased the turbidity by multiplying the existing turbidity by more than 3 times. It can also be observed that none of the extract has coagulated the water to drinking standard (WHO, 2011) of 5 NTU as specified by World Health Organisation. The results are graphically presented in Figure 2.

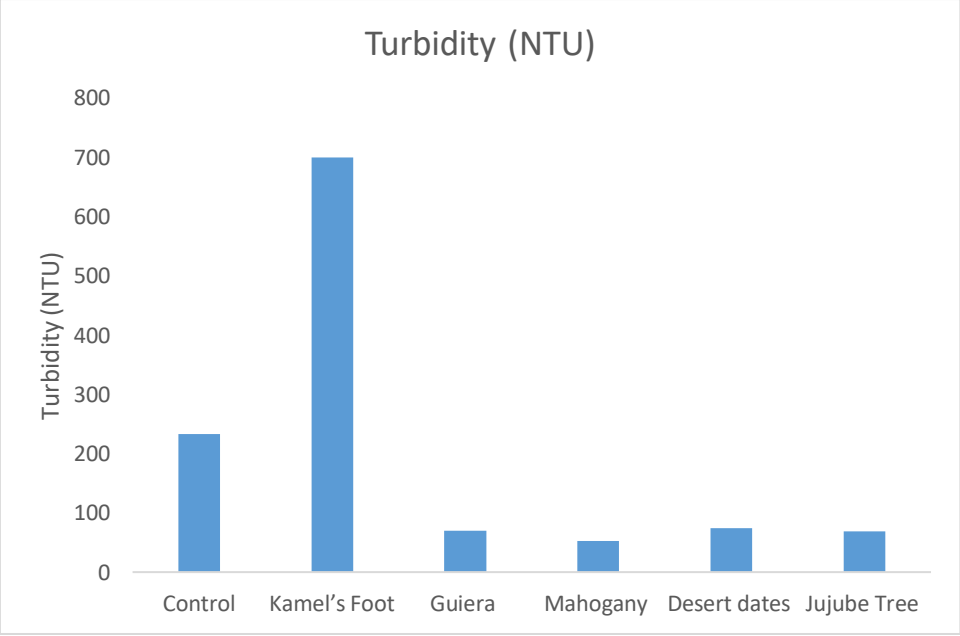

Figure 2: Turbidity test results before and after coagulation using extracts of different trees.

5 NTU limit set by World Health Organization has not been achieved in all the experiments made with the above-mentioned concentrations of the extract in the water samples.

Conclusion

Coagulation potentials of leaves of five set of trees that include: Kamel' Foot, Guiera, Mahogany, Desert Dates and Jujube trees are tested. Extracts obtained from leaves of Mahogany, Jujube, Guiera and Desert Dates trees are found to drastically reduce the turbidity of water by 77.3%, 70.4%, 70.0% and 68.2% respectively. However, Kamel' Foot tree increased the turbidity by multiplying the existing turbidity by more than 3 times. However, none of the extracts has coagulated the water to a drinking standard of 5 NTU.

Recommendations

1. Further studies of increasing concentration of the extracts is recommended.
2. The use of roots and stems of the trees in question is also recommended.

Conflict of Interest

There is no conflict of interest among the authors

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