THE POTENTIAL OF ZOGALE SEEDS AS A WATER TREATMENT CHEMICAL

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ABSTRACT

This investigation has been devoted to finding an alternative and or supplement to existing water treatment chemicals such as coagulants, softeners, pH correctants etc. whose prices are not only increasing at an alarming rate but are not readily available locally. Zogale seed suspension (moringa oleifera) used in this study has been found to have coagulating and softening properties in addition to being a pH correctant (alkalinity reduction). Four raw water samples; two from surface water and two from shallow wells were subjected to jar tests with varying dosages of zogale seed suspension. Water quality tests carried out for turbidity, pH, hardness and alkalinity before and after dosing showed turbidity reduction efficiency varying from 92-99 percent giving final product water values of 10 to 16 NTU which is well within the desirable water quality standard recommended by WHO.

KEY WORDS

Zogale seeds (moringa oleifera), natural coagulants, turbidity, hardness pH correctant.

INTRODUCTION

The cost of chemicals used for water treatment constitute a high percentage of the recurrent expenditure of water utility companies in Nigeria. The Oyo State Water Corporation spends about 42 per cent of its total average annual running cost of ₦24m to treat 56,000m^3/d to supply the city of Ibadan and environs (Salako and Akinola, 1989) while Water Resources and Engineering Construction Agency spends about 65 percent of its average annual running cost of ₦26m to treat 175,000m^3/d to supply Kano City and its environs (WRECA, 1990).

Common chemical coagulant used is alum whose cost has been increasing at an alarming rate from ₦350 per tonne in 1978 to ₦5,000 per tonne in 1990. Alum is manufactured by only two companies in Nigeria; The Federal Superphosphate Co. Ltd at Kaduna and Drury Company at Agbara, Ogun State. Liquified chlorine gas which is imported has increased in cost from ₦8,000 per tonne in 1978 to ₦40,000 per tonne in 1990, while lime has increased in cost from ₦120 per tonne in 1978 to ₦3,000 per tonne in 1990. Lime is however obtainable in large quantities from many areas in the country but demand for other uses is a major contributory factor to the escalating cost (Okoloekwe, 1989; WRECA, 1990).

Most water utility companies in Nigeria cannot cope with these high costs due to dwindling revenues and funding coupled with the inability of local suppliers to satisfy the demand, and due to the foreign exchange problem for imported chemicals.

The outcome of these problems is that water utility companies have to resort to underdosing of chemicals to be able to meet the increasing demand for water which results in water quality deterioration, especially during the rainy season when suspended solids and other pollutant loads in surface waters are very high.

OBJECTIVE: In order to alleviate the problem highlighted earlier on the potential of Zogale Seeds (Moringa Oleifera), a common tropical plant was evaluated for its coagulating properties, softening and buffering capacity. This study is therefore to find an alternative and or supplement to existing water treatment chemicals.

BACKGROUND: In Northern Nigeria Zogale leaves are used as vegetable and for medicinal purposes with the sticks used as climbers, fencing for demarcating property boundaries and as windshields. In Sudan it is used in place of alum by rural women to treat highly turbid Nile water in place of alum because of a traditional

fear of alum which has caused gastro-intenstinal disturbances due to overdosing with the resultant fear of possible abortions in pregnant women (Jahn, 1986). Recent studies by Jahn (1984-86) in Sudan, Folkard et al (1986) in United Kingdom and Malawi (1989), Eilert et al (1981) in Germany and Madsen et al in Sudan and Denmark (1987) indicate that Moringa Oleifera seed suspension has coagulating properties similar to alum with additional advantages of high bacteria reduction during treatment. These beneficial characteristics manifested by Zogale seed are explored in this study for possible adaptation for use in rural water supplies and on large scale by water utility companies. To date on studies have been carried out in Nigeria to explore the potential uses of Zogale seed in water treatment. In this studies bacterial reduction will not however be carried out.

Experimental Method

The dry Zogale seeds used for this study were purchased from rural communities in Yarimawa, Langel and Hambu in Rimi Gado Local Government Area of Kano State. The trees are used in these villages for fences and the leaves as vegetables. These trees are said to be about 15-20 years old.

Preparation of Seed Suspension

The seed coats and seed wings were carefully removed manually and the kernels inspected. Only Kernels which are white or yellowish with no signs of softening, dessication and discolouration were picked for use. The seeds were thoroughly pounded in a mortar with a pestle into a smooth oily paste. Two grams of the seed paste was carefully mixed with 100ml distrilled water and shaken in a flask shaker vigorously for 5 minutes to promote extraction of the active ingredients, and allowed to stand for 10 minutes. The suspension was filtered through filter paper (pore size 100 um). The resulting filtrate was serially diluted to concentrations varying from 40 to 400 mg/1 for use in laboratory experimentation to evaluate dosage variation with water quality. Laboratory analysis for varying jar test dosages included alkalinity, hardness pH and turbidity variation.

Water Sampling Sites:

Most of the population in tropical developing countries live in rural areas not served with potable water. These communities depend on nearby rivers, streams and shallow wells with water of low quality as their water sources; as do residents of periurban and hardcore urban areas where potable water supply is erratic and inadequate. The variability in quality and characteristics of different sources was the main criteria for the choice of water sampling sites. Consideration was also given to the travelling distance from the sources to the Bayero University New Campus which was kept to a minimum from prompt laboratory experimentation and analysis.

Raw water samples were collected from Watari River, Challawa River, Yarimawa well and shallow irrigation wells at Kofar Kabuga all within 14 kilometer radius of the University. See Figure 1 showing sketch map of sampling sites.

Watari River

Watari River is a tributary of Challawa River and is a large slow flowing river with shallow depth. The catchment is large and relatively flat. During the dry season the river dries up and people in the catchment resort to digging shallow wells in the river bed and bank for shadouf irrigation and domestic use. During the rainy season the surrounding flat catchment is used for small holder farming activities. The irrigation water is of brownish colour carrying high suspended solid load due to the sandy clay and clay rich regolith soils in the catchment.

Challawa River

Challawa River takes its source from Bakolori in Sokoto State with other tributaries like Watari River contributing to the large flows in its lower course through Kano to discharge into Kano River. The river is large and slow-moving with the catchment mainly used for subsistance farming and small scale irrigated agriculture during the dry season. This river is also seasonal and dries up during the dry season with shallow pools scattered along the river with people having to dig shallow wells in the river bed and along the banks for their water needs.

Yarimawa Well

The Yarimawa well is located about 14 kilometres west of Kano Metropolis approximately 5 kiliometres off Gwarzo road. The well is about 13m deep but during the dry season the yield is so low that it cannot provide enough water to the small settlement of people

around it. The people have to wait for one or two hours for the well to recuperate; but the users not being patient enough for the suspended solids to settle end up carrying highly turbid water for their use.

Kofar Kabuga Well

Due to the flat topography of the area coupled with the clayish and clayish loam soils and closeness to River Watari catchment the water table is always very high. Wells dug in the area for irrigation and water supply are as shallow as 3 metres.

SAMPLING PROGRAMME

Twelve liters sample were collected from each water source and the on site temperature measured. Laboratory experimentation was carried out within 2 hours of sample collection, so that the raw water samples still maintained their natural characteristics. The sampling period spanned two months from late May to July, 1990 to take care of the transition period between the end of the dry season and the beginning of the rainy season.

LABORATORY PROCEDURE

Coagulation tests were carried out using a 4 beaker jar test apparatus equipped with variable speed monitor and paddle stirrers. Dosages of the previously prepared and serially diluted Zogale seeds suspension from 40 - 400mg/1 concentration range were added to each beaker containing 1 litre of raw water sample. Rapid mixing was carried out at 200rpm for 2 minutes to distribute the suspension evenly followed by slow mixing at 20rpm for 20 minutes to allow for flocculation. A settling period of 2 hours was allowed for each sample. Both raw water and treated water sample turbidities were measured using a Flach Portalab Turbidimeter. Other parameters measured were pH, alkalinity and total hardness using procedures outlined in Standard Methods of Analysis of Water and Wastewater (APHA, 1985) for both raw and treated water.

ANALYSIS OF RESULTS

Due to wide variation in dose response throughout the two month monitoring period, data obtained for each raw water source, for ease of presentation, have been averaged for all tests carried out.

WATARI RIVER SAMPLE

Figures 2,3 and 4 depict the variation of dosage with turbidity, alkalinity and hardness.

In Figure 2 it is observed that as dosage increases from 40mg/1 to 200mg/1 turbidity decreases 255 NTU to 15 NTU representing a reduction of 94 percent within a settling period of 2 hours. Figure 3 shows a decrease in alkalinity with increasing dosage from 140mg/1 to 95mg/1 minimum at 100mg/1 dosage; increasing again to 120mg/1 at 200mg/1 dosage.

In figure 4 the total hardness is found to decrease with increasing dosage from 54.8mg/1 as $CaCo_3$ to 25mg/1 as $CaCo_3$.

CHALLAWA RIVER SAMPLE

Figures 5,6 and 7 show the relationship between increasing dosage with turbidity, hardness and alkalinity.

In figure 5, it is observed that with increasing dosage turbidity reduces from 986 NTU to 10NTU, a reduction of 99 percent. In figure 6, total hardness reduces from 95mg/1 as $CaCo_3$ to 30mg/1 as $CaCo_3$: in Figure 7, alkalinity reduces from 65.4mg/l as $CaCo_3$ to 20.88mg/1 as $CaCo_3$ with increasing dosage.

YARIMAWA WELL WATER SAMPLE

Figures 8,9 and 10 show the relationships between increasing dosage and turbidity, hardness and alkalinity respectively.

In figure 8, it is observed that with increasing dosage turbidity decreases from 847 NTU to 13 NTU a reduction of 98.7 percent after 2 hours settling. In figure 9, hardness is found to decrease from 11.20mg/1 as $CaCo_3$ with increasing dosage but increase to 12.3mg/1 as $CaCo_3$ at 100mg/1 dosage. In figure 10, alkalinity is observed to decrease with increasing dosage from 223.5mg/1 as $CaCo_3$ to 177.5mg/1 as $CaCo_3$.

KOFAR KABUGA WELLWATER SAMPLE

Figures 11,12 and 13 depict the relationships between increasing dosage and turbidty, hardness, alkalinity respectively.

In figure 11 it is observed that with increasing dosage turbidity reduced from 205 NTU to 16 NTU, a decrease of 92 percent within 2 hours of settling. In figure 12 it is found that with increasing dosage hardness reduces from 21mg/1 to 17mg/1 as $CaCo_3$ but at a dosage of 150mg/1 the hardness suddenly goes up to 20mg/1. Further dosage increase to 240mg/1 however, results in decrease to 17mg/1 as $CaCo_3$. In figure 13, the alkalinity is observed to decrease from 200mg/1 as $CaCo_3$ to 110mg/1 as $CaCo_3$ with increasing dosage.

DISCUSSION AND CONCLUSIONS

From the relationships established in Figures 2,5,8 and 11 it may be concluded that Zogale seed suspension has coagulating properties which was found to clarify water from diverse sources. The turbidity reduction efficiencies were found to increase with raw water with high initial turbidity values for example 9 percent turbidity reduction was observed for Challawa River water sample with initial turbidity of 986 NTU while a 92 percent reduction was observed for Kofar Kabuga well sample with initial turbidity of 205 NTU. This observation compares with Fokard's (1989) work.

This observation will prove to be an asset since durig the rainy season, surface water sources are known to have high suspended solids and therefore high turbidities which will make treatment of such waters easy and cost effective using zogale seed suspensions. The final turbidity values which ranged from 10 NTU to 16 NTU are all within the World Health Organisation (WHO) recommended standard for portable water supplies of 5-25 NTU. It is also pertinent to note the reduction of hardness from 52.8 mg/1 as $CaCo_3$ to 25 mg/1 as $CaCo_3$ for Watari river sample representing about 53 percent reduction and 59 mg/1 as $CaCo_3$ to mg/1 as $CaCo_3$ represents a reduction of about 49 percent for Challawa river sample. This apparent softening property of Zogale seed suspension requires further exploration for use as a softener for hard surface waters.

However in the case of the two well water sources there is reduction in hardness with increasing dosage, but at 150 mg/1 and 100 mg/1 respectively there is sudden increase in total hardness from 17 mg/1 to 20 mg/1 and 11.2 mg/1 to 12.30 mg/1 respectively. The cause of such behaviour is not fully understood. It may be due to the presence of zones of stability similar to hydrolysing electrolytes. There is therefore the need to carry out studies to explore the characteristic reaction.

The two well waters used were observed to have relatively high alkalinity values of 224 mg/1 and 200 mg/1 as $CaCo_3$ respectively with rather low total hardness values of 11.2 mg/1 and 21 mg/1 ad $CaCo_3$ respectively. This may be due to the presence of sodium-bicarbonate caused by the base exchange softening including natural softening in the underground strata (Twert et al, 1974).

The pH variation with increasing dosage (Tables 1,2,3 and 4) all indicate reduction and stabilization with increasing dosage. The natural buffering capacity of the zogale seed suspension relatively high natural alkalinity in the well waters to be further investigated.

From all the observations noted in the investigations carried out to evaluate the potential of zogale seed suspension in water treatment, it may be concluded that;

1) It has a potential for use as a softener for hard waters.

2) It has a great potential for use as a coagulant for the treatment of surface waters.

3) It has a natural buffering capacity which can handle moderately high to high alkaline surface and ground waters. This property may also be investigated for the treatment of alkaline industrial wastewaters.

RECOMMENDATIONS

1. Further research needs to be carried out to determine the optimum dosage range for each of the identified properties viz softening coagulation, buffering capacity to enable it to be used by water utility companies on a large scale, rural water supplies in small communities.

2. It is recommended that pilot plant studies, demonstrations enlightement campaigns, and preparation of guidelines for field use etc. be carried out by Federal, State and Local Government agencies responsible for provision of

water.

3. Research should be initiated to develop the appropriate technologies required for planting, harvesting, processing, storage, and marketing zogale seeds for use in water treatment. This will help also reduce unemployment, threat of desert encroachment and soil erosion, etc.

4. Studies will need to be carried out to investigate the antibiotic properties of the seed for use as a disinfectant in water treatment.

5. Finally, there is the urgent need to set up research endowment funds in existing research institutions and universities to encourage research into the use of other natural products in water purification which is practised on a small scale by rural communities in parts of Nigeria.

ACKNOWLEDGEMENT

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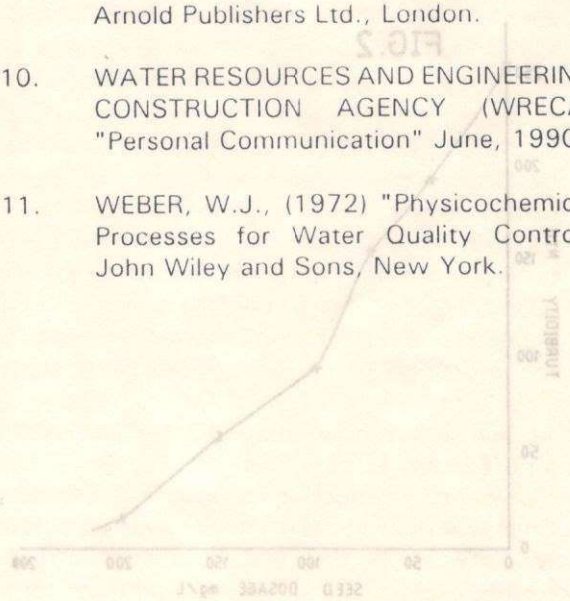
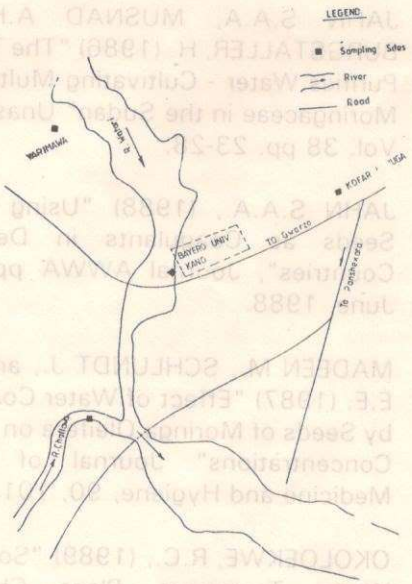


FIG. 1



SKETCHMAP SHOWING WATER SAMPLING SITES

FIG.2

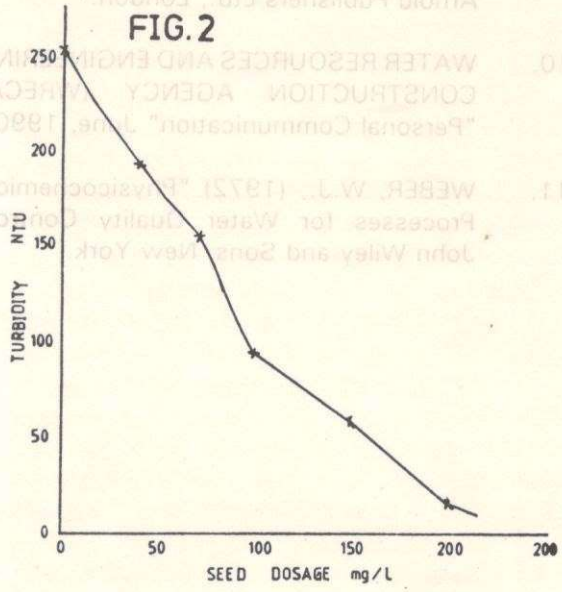


FIG. 3 WATARI RIVER SAMPLE

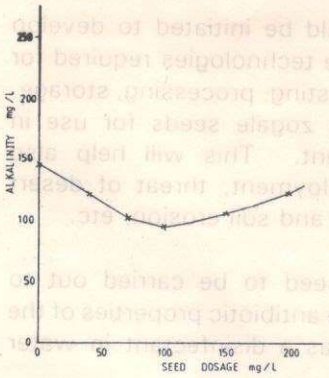


FIG. 4

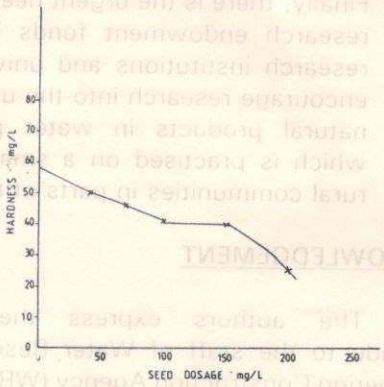


FIG. 5

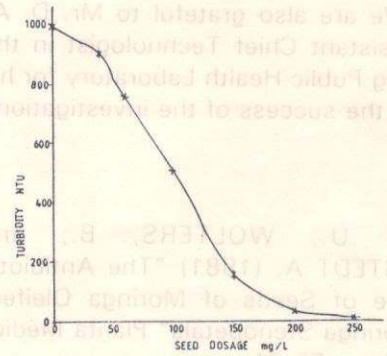


FIG. 6

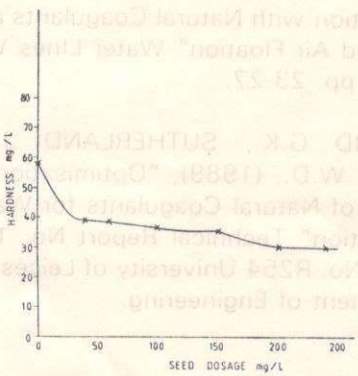


FIG.7 CHALLAWA RIVER

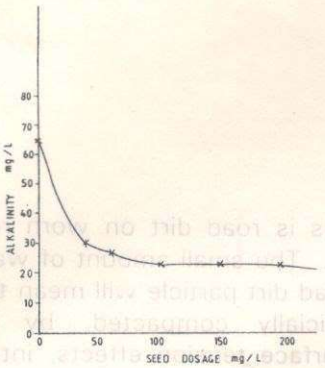


FIG 8

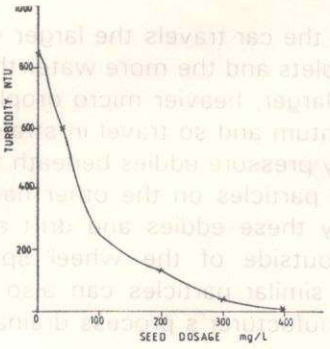


FIG. 9 YARIMAWA WELL

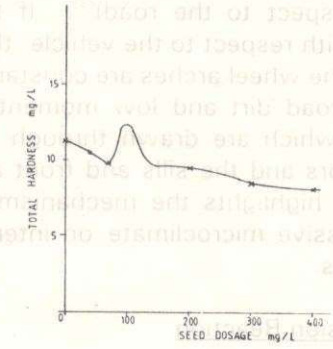


FIG. 10

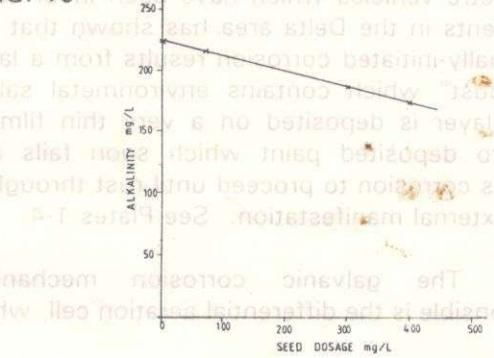


FIG. 11

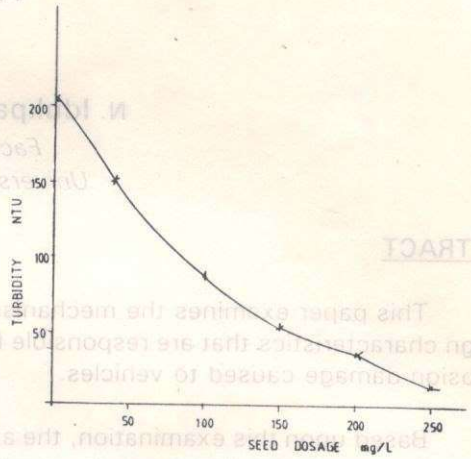


FIG. 12 KOFAR KABUGA

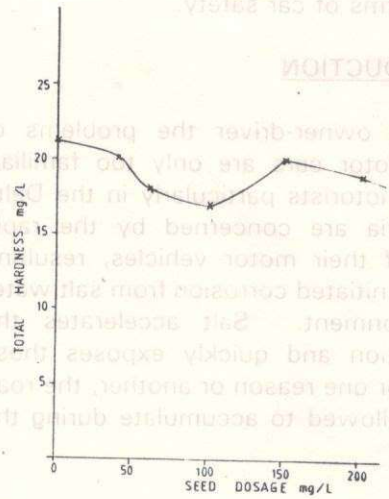


FIG. 13

