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Moringa oleifera and other local seeds in water purification in developing countries

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Abstract

The drinking water qualities in three countries in the South Pacific Islands, namely Fiji, Tonga and Kiribati, were examined due to the deteriorating water quality. This paper reports the uses of the seeds of the local plant Moringa oleifera and a few other local seeds, such as peanuts (Arachis hypogaea), cowpeas (Vigna unguiculata), urad (Vigna mungo) and corn (Zea mays) for their effectiveness in water clarification as natural coagulants in water treatment in the South Pacific.

Moringa oleifera seeds contain proteins that have active coagulation properties and are being used for turbidity removal in many countries. The quality of the treated water was analyzed and experiments were conducted on different dosages of Moringa oleifera seeds. Determinations of pH, turbidity, hardness as calcium and magnesium, heavy metals and nutrient levels were conducted before and after treatment with Moringa oleifera and other seeds. In this study, Moringa seeds were found to be better than the other seeds in turbidity removal and had greater potential for water purifications than the other seeds tested. The use of the local Moringa seeds for clarification is therefore useful in the purification of drinking water in developing countries, since other chemicals used in water purification are expensive.

Keywords: Moringa seeds, water purification.

Introduction

Water that is used for human consumption in the villages of the South Pacific Island countries such as Fiji, Tonga and Kiribati are fresh surface water or groundwater. Water, in rivers, boreholes and wells, acquires chemicals from a variety of sources and these chemicals are accumulated as dissolved and/or suspended constituents[2]. The composition of surface water and groundwater changes on time scales of minutes to years[2]. Natural waters occur at or near the surface of the earth that comes in contact with sedimentary and ingenious rocks promoting metal levels in water[2]. Groundwater is obtained from holes drilled in the ground and water is usually saturated with rock chemicals found at different depths[3].

The chemicals present in groundwater can be due to natural origins and anthropogenic sources such as nitrate from fertilizers and bacteriological contamination from sewage[4]. The groundwater intakes are susceptible to seasonal fluctuations. The rainwater is also used during times of drought is in South Pacific[5]. Rainwater systems, particularly those involving storage tanks, can be a relatively safe supply of water. Surface water used for drinking and cooking purposes requires treatment because it is more vulnerable to contamination from activities occurring at the earth's surface. These are contamination from human waste, livestock and other hazards at the source[6] while groundwater is prone to contamination if soil conditions are sandy and the water tables are shallow[7]. In the rural context, the availability of synthetic chemicals used in the purification of water, its acceptability and environmental safety has to be ensured[8]. However, the use of natural biodegradable materials of plant origin to purify turbid surface waters, if successful, can be promoted. Seeds from *Moringa oleifera* have been recommended for water treatment in Africa and in south Asian countries[9]. According to Jahn[10], the seeds of the *Moringa* family are very efficient water coagulants and toxic side effects have not been noted[11]. This paper reports the use of *Moringa oleifera* and four other local seeds in an attempt to study water clarity and pollutant removal in water treatment in the South Pacific.

Material and Methods

Sample Collection and Handling: The standards methods were used for sample collection and storage to ensure that there was less influence on the distribution system of water samples[12]. For the boreholes and well water, samples were collected close to the source of the supply. River water samples were collected from flowing water. Chemical preservations were employed according to the standard reported methods and the samples were analysed within 10 to 14 days after collection[12]. The pH, temperature and turbidity were measured at the collection sites in order to monitor the chemical and physical characteristics of water samples which are prone to change during transportation.

Seed Preparation and Treatment: For water treatment purposes, the seedpods were first allowed to dry naturally on the tree prior to harvesting[13]. The seed powders of *Moringa* and other local seeds were prepared just before their use. For each treatment, a paste of seed kernel powder with water was prepared and was stirred for 10-15 minutes to release the active components of seed in water[14]. The test water sample was treated with the seed extracts and was stirred rapidly for about 2 minutes and slowly for 10-15

minutes and was then left undisturbed for 2 hours. This process involved the formation of flocs and permitted the impurities to sink to the bottom of the beaker thus leaving a clean water sample, which was filtered and stored for analysis. It was expected that water from different locations and sources would require different quantities of the clarifier due to the variable compositions of suspended materials.

Results and Discussion

It has been shown that water clarification by *Moringa* seeds is due primarily to the action of seed proteins[14]. The *Moringa* seed kernel contains about 37 % of proteins[15]. The isolated *Moringa* flocculants show that the basic polypeptides with molecular weights ranging from 6000 to 16000 Daltons are the main causes of clarifiers. The functional groups in the side chain amino acids of the *Moringa* seed proteins contribute to the water clarification. The mechanism of coagulation with the seeds of *Moringa oleifera* consists of adsorption and neutralization of the colloidal positive charges that attract the negatively charged impurities in water. At a pH below 10, the *Moringa* seed proteins are positively charged and thus the seeds when added to water samples bind to the negatively charged particles (if any) in the samples [15]. In this study, the addition of *Moringa* seeds did not have any effect on the pH of the water samples.

Effect of the treatments with seeds on the turbidity of the water: Figure 1 shows the effect of treating turbid water samples with five different seeds. Compared to the original turbidity of the water sample (Figure 1), *Moringa* was more effective than the others in turbidity removal. The seeds would have been much better turbidity removers, if de-fatted seeds were used in the study, as the seed oils get released into the water affecting the turbidity levels as seen when peanuts, which are rich in fatty oils, were used. Figure 2 shows the effect of time on turbidity removal by *Moringa* and other local seeds. Within two hrs after treatment, *Moringa* seeds were observed to reduce the turbidity levels by almost one-fifth the original turbidity in the water sample tested. The flocculations of particles by *Moringa* seeds apparently involves charge neutralization and inter particle bridging between the negatively charged proteins in seeds that brings about floc formation[16, 17].

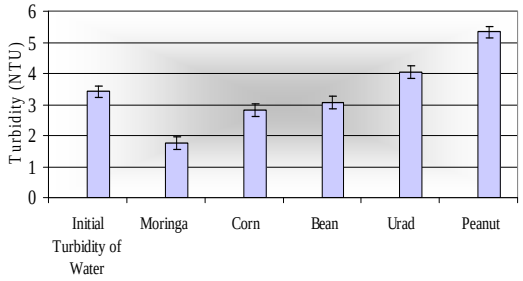

Fig. 1: Effects of Local Seeds on Turbidity of Water Sample.

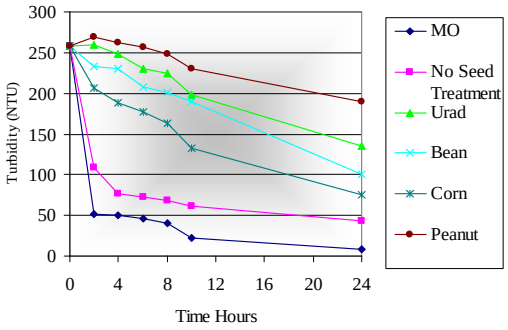

Fig. 2: The graph of Turbidity versus Time for *Moringa* and other Local seeds

Hardness removal: Figure 3 shows the total hardness removal of water using *Moringa* seeds, peanuts, corn and beans (cowpeas) and *urad*. The percentage removal of hardness for peanuts, corn, beans (cowpeas) and *urad* was about 25 %, 19 %, 22 % and 24 % respectively. However, *Moringa* seeds showed a higher percentage (34 %) of hardness removal compared to the other seeds. Hardness removal is considered to be due to the types of the proteins that are present in the seeds and the adsorption due to chelations of the metal ions to these proteins.

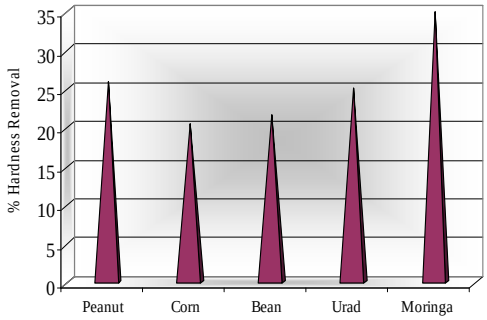

Fig. 3: Percentage removal of Water Hardness using other Local Seeds

Removal of heavy metals: The adsorption of metals using *Moringa* seeds is considered to be not very high due to the limited adsorption surface since it is a cationic polyelectrolyte of a short chain and having a relatively low molecular weight[18]. However, figure 4 shows that *Moringa* seeds removed the heavy metals tested (Cu, Pb, Cd, Cr and Zn) better than beans (cowpeas), *urad*, peanut or corn. The percentage removal of the metals tested by *Moringa* seeds (Figure 4) were: copper (90 %), lead (80 %), cadmium (60 %), zinc (50%) and chromium (50 %). Beans (cowpeas) and peanuts were found not to be very effective in the removal copper and cadmium. The study showed that beans (cowpeas) and peanuts adsorbed less than 15 % of these metals from the water samples tested. Corn and *urad* showed ability to remove heavy metals from water but not as effective as *Moringa* seeds (Figure 4).

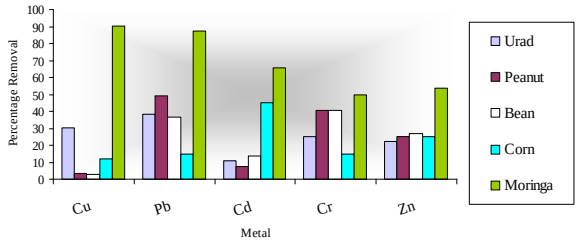

Fig. 4: Percentage Removal of Metals Using *Moringa* and other Local Seeds.

The nitrate/nitrite and the phosphate levels in the water samples collected from the three regions were relatively low and well below the WHO permitted levels and thus did not pose any threat to the drinking water tested. It must be mentioned here that the nitrate/nitrite and phosphate levels of the water samples tested showed a slight increase in the levels of these nutrients compared to the levels in the original water samples. This is not surprising considering the fact that the treatment of water samples by the addition of seeds would inevitably add the seeds' natural phosphate and nitrate/nitrite to the water samples as leachates. According to the literature, orthophosphate levels in water, during treatment increase with the *Moringa* dose and also slight increases were noted in the total nitrates and nitrites after treatment-using *Moringa* extracts[19]. It could also be suggested at this stage that if this is a concern, then instead of using the seed powders for water clarification, one could use only the purified proteins extracted from the *Moringa* seeds. These proteins have indeed been shown to be effective in the removal of phosphates and nitrates in the water samples tested[19].

Conclusion

The paper evaluates *Moringa oleifera* (the local variety) seeds as a water purifier in the South Pacific and shows that it would be possible to develop an economical and an environmentally safe method of water purification. In this study, other locally produced seeds such as peanuts (*Arachis hypogaea*), cowpeas (*Vigna unguiculata*), urad *(Vigna mungo*), corn (*Zea mays*) that have almost similar types of cationic poly-electrolytes and proteins[20] have been tested for their effectiveness in purifying drinking water. Comparing these results with those obtained by using the other local seeds, *Moringa* seeds show a higher efficiency and thus, a greater potential to serve as an alternative coagulant for water treatment. The results obtained in this study were comparable with the performance achieved by previous workers using *Moringa oleifera* extracts for water purification. Thus, interventions to improve the quality of drinking water will provide significant benefits to the health of people in the Pacific. The use of local *Moringa* seeds as primary coagulants for clarification of turbid waters is useful in the production of drinking water in developing countries where purchase of other coagulants are expensive and the operating costs are high.

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