



Moringa oleifera - The Nature's Gift

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Abstract:

Moringa oleifera belongs to the family *Moringaceae* which is a single genus family of shrubs and trees cultivated across the whole of the tropical belt and used for a variety of purposes. Each tree can produce approximately 15000-25000 seeds and 400-1000 pod /year the average of weight of non shelled seed is 0.3 gm (300 mg). Many researchers have reported on the various uses of *Moringa oleifera* seeds as coagulant and coagulant aid in the last 20 years. *Moringa oleifera* coagulant has been found to have high coagulation activity only for high turbidity water. Extracts of seeds from the *Moringa oleifera* tree have been found to be one of the most effective clarifiers. The sludge left over from the water after treatment can also be used as a bio-fertilizer/bio-compost which has been shown to increase yields of other staple food crops. *Moringa* leaves can also be used very effectively as an animal feed. Its seeds yield 38-40% edible oil known as Ben Oil. In traditional medicines, it is used to treat a wide variety of ailments like headaches, worms, diarrhoea, stomach ulcers, skin conditions, anemia, infections, fevers, urinary problems, liver and spleen problems, arthritis and rheumatism.

Keywords: *Moringa oleifera*, natural coagulant, water purification, medicinal uses.

1.0 Introduction:

Moringa oleifera belongs to the family *Moringaceae* which is a single genus family of shrubs and trees cultivated across the whole of the tropical belt and used for a variety of purposes (Jahn, 1986). The dry seed suspension is known to be a natural coagulant and coagulant aid (Folkard *et al.*, 1989). In the Sudan, dry *Moringa oleifera* seeds are used in place of alum by rural women to treat highly turbid Nile water. In Northern Nigeria, the fresh leaves are used as a vegetable, roots for medicinal purposes and branches for demarcation of property boundaries and fencing. Studies by (Eilert *et al.*, 1981) identified the presence of an active antimicrobial agent in *Moringa oleifera* seeds. The active agent isolated was found to be 4a L-rhamnosyloxy-benzyl isothiocyanate, at present the only known glycosidic mustard oil. (Madsen *et al.*, 1987) carried out coagulation and bacterial reduction studies on turbid Nile water in the Sudan using *Moringa oleifera* seeds and observed turbidity reduction of 80-99.5% paralleled by a bacterial reduction of 1-4 log units (90-99.9%) within the first one to two hours of

treatment, the bacteria being concentrated in the coagulated sediment. (Sani, 1990) carried out jar tests with *Moringa oleifera* as the primary coagulant using water from four different sources (viz two surface and two shallow wells) with turbidities from 100 to 800 ntu and 80 to 150 ntu respectively and hardness from 180 to 300 mg/l as CaCO₃. It was observed that in addition to turbidity reduction of 92-99%, the hardness was also reduced to between 60-70% after coagulation and two hours settling. The softening property of *Moringa oleifera* which was accidentally discovered in that study is the only one documented to date. The present study was therefore carried out to explore further the potential of this multipurpose tropical plant as a new method for use in the softening of hard groundwater.

Each tree can produce approximately 15000-25000 seeds and 400-1000 pod /year. The average of weight of non shelled seed is 0.3 gm (300 mg). The kernel to hull ratio is 75.25% (Jahn, 1988). About 75% of the present world population lives in the developing countries of the world. About 1.2 billion people still lack safe drinking water and more than 6

million children die from diarrhea in developing countries every year. However, it is untenable and unbelievable under all situations that waterborne diseases still kill on the average 25,000 people every day in developing countries while millions suffer the debilitating effects of these diseases (Gassenschmidt *et al.*, 1995; Kalbamatten *et al.*, 1983). Safe drinking water is essential to the health and welfare of a community, and water from all sources must have some form of purification before consumption. Various methods are used to make water safe and attractive to the consumer. The method employed depends on the character of the raw water. One of the problems with treatment of surface water is the large seasonal variation in turbidity (McConnachie *et al.*, 1999).

Current operational procedures at many treatment works in developing countries are based on arbitrary guidelines, particularly in relation to the dosage of chemicals. Besides that, there is also the problem of inadequate number of skilled workers and inadequate laboratory facilities to monitor process performances required to operate the plants. Coagulation-flocculation followed by sedimentation, filtration and disinfection, often by chlorine, is used worldwide in the water treatment industry before distribution of treated water to consumers (Rauter, 2003).

Many coagulants are widely used in conventional water treatment processes for potable water production. These coagulants can be classified into inorganic coagulant, synthetic organic polymer, and naturally occurring coagulant. Synthetic polyelectrolytes are used as primary coagulant as well as coagulant aid to improve the strength of particle aggregates, enhance coagulation and deposition (filtration) (Muyibi *et al.*, 1995a). Naturally occurring coagulants are usually presumed safe for human health while there is a fear by using aluminum salts that may induce Alzheimer's disease (Martyn *et al.*, 1989). Some studies on natural coagulants have been carried out and various natural coagulants were produced or extracted from microorganisms, animals or plants (Ganjidoust *et al.*, 1997; Kawamura 1991). Recently, however, there has been a resurgence of interest in natural coagulants for water treatment in developing countries (Ndabigengesere *et al.*, 1998).

Moringa oleifera is one of the most wide spread plant species that grows quickly at low altitudes in

the whole tropical belt, including arid zones. It can grow on medium soils having relatively low humidity (Ndabigengesere *et al.*, 1998). *Moringa oleifera* seeds are an organic natural polymer. It has presented *Moringa oleifera* as a coagulant after her studies in the Sudan when she noticed that Sudanese village women used it at home to clear the turbid Nile water. Later, many researchers have reported on the various uses of *Moringa oleifera* seeds as coagulant and coagulant aid in the last 20 years. *Moringa oleifera* coagulant has been found to have high coagulation activity only for high turbidity water. The activity is low for low turbid water. Therefore, it is important to improve the characteristics of this plant by identifying its bioactive constituents, which has high coagulation activity. This is one of the objectives of this study.



Figure 1: *Moringa oleifera* Tree

Pollution of surface and groundwater from agriculture, domestic and industrial activities has not been regularly monitored and recorded as a problem. This may be due to the absence of a problem or the lack of monitoring facilities in the Pacific Island Countries (Litidamu *et al.*, 2003). The quality and accessibility of drinking water are of paramount importance to human health. Drinking water may contain disease-causing agents and toxic chemicals and to control the risks to public health, systematic water quality monitoring and surveillance are required.

Thousands of chemicals have been identified in drinking water supplies around the world and are considered potentially hazardous to human health at relatively high concentrations (WHO, 2004). Heavy metals are the most harmful of the chemical

pollutants and are of particular concern due to their toxicities to humans. Metals and metalloids with atomic weights ranging from 63 to 200.6 g/mol and densities greater than 4.5 g/cm³ are stable in nature. There are 59 elements classified as heavy metals and out of these five are considered to be highly toxic and hazardous heavy metals. These are cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb) and zinc (Zn) which are released into the environment by human activities or through natural constituents of the earth's crust (Lata *et al.*, 2002).

Cadmium pollutants in water may occur from industrial discharge and mining waste (Manahan, 2005). Cadmium contamination is caused by its release in wastewaters and contamination from fertilizers and air pollutants. Cadmium is more toxic than lead and chromium. Cadmium at extreme levels causes itai-itai disease and at low levels over prolonged periods causes high blood pressure, sterility among males, kidney damage and flu disorders. Hence, cadmium removal in water using natural polyelectrolytes such as *Moringa* seeds would be an advantage (Muyibi *et al.*, 2002).

Chromium is widely distributed in the earth's crust and is used in metal plating (Crosby, 2002). In general, food appears to be the major source of chromium intake and on the basis of guideline value, there are no adequate toxicity studies available to provide long-term carcinogenicity study (Sawyer *et al.*, 2003). In epidemiological studies, an association has been found between exposure to chromium (VI) by the inhalation route and lung cancer.

Copper is both an essential nutrient and a drinking water contaminant. Recent studies have shown effects of copper in drinking water on the gastrointestinal tract, but there is some uncertainty regarding the long term effects of copper on sensitive populations such as carriers of the gene for Wilson disease and other metabolic disorders of copper homeostasis (Sawyer *et al.*, 2003). Lead in water arises from a number of industrial and mining sources and is the most widely distributed of all toxic metals.

Lead in water causes serious problems such as anaemia, kidney disease and affects the nervous system. Placental transfer of lead in humans affects babies and young children absorb 4–5 times as much lead as adults. The lead toxicant accumulates in the skeleton and causes adverse health effects and

interferes with calcium metabolism and with vitamin D metabolism (Baird, 1999). However, evidence from studies in humans show adverse neurotoxic effects other than cancer occurring at very low concentrations of lead. Therefore, there is need for the removal of lead from all drinking water.

Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complexes. Zinc is found in industrial waste and used in metal plating. Therefore, sources of zinc in water are mainly from industrial discharge and natural sources. The removal of zinc is important for water treatment processes in producing good quality water (Xue *et al.*, 1994).

2.0 Cyanobacteria Removal:

In conventional water-treatment processes, the clarification stage involves the addition of chemical coagulants and flocculants to remove colour, turbidity, and organic matter. Regarding cyanobacteria removal by coagulation, good results have been reported, depending on the characteristics of organic matter present in water, the prevalent cyanobacteria species, and the type and concentration of coagulant (Fatoki *et al.*, 2002).

Aluminum sulfate is the most common of these coagulants. However, the production of Non-biodegradable sludge and indications of health hazards have led to the search for other coagulants that are less harmful to the environment and to human health. Therefore, several natural coagulants are being studied, including the seeds of the horseradish tree *Moringa oleifera* Lam. This material is non-toxic and biodegradable. It is environmentally friendly, and unlike alum, does not significantly affect the pH and conductivity of the water after the treatment (Heng *et al.*, 2009).

The use of natural materials to clarify water has been practiced for centuries. Extracts of seeds from the *Moringa oleifera* tree have been found to be one of the most effective clarifiers. Studies to test its effectiveness for treating water have been conducted since the early 1970's (Henderson *et al.*, 2010). These early investigations established its effectiveness as a coagulant for treatment of water with high levels of turbidity. Other plant extracts, such as from the seeds of *Prosopis juliflora* tree, have also been shown to be good coagulants (Shen *et al.*, 2011). Of equal importance to coagulation

efficiency is the human health issue in the use of such coagulants for potable water production. Toxicological assessments indicate that use of *Moringa oleifera* as a primary coagulant does not pose a human health threat (Rondeau *et al.*, 2001). The use of non-toxic natural coagulants obtained from local resources would lessen the economic hardship in developing countries of procuring conventional chemical coagulants. Several in-depth studies have confirmed that *Moringa oleifera* seeds possess effective coagulation properties (Nkurunziza *et al.*, 2009). Treatment efficiency for this alternate natural coagulant is high. It has reported turbidity removals by *Moringa oleifera* used as a primary coagulant as high as 99% for river waters with initial turbidities ranging from 105 to 350 nephelometric turbidity units (NTU) (Beth, 2005). These studies have also revealed that a crude water extract of *Moringa oleifera* compares quite positively with aluminum sulfate and, as such, its use has been suggested for use as a water treatment agent in developing countries (Forster *et al.*, 1999).

Early studies focused on the quality of water treated by coagulation using two forms of the moringa seed shelled versus unshelled seeds (Berger *et al.*, 1984). Extracts prepared from powdered unshelled seed were less effective in coagulation and removal of turbidity. Mature seed extracts are more effective in turbid waters than immature seed extracts (Grabow *et al.*, 1985). These studies indirectly addressed the level of active ingredient in *Moringa oleifera* preparations, which have been purified and isolated as dimeric cationic proteins. A disadvantage of its use is that the concentration of organic matter in treated water increases with coagulant dose, which may pose water quality problems with storage of treated water. In addition, coagulation efficiency of *Moringa oleifera* decreases with an increase in storage duration because it is highly biodegradable with a short shelf life (Muyibi *et al.*, 1995b). Other studies have also shown that the coagulation efficiency can be increased by extracting its active component using a salt (Muyibi *et al.*, 1996).

3.0 Nutrition:

Nearly all parts of the Moringa tree have a high degree of nutritional value. Together, the edible parts of the tree contain high amounts of the 8 "essential amino acids" that your body does not produce but must be replenished daily (Amagloh *et al.*, 2009).

4.0 Purifying Water:

When crushed into a powder, the seeds from Moringa trees act as a natural flocculent which can be used to purify dirty water, eliminating between 90-99% of bacteria. The powder joins to the solids in the water and sinks to the bottom. The residue (seed cake) left over from making Ben Oil from the seeds can be used in the same way. The sludge left over from the water after treatment can also be used as a bio-fertilizer/bio-compost which has been shown to increase yields of other staple food crops. This therefore presents an excellent cycle for the seeds which can be used by rural communities: firstly using the seeds to make Ben Oil (which can be sold on); then using the seed cake from the oil extraction process to purify water and then finally using the sludge left over from the water purification process as a bio-fertilizer for other crops (Jahn, 1988).

5.0 Animal Fodder and Crop Fertilizer:

Moringa leaves can also be used very effectively as an animal feed. One study found that after giving milk cows a continued diet of Moringa leaves their daily weight gain increased by up to 32% and their milk production went up from 43-65%. When harvesting Moringa leaves, the leftover stalks can be fed to livestock with similar benefits. Furthermore, another study has found by extracting the juice from the green matter of the plants, mixing it with water and then spraying it onto other crops, it increased the growth of young plants; produced more fruit and larger fruit on other plants and increased yields in some crops by 20-35% (Ndabigengesere *et al.*, 1995; Katayon *et al.*, 2004).

6.0 Enterprise Development - Ben Oil:

The seeds of Moringa yield 38-40% edible oil known as Ben Oil. This oil is relatively easy to extract using simple household technology and can be used/sold for a huge variety of uses: cooking (it is colorless, odorless and resists rancidity), cosmetics (it has properties which are very nourishing for the skin), perfumes, massages, aromatherapy, oiling machinery, making soap and it has even been speculated that it could be used as a biofuel. It is one of the most stable oils in nature and does not go rancid, having a shelf life of up to 5 years. Therefore, extracting Ben Oil from Moringa seeds has a lot of potential commercially for communities in developing countries. There is already an increasing demand for Moringa oil in the west, where it is

recognized as luxury aromatherapy oil (Katayon *et al.*, 2006a; Katayon *et al.*, 2006b).

7.0 Medicinal Uses:

Various parts of the Moringa tree have been used as traditional medicines to treat a wide variety of ailments in Asia and Africa. It is said that the various parts of the Moringa tree can effectively treat ailments such as: headaches, worms, diarrhoea, stomach ulcers, skin conditions, anemia, infections, fevers, urinary problems, liver and spleen problems, arthritis and rheumatism. However, one should be cautious when promoting Moringa for this purpose at this point in time as these traditional remedies have yet to be scientifically proven. This is especially important for remedies relating to the use of Moringa roots, which can be highly toxic if not prepared correctly (Tsatsuji *et al.*, 2001; Tsatsuji *et al.*, 1999).

8.0 Conclusion:

It is concluded from this text that *Moringa oleifera* has rich potential applications for human and animals. Many researchers reported different applications of *Moringa oleifera* as coagulant, bio-fertilizer/bio-compost, animal feed, oil, medicine, cyanobacteria removal, nutritional value and heavy metal removal (Cadmium, Chromium, Copper, Lead and Zinc). Here we brought together all potential applications to convey the richness of the nature's gift- *Moringa oleifera*.

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