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Research paper

Evaluation of the efficacy of moringa oleifera seed powder on some physicochemical parameters in White Nile River water

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Abstract

This study was aimed to evaluate the efficacy of Moringa oleifera seeds powder on purification of White Nile River water, during the dry season (March-April 2014). Water samples were collected from twelve different locations from the River at El duwaim city, on dimension 3.0 meters in front of the bank and 20 centimeters in depth. The physico-chemical parameters concentrations of water samples (pH, turbidity, electrical conductivity, total dissolved salts, total hardness, iron and chloride ions) were detected before treatment by Moringa oleifera seeds powder., various doses of Moringa seed powder (50, 100 and 150 mg/L) were added to water samples for a duration of one to two hours, then analyzed to detect the effects on that parameter. The results showed significant ($p \leq 0.05$) decreased concentrations of all mentioned parameters, directly proportional with increasing dose and time respectively (except pH).

Keywords: *Disinfectant; Health Risk; Household Water; Moringa Oleifera; Physico-Chemical.*

1. Introduction

Water is a major need for life survival on the earth. Good quality of drinking water is one of the most human necessities, and the lack of access to adequate safe water supplies leads to the spread of diseases [18-6]. Surface water was polluted by people at greatest risk are children, people living under unsanitary conditions and the elderly [15]. For many developing countries water treatment process involved coagulation, flocculation and sedimentation and disinfection are expensive processes because of the high costs involved and the difficulty in assessing the chemical coagulants including alum. This is the reason why these countries need low-cost methods requiring low maintenance and skill. Poly aluminum chloride and alum added impurities such as epichlodine are carcinogenic [16]. Many plants have been used to clarify water. Naturally occurring coagulants are usually presumed safe for human health. These include Moringa oleifera, Moringa stenopetala, Vicia faba [19-20]. Many researchers reported that the Moringa oleifera seed is non-toxic and good coagulant in water treatment. It is recommended to be used as a coagulant in developing countries. The major problem of drinking water in Sudan and other developing countries is not just a lack of water availability, but in fact, that the people are not concerned with the water quality which, causes health risk. In Sudan for many years drinking water pollution problems were not payed attention, but today the population is aware of the importance of good water quality and its relationship to health. The knowledge that seeds from the Moringa oleifera tree can purify water is not new; the seeds have been used for generations in countries like India and Sudan [22]. The traditional use of the Moringa oleifera seeds for domestic household water treatment has been well known to certain rural areas in the Sudan [20]. In some countries flowers and fruit appear twice a year, so two harvests occur [7]. In the West Asia, one of the best-known uses for Moringa oleifera is the use of powdered seeds to flocculate contaminants and purify drinking water [6]. Detailed studies have been carried out on the use of Moringa oleifera seeds extract in water treatment [3]. The coagulant property in the seeds was first confirmed in the year 2000 [1]. The active agent is believed to be a protein, but the exact form of the protein is not yet known. Recent researchers have identified proteins of sizes ranging from 3 to 60 kDa, all possessing coagulating ability, which means that the Moringa oleifera seeds probably contain several different proteins that may act as coagulants. These protein(s) act as cationic polyelectrolytes [10], which attach themselves to the soluble particles and create bindings between them, leading to large flocs in the water. Stirring and mixing accelerates the electrostatic flocculation, and the flocs condense [25]. It was identified that the active ingredient in the Moringa oleifera seed to be a Polyelectrolyte [14]. According to (Jahn, 1988), the Moringa oleifera flocculants are basic polypeptides with molecular weights ranging from 6,000 to 16,000 Daltons. Six polypeptides were identified with their amino acids being mainly glutamic acid, proline, methionine, and arginine. [7] identified the active ingredient as a polypeptide acting as cationic polymers; and [19] reported that the active ingredients in an aqueous Moringa extract are dimeric cationic proteins with molecular weights of about 13 000 Daltons and iso-electric point of between 10 and 11. Coagulation is by far the most widely used process to remove the substances producing turbidity in water. These substances normally consist largely of clay minerals and microscopic organisms and occur in widely varying sizes ranging from those large enough to settle readily to those small enough to remain in suspension for a very long time. Colloidal and fine impurities in water possess a certain anticoagulation stability which is due to the presence of hydrate shells or a double electric field around particles. This anti-coagulation stability of impurities can be disturbed by heating, freezing, addition of electrolytes to water or by the application of a magnetic field. This problem is most often solved by coagulating hydrophilic and hydrophobic impurities [21]. The active ingredient in the Moringa oleifera seed has also been identified as a polyelectrolyte [14]. Its use for coagulation, co-coagulation, or coagulant aid has been a subject of investigation in many parts of the world. Most of these works have been documented by [19-9]. Turbid water-clarifying properties of Moringa oleifera were first reported by Jahn after observing the use of its seeds by Sudan women for clarifying turbid Nile water. Softening of water with Moringa oleifera has a potential advantage since it is accompanied by very low reduction in alkalinity, which is required to provide the necessary buffering capacity to achieve required treatment objectives [18].

2. Statistical analysis

Study results were statistically analyzed in accordance to SPSS version 2019. Purification potential of M. oleifera seed powder was tested by analyzing the physicochemical characteristics of White Nile River water samples. The mean values of various physicochemical parameters corresponding to twelve different water sources before and after treatment with 50, 100 and 150 mg/L concentrations of M. oleifera seed powder according to 1 and 2-hour(s) time intervals were represented in Table-1 and Table-2, the mean values of physicochemical parameters before treatment of water samples were reported. The addition of powdered moringa seed (M. oleifera) as a coagulant in River water treatment processes did not significantly affect the temperature. Temperature of each sample was still in the normal temperature range for water.

3. Experimental designs

Total dissolved solids (T.D.S), electrical conductivity (E.C), and pH were determined in accordance to method described by [14]. Samples' alkalinity (mg/l) were determined in accordance to method described by [14]. Water hardness (mg/l) was determined in accordance to method described by [24]. Turbidity measurements (mg/l) were conducted in accordance to method described by [23]. Iron concentration (mg/l) was detected in accordance to method described by [6].

4. Results

Table 1: Physicochemical Parameters Before and After Treatment of White Nile River Water with Dose 50 Mg/L of M. Oleifera Seed Powder at Different Settling Time Intervals

Parameters	Control	50 mg/L 0ne hour	Two hours
PH	7.49 ± 0.10^{a}	7.22 ± 0.29^{b}	7.30 ± 0.18^{ac}
Turbidity (mg/L)	337.09 ± 21.53^{a}	109.48 ± 6.26^{b}	88.23 ± 6.67^{bc}
Conductivity	182.10 ± 4.75^{a}	139.48 ± 3.75^{b}	123.94 ± 3.14^{c}
T.D. S (mg/L)	77.38 ± 1.99^{a}	49.57 ± 1.36^{b}	45.95 ± 1.34^{c}
Hardness (mg/L)	8.46 ± 0.17^{a}	5.75 ± 0.13^{b}	5.24 ± 0.12^{c}
Alkalinity (mg/L)	46.70 ± 1.54^{a}	17.63 ± 0.60^{b}	16.26 ± 0.47^{bc}
Iron (mg/L)	0.34 ± 0.02^{a}	0.23 ± 0.01^{b}	0.22 ± 0.01^{cb}
Chloride (mg/L)	21.37 ± 1.31^{a}	15.42 ± 1.03^{b}	14.69 ± 0.94^{bc}

Data are presented as means ± SE.$^{a, b, c, d, e, f, \text{ and } g}$ value with different superscripts in the same round column are significantly different at ($P \leq 0.05$).

Table 2: Physicochemical Parameters Before and After Treatment of White Nile River Water with Doses 100 & 150 Mg/L of M. Oleifera Seed Powder at Different Settling Time Intervals

Parameters	Control	100 mg/l 1 Hour	2 Hours	150 mg/l 1 Hour
PH	7.49 ± 0.10^{a}	7.40 ± 0.20^{ad}	7.42 ± 0.21^{e}	7.43 ± 0.13^{af}
Turbidity (mg/L)	337.09 ± 21.53^{a}	67.05 ± 4.27^{dc}	42.03 ± 2.61^{e}	23.07 ± 1.43^{ef}
Conductivity	182.10 ± 4.75^{a}	113.85 ± 3.09^{de}	109.41 ± 3.01^{e}	78.52 ± 2.31^{f}
T.D. S (mg/L)	77.38 ± 1.99^{a}	37.57 ± 1.04^{d}	32.82 ± 0.98^{e}	24.32 ± 0.71^{f}
Hardness (mg/L)	8.46 ± 0.17^{a}	4.22 ± 0.15^{de}	3.96 ± 0.09^{e}	2.79 ± 0.07^{f}
Alkalinity (mg/L)	46.70 ± 1.54^{a}	15.44 ± 0.58^{dbc}	15.14 ± 0.59^{ebd}	14.26 ± 0.68^{fcd}
Iron (mg/L)	0.34 ± 0.02^{a}	0.15 ± 0.01^{d}	0.13 ± 0.00^{ed}	0.13 ± 0.00^{fd}
Chloride (mg/L)	21.37 ± 1.31^{a}	12.46 ± 0.81^{cd}	11.11 ± 0.66^{ed}	8.88 ± 0.57^{fg}

Data are presented as means ± SE.$^{a, b, c, d, e, f, \text{ and } g}$ value with different superscripts in the same round column are significantly different at ($P \leq 0.05$).

5. Discussions

The pH increases with increasing concentrations of the Moringa as coagulant. It was reported that the action of Moringa oleifera as a coagulant lies in the presence of water-soluble cationic proteins in the seeds. This suggests that in water, the basic amino acids present in the protein of Moringa oleifera would accept a proton from water resulting in the release of a hydroxyl group making the solution basic [11]. It was observed that the turbidity of River water was significantly decreased at ($P \leq 0.05$) with increasing of Moringa oleifera seed powder dose at 50, 100 and 150 mg/l respectively. Residual turbidity was reduced to 23.07 NTU. This result agrees with range of optimum dosage research work by [9]. Due to this there was an improvement in the flock size and flock settled rapidly. The overdosing resulted in the saturation of the polymer bridge sites and caused destabilization of the destabilized particles due to insufficient number of particles to form more inter-particle bridges. The high positive charge and small size suggest that the main destabilization mechanism may be adsorbed and charge neutralization. This was also reported by [12] who reported that 90-99% of turbidity was removed by using Moringa oleifera seed powder. Electrical conductivity in River water samples before and after treatment was shown in Table 1, and Table 2. Before the treatment with Moringa oleifera seeds electrical conductivity was 182.10 µS/cm. After the treatment, the electrical conductivity of River water was reduced with increasing dose of Moringa oleifera seed powder 50,100 and 150 mg/L respectively. The range of decreased electrical conductivity was 131-73 µS/cm. The decrease in EC of water with Moringa oleifera seeds was due to the presence of lower molecular weight water soluble proteins which carry positive charge [14-1]. TDS levels in River water samples before and after treatment were given in Table 1. Moringa oleifera is known to be a natural cationic polyelectrolyte and flocculent with a chemical composition of basic polypeptides with molecular weights ranging from 6000 to 16,000 Daltons, containing up to six amino acids of mainly glutamic acid, methionine and arginine [16]. The presences of hardness in River water samples before and after treatment were shown in Table-1. And Table 2. Mean hardness was 8.47 mg/l for river water sample. It was observed that hardness of water was decreased with increased dose of Moringa seed powder at 50, 100 and 150 mg/l of river water. Hardness range was 5.75 – 2.79 mg/l which within the limits of WHO standards. Alkalinity levels in river water samples, before and after treatment were shown in Table 1, and Table 2, Alkalinity during the present research work was observed to be 46.71mg/l for River water. Iron metal concentration was reduced significantly after treatment with different dosage of Moringa oleifera seeds shown in Table 1 and Table 2. The removal of metal ions increased with increased of Moringa oleifera seed powder. More decrease in metals load was observed for Moringa was due to heterogeneous properties, the aqueous solution of Moringa oleifera seeds contains low molecular weight amino acids. These amino acids contain physiologically active group of binding agents which at low concentration interact with metals to increase the sorption of metal ions [2]. In addition, these proteinous amino acids have pH dependent properties which generate negative charged environment playing important role in binding of metals [12]. Chloride ion concentration in River water samples before and after treatment were shown in Table 2.

6. Conclusions

Moringa oleifera seeds powder acts as a natural coagulant, flocculent, absorbent for the treatment of drinking water. It reduces the total hardness, turbidity, alkalinity, chloride, and iron after the treatment. It is eco-friendly and cheaper method of purification of water and therefore can be used in the rural areas where no facilities are available for the treatment of drinking water.

7. Recommendations

Due to its efficiency in water purification compared to chemicals and low cost, Moringa oleifera seeds powder is recommended. Further researches for advanced techniques to isolate the active ingredients in the Moringa oleifera seeds are highly recommended.

References

[1] A.B. Olayemi, R.O. Alabi, Studies on traditional water Purification using M. oleifera seed, African study monographs 15 (1994) 101-109.

[2] A.C. Brostlap, J. Schuurmans," Kinetics of valine uptake in tobacco leaf disc. Comparison of wild types the digenic mutant and its monogenic derivatives". Planta 176 (1988) 42-50. https://doi.org/10.1007/BF00392478.

[3] A. Ndabigengesere, K.S. Narasiah, Quality of water treated by coagulation using Moringa oleifera seeds, Wat. Res 32 (3) (1998) 781-791. https://doi.org/10.1016/S0043-1354(97)00295-9.

[4] APHA. Standard methods for the examination of water and wastewater. 18th ed. American Public Health Association, Washington, DC (1992).

[5] APHA. Standard methods for the examination of water and wastewater,19th edu. American Public Health Association (1995).

[6] A. Vogel, Textbook of Quantitative Inorganic Analysis, 3rd Ed pp. 294, 310 and 787.

[7] C. Ramachandran, K.V. Peter, P.K Gopalakrishnan, "Drumstick (Moringa oleifera): A multipurpose Indian vegetable", Economic Botany 34 (3) (1980) 276–283. https://doi.org/10.1007/BF02858648.

[8] E.A. Atekwanaa, R.S. Roweb, J.D. Werkema, F.D. Legalld, "The relationship of total dissolved solids measurements to bulk electrical conductivity in an aquifer contaminated with hydrocarbon" (PDF), Journal of Applied Geophysics, Elsevier 56 (4) (2004) 281–294. https://doi.org/10.1016/S0926-9851(04)00057-6.

[9] G.K. Folkard, J.P. Sutherland, W.P. Grant, Optimization on the use of natural coagulants for water purification; Technical report No. R4254; Department of Engineering, University of Leicester (2005).

[10] J. Robles-Molina, F.J. Lara-Ortega, B. Gilbert-López, J.F. García-Reyes, A. Molina-Díaz, Multi-residue method for the determination of over 400 priority and emerging pollutants in water and wastewater by solid-phase extraction and liquid chromatography-time-of-flight mass spectrometry, J Chromatogr A 1350 (2014) 30–43. https://doi.org/10.1016/j.chroma.2014.05.003.

[11] M. Agarwal, S. Rajani, A. Mishra, Study on flocculating efficiency of Okromucilage in sewage wastewater. Macromol. Mat. Eng 286 (9) (2007) 560-563. https://doi.org/10.1002/1439-2054(20010901)286:9<560::AID-MAME560>3.0.CO;2-B.

[12] M. Madsen, J. Schlundt, E.E. Omer, Effect of water Coagulation by seeds of Moringa oleifera on bacterial concentration. Journal of tropical Medicine and Hygiene 90 (1987) 101-109.

[13] M.R. Berger, M. Habs, S.A. John, D. Schmahi, Toxicological assessment of seeds from Moringa oleifera /jeters and Moringa. Stenopetala two efficient primary coagulants for domestic water treatment of tropical waters, East African Med. Jr (1984) 712-716.

[14] N.A. Eman, A. Suleyman, H.M. Muyib, et al. Production of Natural Coagulant from Moringa oleifera Seed for Application in Treatment of Low Turbidity Water. J. Water Resource and Protection (2010) 259-266. https://doi.org/10.4236/jwarp.2010.23030.

[15] P. Sharma, P. Kumari, M.M. Srivastava, S. Srivastava, Bio resource Technol 97 (2) (2006) 299-305. https://doi.org/10.1016/j.biortech.2005.02.034.

[16] S.A. Jahn, Proper use of African natural coagulants forrural water supplies- Research in the Sudan and a guide to new projects;GTZ Manual 191 (1986).

[17] S.A. Jahn, Using Moringa seeds as coagulants in developing countries. J. Am. Water Works Assoc 80 (1988) 43-50. https://doi.org/10.1002/j.1551-8833.1988.tb03052.x.

[18] S.A. Muyibi, L.M. Evison, Wat. Res 29 (4) (1994) 1099-1105. https://doi.org/10.1016/0043-1354(94)00250-B.

[19] S.A. Muyibi, .C.A. Okuofu, Softening hard well waters with Moringa Oleifera seed extracts; Intern. J. Environmental Studies 50 (1996) 247-257. https://doi.org/10.1080/00207239608711061.

[20] S.A. Muyibi, M.M. Noor, T.K. Leong, L.H. Loon. Effects of oil extraction from Moringa oleifera seed on Coagulation of Turbid water. International Journal of Environmental Studies 59 (2) (2002) 243-254. https://doi.org/10.1080/00207230210924.

[21] S.A. Muyibi, A.A. Saad, J.N. Megat, R.A. Fakrul, Enhanced coagulation efficiency of Moringa oleifera seeds through selective oil extraction. IIUM Engineering Journal 4 (1) (2003) 1-11. https://doi.org/10.31436/iiumej.v4i1.366.

[22] S. Katayon, M.N. Megat, M. Asma, L.A. Ghani, A.M. Suleyman, J. Bio resource Technology 97 (13) (2005) 1455-1460. https://doi.org/10.1016/j.biortech.2005.07.031.

[23] Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 2130B (1992) 2-9
[24] T. Lund, Determination of the hardness of tap water using EDTA titration.10.13140/RG.2.2.27849.39527 (2019).
[25] U. Gassenschmidt, K.D. Jany, B. Tauscher, H. Niebergall, Isolation and charaterization of a flocculating protein from Moringa oleifera Lam. Biochimica et Biophysica Acta 12 (43) (1995) 477-481. https://doi.org/10.1016/0304-4165(94)00176-X.