Journal of Qassim University for Science
2024, *Vol 3* (Issue 1), pp. 116-126

Received: 15 February 2024
Revised: 15 March 2024
Accepted: 30 March 2024

JQUS

Investigation of Boscia Senegalensis Biomass as a Coagulant for Turbidity Removal in Natural Water

Abdelhamid M. Essa
Faculty of Graduate Studies, KARARY University, 12304, Khartoum, Sudan.
Dépt. de Chimie, Faculté des Sciences et Techniques, Université Adam Barka, Abéché, Tchad, E-mail misra.essa@gmail.com

E. E. Hago
Dept. of Chemical Engineering, KARARY University, 12304, Khartoum, Sudan.
Faculty of Graduate Studies, KARARY University, 12304, Khartoum, Sudan, E-mail eltiganihago@gmail.com

B. K. Abdalla
Dept. of Chemical Engineering, KARARY University, 12304, Khartoum, Sudan.
Faculty of Graduate Studies, KARARY University, 12304, Khartoum, Sudan, E-mail babiker.k.abdalla@gmail.com

Abuzar E. A. E. Albadri
Dept. of Chemistry, College of Science, Qassim University, Buraydah, 51452, Saudi Arabia.
Dept. of Chemistry, Faculty of Science, University of Khartoum, PO Box 321, Khartoum, Sudan , E-mail aa.albadri@qu.edu.sa

Abstract: The objective of this study was to evaluate the effectiveness of powdered *Boscia Senegalensis* (Pers.) Lam. ex Poir plant as a natural coagulant for turbidity removal in raw water and the improvement of drinking water quality. Jar tests were conducted using different amounts of *Boscia Senegalensis* leaves (BSL) and barks (BSB) to determine their efficacy in reducing turbidity levels, starting with a turbidity range of 700-600 NTU. The results demonstrated that both BSB and BSL powders exhibited activity in turbidity removal. The BSB powder achieved turbidity removal percentages of 24.74, 88.17, 87.87, 87.48, 88.33, 86.83, and 82.00% for the different flocculent amounts (0, 0.2, 0.4, 0.6, 0.8, 1.0, and 1.2 g/l) tested. Similarly, the BSL powder achieved turbidity removal percentages of 22.91, 59.94, 67.63, 65.86, 64.26, 61.53, and 54.33%. The optimal dosage for BSB was determined to be 0.8 g/l, resulting in a turbidity removal percentage of 88.33%, while the optimal dosage for BSL was 0.4 g/l, achieving a turbidity removal percentage of 67.63%. Other parameters, including pH, alkalinity, and total dissolved solids (TDS), were also analyzed. The pH values showed minor changes, decreasing from 8 to 7.7 for all tested doses of both BSB and BSL. Alkalinity levels slightly increased, ranging from 92 to 90 mg/l for BSB and from 86 to 120 mg/l for BSL. The alkalinity increased with higher doses of BSL and BSB, indicating a correlation between the coagulant dosage and alkalinity. Overall, the results indicated that Boscia Senegalensis demonstrated efficiency in turbidity removal. The BSB powder exhibited superior performance compared to the BSL powder, which is consistent with previous studies on the topic.

Keywords: Boscia Senegalensis, BSB, BSL, removal turbidity, water treatment.

1. INTRODUCTION

An estimated 75 % of the Earth's surface is water; about 97 % of this water is not drinkable, and 2 % is solids in the form of glaciers and ice caps [1–3]. The residual of this amount, that is, 1 %, is fresh water available to humanity. These are small amounts found in groundwater and surface water [4]. The absence of good-quality water is the reason for the deaths of an estimated 5 million children in developing countries [5–9]. If discharged into water, chemical, physical or biological pollutants (from runoff, soil erosion, or microbial presence) may be deposited on a waterbed or suspended [10], causing turbidity [11]. Turbidity is considered one of the most common characteristics of water contamination. Turbidity, which can make water appear muddy or cloudy, is caused by dissolved and suspended matter, such as some kind of clay, silt, finely divided organic matter, plankton and other microorganisms, organic acids, and dyes [12–16]. Many researchers have treated coagulation in raw water by using various presses, such as chemical precipitation, extraction of the different solvents, ion exchange, and the reverse osmosis technique [11]. The chemical method is the most effective, and is commonly used to treat water in large treatment plants. In contrast, natural coagulants are often used in rural areas [17], which can be sustainable processing resources [18–21]. The natural coagulants in water treatment are biodegradable [22], renewable [23], cost-effective [24], charge-neutralizing [25], most importantly [20], non-toxic [20, 26], and they can also efficiently remove turbidity [11, 27, 28]. This study compared the parts of *Boscia senegalensis* (leaves and barks). Its use as a natural coagulant, *Boscia senegalensis,* was studied to remove turbidity from drinking water in rural areas where the plant is available in large quantities. Secondly, the study used the plan in powder format, which reduced the turbidity in general. *Boscia Senegalensis* (family Capparidaceae) is an evergreen shrub [29]. It is native to the Sahel and Sahara savannas stretching from Mauritania, Senegal, Mali, Niger, Nigeria, Chad, Cameroon, and across Africa to Egypt, Sudan, Somalia, Ethiopia, and Kenya [29, 30]. The research aimed to evaluate the effectiveness of *Boscia Senegalensis* (Pers.) Lam. ex Poir plant parts (leaves or barks) in removing turbidity from untreated raw water.

2. MATERIALS AND METHODS

2.1 Analytical Methods:

In this study, various doses of *Boscia S.* powder (leaves and barks) were utilized to reduce water turbidity under both wet and dry conditions, specifically in June 2021 and March 2022. Physical tests were conducted on the collected samples, including temperature, pH, turbidity, total dissolved solids (TDS) concentration, odour, colour, and alkalinity measurements. Turbidity concentration was quantified using a turbidity meter (HACH Code: 2100P, Abéché, Chad) and (HACH Code: 2100N, Hach instruments, Bahri, Sudan) in units of nephelometric turbidity units (NTU). Total alkalinity was determined using standard titration methods [31]. The multi-parameter instrument from the Bahri Water Treatment Plant Laboratory in Sudan was employed to measure temperature, pH, and TDS.

2.2 Collection of the untreated raw Water:

Untreated raw water samples were obtained from various sources in the rural area surrounding Abéché, Chad Republic, including small ponds and a large pool known as Abou-Kdos. These water resources are extensively used for daily consumption, particularly for drinking and household purposes. The Abou-Kdos pool covers an approximate area of 10,000 m^2, making it a significant regional water source. Additionally, samples were also collected from the Blue Nile River in Khartoum Bahri, Sudan. These diverse raw water sources provide valuable samples for water quality assessment and analysis in the respective regions.

2.3 Jar test:

The jar test is a widely recognized and standard process used in water treatment [32]. The jar test's fundamental principle involves adding coagulants to untreated raw water. Coagulants, which are electrolytes, form micelles when introduced into water. These micelles neutralize the colloidal materials present in the water, resulting in the formation of larger flocs that gradually settle down. In this study, a plant-based natural coagulant in the form of defatted and fine powder was added to the water using the following procedure: Experiments were conducted in liter beakers filled with (500±5) ml of turbid water, which were then placed in the Jar Test apparatus. Various doses of BSB and BSL powders were added to the beakers during the coagulation stage. The beakers were agitated rapidly for three minutes at a speed of 160 revolutions per minute (rpm). Subsequently, the mixing speed was reduced to 30 rpm for 20 minutes during the flocculation stage. In the settling stage, the suspensions in all beakers were left undisturbed for approximately 40 minutes to allow for natural sedimentation. After this process, the beakers collected the supernatant to measure turbidity and other parameters such as temperature, pH, total dissolved solids (TDS), and alkalinity. The percentage of turbidity removal can be calculated using the following equation:

$$\text{Turbidity removal } (\%) = \frac{\text{Ti} - \text{Tf}}{\text{Ti}} \times 100\ \%$$

Ti is the water's initial Turbidity, and Tf is the final Turbidity after the treatment [33].

2.4 Preparation of Boscia Senegalensis plant:

The coagulant used in this study was obtained in powdered form from the plant through a sequence of operations. First, the plant material was thoroughly cleaned and washed with potable water. Then, the thin barks of the plant were carefully scraped off and dried in a location shielded from direct sunlight. Subsequently, the dried plant material was ground into a fine powder in the laboratory using a pestle and mortar. The resulting powder had particle sizes ranging from 0.200 to 0.5 mm for both leaves and barks [33, 34]. The Jar Test experiments used the fraction of the powdered coagulant with these specific particle sizes. For visual reference, Figure 1 depicts the appearance of the *Boscia Senegalensis* (Pers.) Lam. ex Poir. Plant.

Figure 1. *Boscia senegalensis* (Pers.) Lam. ex Poir

2.5 Characterization of the plant:

To assess the functional groups, present in the dried leaves of the plant powder, Fourier transform infrared spectrophotometer (FTIR) analysis was conducted. This analytical technique provides valuable insights into the sample's chemical composition and functional groups. The dried leaves of the plant powder were prepared for FTIR analysis by obtaining a representative sample. The sample was then finely ground to ensure homogeneity. Subsequently, the powdered sample was pressed into a pellet or prepared as a thin film for analysis using an FTIR spectrophotometer (Shimadzu Code: HI-8400S, Japan, University of Khartoum Shambat, Sudan).

3. Results and DISCUSSION

3.1 Results

3.1.1 Characterization of functional groups in dried leaves of Boscia Senegalensis using FTIR

The infrared spectrum of Boscia S. leaves was obtained using an FTIR spectrophotometer in the wavenumber range of 4000 to 400 cm^{-1}. Figure 2 illustrates the infrared spectra of Boscia S. leaves. The spectrum displayed an intense stretch in the range of 3000-3500 cm^{-1}, indicating the presence of the polymeric hydroxyl group (O-H) bond. A stretching vibration of C-H at 2925 cm^{-1} was observed between 2800-3000 cm^{-1}, suggesting its presence in phenols [35, 36]. The bands at 1731 cm^{-1} indicated the presence of the carbonyl function (C=O) typically found in amino acids (proteins) esters. A peak at 1645 cm^{-1} indicated the presence of C=N bonds. In the range of 1300-1500 cm−1, several weaker peaks corresponding to phosphodiester groups were observed, along with a bending vibration of CH_2 at 1315 cm^{-1}. The peak at 1242 cm^{-1} indicated the presence of phenolic compounds with a CO bond. An additional peak at 1398 cm^{-1} suggested the presence of amino acid side chains. In the 940-1175 cm^{-1} range, peaks corresponding to CO vibrations of phenols and flavonols were observed [35, 36]. A peak indicated the presence of an aromatic CH bond at 619.11 cm^{-1}. Previous studies [14, 33, 37] have reported that these peaks confirm the presence of amide groups (NH), while the carboxyl group (COOH) has been found to remove turbidity from turbid water.

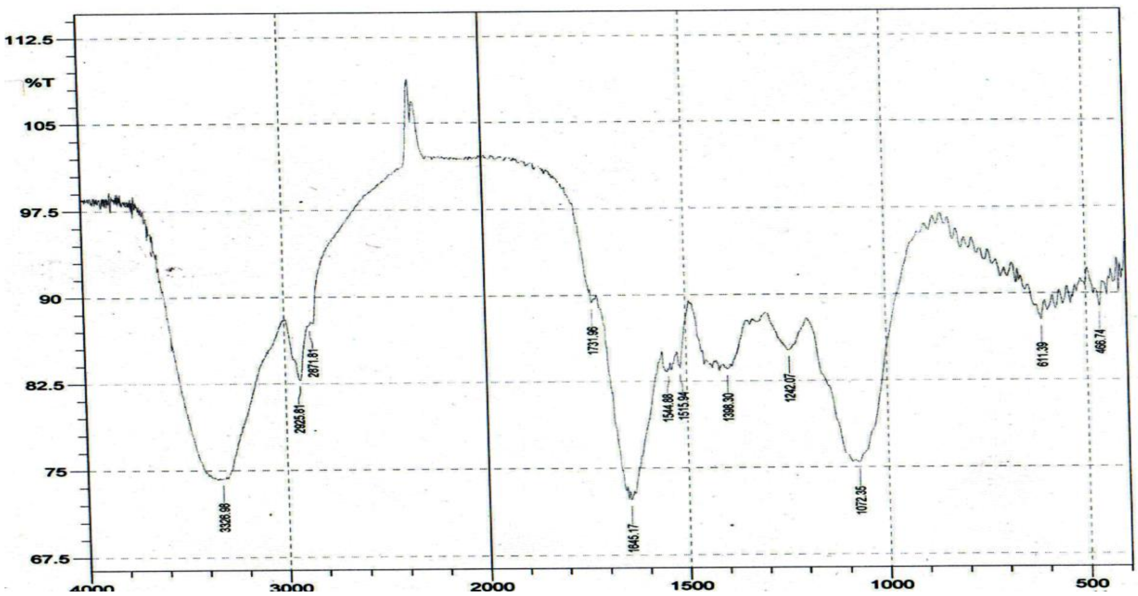

Figure 2 : FTIR analyses of Boscia Senegalensis (Pers.) Lam. ex Poir

Table 1: The results of removal turbidity, pH, TDS, and Alkalinity for *BSL* at different doses and comparison with WHO Parameter Guidelines [38]

Exp.	**DOSE** (g/L)	**Turbidity Removal** (%)	**pH**	**TDS** (mg/L)	**Alkalinity** (mg/L)
1	0	22.91	8	115	86
2	0.2	59.94	8	124	110
3	0.4	67.63	8	133	110
4	0.6	65.86	8	142	112
5	0.8	64.26	7.9	152	114
6	1	61.53	7.9	162	120
7	1.2	54.33	7.7	172	120
G.L.WHO		< 5 NTU	6.5-8.5	< 300	---

*G.L. WHO is the Guidelines Standards of the World Health Organization (WHO).

3.1.2 Coagulant's effect on untreated raw water treatment efficiency

Tables 1 and 2 present the primary characteristics of untreated raw water both before and after treatment. The results provided in these tables, along with the corresponding figures, demonstrate the impact of the coagulant on the removal efficiency of turbidity, total alkalinity, pH, and total dissolved solids (TDS).

Table 2:. The results of removal turbidity, pH, TDS, and alkalinity for *BSB* at different doses and comparison with WHO Parameter Guidelines. [38]

Exp.	**DOSE** (g/L)	**Turbidity Removal** (%)	**pH**	**TDS** (mg/L)	**Alkalinity** (mg/L)
1	0	24.74	7.9	115	92
2	0.2	88.17	7.7	122	90
3	0.4	87.87	7.7	130	90
4	0.6	87.48	7.7	135	90
5	0.8	88.33	7.7	143	90
6	1	86.83	7.7	150	90
7	1.2	82.00	7.7	156	90
G.L.WHO		< 5 NTU	6.5-8.5	< 300	----

*G.L. WHO is the Guidelines Standards of the World Health Organization (WHO).

3.2 Discussion

3.2.1. The Effect of Biomass Dosage on Removal Turbidity:

Figure 3 illustrates the impact of dosage on water turbidity removal using coagulants derived from the Boscia Senegalensis plant. The powdered forms of *BSL* and *BSB* were utilized as distinct coagulants and added to untreated raw water at dosages of (0.0, 0.2, 0.4, 0.6, 0.8, 1, and 1.2) g/L. The turbidity removal results for *BSB* powder were as follows: 24.74, 88.17, 87.87, 87.48, 88.33, 86.83, and 82.00 % at respective dosages. Similarly, the turbidity removal percentages for *BSL* powder were 22.91, 59.94, 67.63, 65.86, 64.26, 61.53, and 54.33%. The findings demonstrate the optimization of *BSL* in conjunction with BSB for treating highly turbid water, as depicted in Figure 3 and Tables 1 and 2. The results indicate that the optimal dosages for high turbidity reduction were 0.8 g/L for BSB (88.33% removal) and 0.4 g/L for *BSL* (67.63% removal). However, it should be noted that even at the highest dosages, turbidity could not be reduced below 50 NTU when it initially exceeded 600 NTU. These results differ from a previous study [30] aiming to achieve turbidity levels below 5 NTU. The disparity can be attributed to variations in flocculation and settling times, as the previous study employed a 24-hour duration, whereas our study utilized less than an hour. Coagulation mechanisms involving polymeric matter can be categorized as anionic, cationic, or non-ionic, with the former two collectively known as polyelectrolytes. Natural coagulants, often polysaccharides or proteins, are referred to as polyelectrolytes in many studies despite non-ionic polymers potentially possessing charged interactions due to partially charged groups (e.g., –OH) along their chains [39]. The observed saturation of polymer bridge sites at the given dosages resulted in the re-stabilization of unstable particles, as there were insufficient particles available to form additional interparticle bridges [40]. In this study, the results showed that the optimum turbidity removal was reduced to 88.33% for *BSB* and 67.63% for *BSL*. Results of previous studies in which several plants (Aloe vera, Moringa oleifera, Maerua subcordata, Moringa stenopetala, and Acorn Leaves) as natural coagulants in different doses were used showed the turbidity removal efficiency decreased to (87.84%, 99%, 80%, 83%, and 91.07%) [14, 40, 41, 33], respectively. It was observed that all amounts could not mitigate the residual turbidity below 50 NTU when it was at high levels in this study. These plants were used as one of the natural treatment methods for drinking water in different regions and countries, depending on the availability of the plant in the country of study.

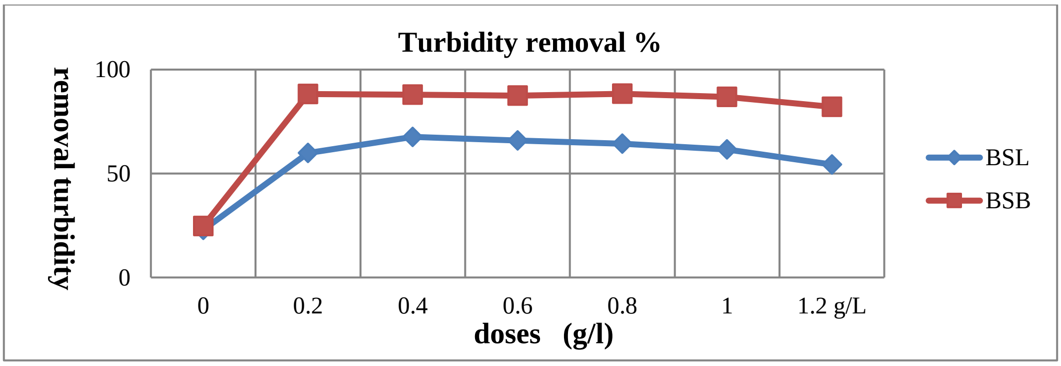

Fig 3. Effect of biomass dosage (BSL & BSB) on turbidity removal efficiency using coagulants

3.2.2 Effect of Coagulant Dosage on Water pH and Total Alkalinity:

Figures 4 and 5, along with Tables 1 and 2, illustrate the influence of coagulant dosage on pH and alkalinity parameters in turbid water. When coagulants derived from the Boscia Senegalensis plant, namely BSL and BSB, were introduced, slight variations were observed in pH and alkalinity values. These results can be attributed to the organic nature of the coagulant materials, as mentioned in the literature [14]. The organic matter present in the coagulants, specifically the protein chains within the protein molecules, plays a significant role in aggregating certain substances and forming flocs. Conversely, coagulants based on metal hydrolysis release hydrogen ions (H^+) into the water, decreasing pH. Additionally, alkalinity is generated by dissolved carbon dioxide (CO_2) species, typically expressed as mg/l $CaCO_3$. Also, a previous study that looked into how well Aloe vera worked as a natural coagulant found that pH and alkalinity did not have a big effect on the process of purifying water [14].

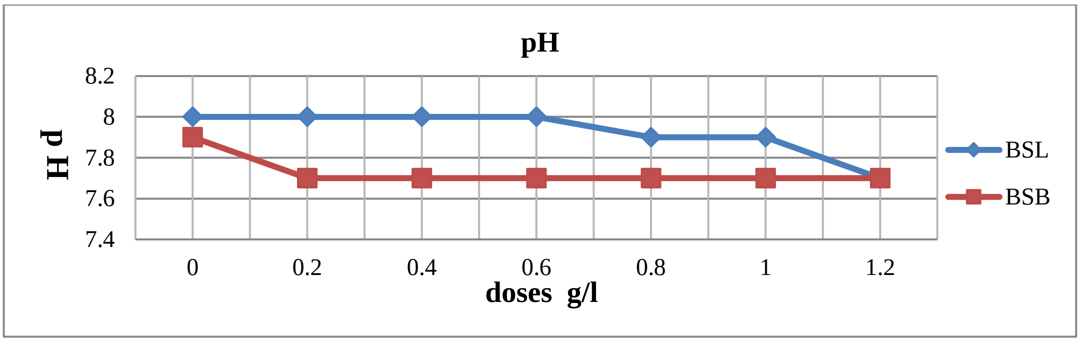

Fig 4. Effect of biomass (BSL&BSB) dosage on water pH levels using coagulants

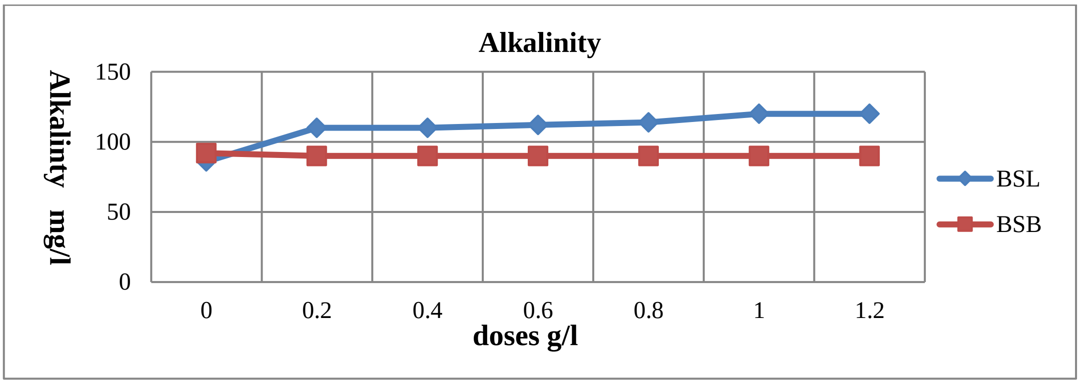

Fig 5. Effect of biomass (BSL&BSB) dosage on water alkalinity levels using coagulants

3.2.3 Effect of Coagulant Dosage on Total Dissolved Solids (TDS):

Figure 6, along with Tables 1 and 2, demonstrate the influence of coagulant dosages on the levels of Total Dissolved Solids (TDS). TDS refers to the total amount of ions, salts, or minerals that are mobile and dissolved in water. It is quantified in units of mg/L of water. TDS serves as an indicator of water quality and the effectiveness of water purification systems, encompassing all substances present in water apart from pure water molecules and suspended solids [14, 42]. In Fig. 6 and Table 2, the dosage effect on TDS for BSB ranged from 115 mg/L at 0 g to 156 mg/L at 1.2 g. It was observed that the increase in coagulant dosage resulted in a proportional increase in TDS levels. Similarly, in Fig. 6 and Table 1, for BSL, TDS levels ranged from 115 mg/L at 0 g to 172 mg/L at 1.2 g. The quantities of coagulant dosage exhibited a direct relationship with TDS values, indicating an increase in TDS levels with higher doses of BSL.

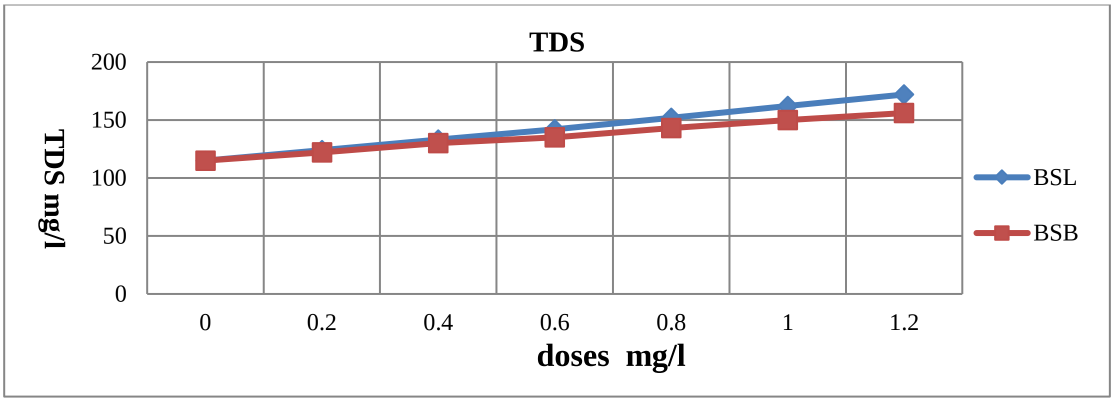

Fig 6. Effect of biomass (BSL&BSB) dosage on TDS using coagulants

4. Conclusions:

This study investigated the effectiveness of a natural coagulant in treating untreated raw water samples with high turbidity levels exceeding 600 NTU. The selected plant for this investigation was chosen based on its abundance in various water sources and its availability at a reasonable cost. Additional doses of BSL and BSB demonstrated efficacy in turbidity removal, with a preference observed for bark powder over leaf powder. However, as demonstrated in previous studies, the achieved turbidity reduction did not meet the World Health Organization's (WHO) recommended levels of less than 5 NTU. To address this limitation, further research should focus on exploring methods to isolate and extract the active components involved in the coagulation process. This could enable the development of natural coagulants on a larger scale, suitable for urban and rural areas. Notably, the dosage of natural coagulants did not exhibit any noticeable effect on pH. In conclusion, this study emphasizes the need for continued investigation and development of natural coagulants to enhance their efficacy in achieving WHO standards for turbidity removal in water treatment processes.

References

[1] R. K. Mishra, ‘Fresh Water availability and Its Global challenge’, British Journal of Multidisciplinary and Advanced Studies, vol. 4, no. 3, pp. 1–78, May 2023, doi: 10.37745/BJMAS.2022.0208.

[2] A. Ahsan et al., ‘Evaluation of Water Quality Index (WQI) in and around Dhaka City Using Groundwater Quality Parameters’, Water 2023, Vol. 15, Page 2666, vol. 15, no. 14, p. 2666, Jul. 2023, doi: 10.3390/W15142666.

[3] S. Varol and A. Davraz, ‘Evaluation of the groundwater quality with WQI (Water Quality Index) and multivariate analysis: a case study of the Tefenni plain (Burdur/Turkey)’, Environ Earth Sci, vol. 73, no. 4, pp. 1725–1744, Feb. 2015, doi: 10.1007/S12665-014-3531-Z.

[4] J. Atmadja and A. C. Bagtzoglou, ‘State of the Art Report on Mathematical Methods for Groundwater Pollution Source Identification’, Environ Forensics, vol. 2, no. 3, pp. 205–214, Sep. 2001, doi: 10.1006/ENFO.2001.0055.

[5] G. Holgate, ‘Water Quality: DETR consultation on new regulations for drinking water’, Environmental and Waste Management, vol. 3, no. 3, pp. 105–112, 2000.

[6] A. Mahmud, S. Sikder, and J. C. Joardar, ‘Assessment of groundwater quality in Khulna city of Bangladesh in terms of water quality index for drinking purpose’, Appl Water Sci, vol. 10, no. 11, Nov. 2020, doi: 10.1007/S13201-020-01314-Z.

[7] ‘Water | Free Full-Text | Evaluation of Water Quality Index (WQI) in and around Dhaka City Using Groundwater Quality Parameters’. Accessed: Nov. 04, 2023. [Online]. Available: https://www.mdpi.com/2073-4441/15/14/2666.

[8] Y. J. Wong et al., ‘Application of artificial intelligence methods for monsoonal river classification in Selangor river basin, Malaysia’, Environ Monit Assess, vol. 193, no. 7, Jul. 2021, doi: 10.1007/S10661-021-09202-Y.

[9] Y. J. Wong, Y. Shimizu, K. He, and N. M. Nik Sulaiman, 'Comparison among different ASEAN water quality indices for the assessment of the spatial variation of surface water quality in the Selangor river basin, Malaysia', Environ Monit Assess, vol. 192, no. 10, Oct. 2020, doi: 10.1007/S10661-020-08543-4.

[10] N. Jorge, A. R. Teixeira, M. S. Lucas, and J. A. Peres, 'Combined organic coagulants and photocatalytic processes for winery wastewater treatment', J Environ Manage, vol. 326, p. 116819, Jan. 2023, doi: 10.1016/J.JENVMAN.2022.116819.

[11] B. Koul, N. Bhat, M. Abubakar, M. Mishra, A. P. Arukha, and D. Yadav, 'Application of Natural coagulants in water treatment: A sustainable alternative to chemicals', Water (Basel), vol. 14, no. 22, p. 3751, 2022.

[12] M. Saleem and R. T. Bachmann, 'A contemporary review on plant-based coagulants for applications in water treatment', Journal of Industrial and Engineering Chemistry, vol. 72, pp. 281–297, 2019.

[13] M. Saleem, J. Abbas, I. Ahmed, M. I. Tousif, and M. Y. Khokhar, 'Analysis of heavy metals by atomic absorption spectrophotometry in commercially available multivitamins', Journal of Contemporary Research in Chemistry, vol. 1, no. 1, pp. 51–59, 2016.

[14] A. Benalia et al., 'Use of Aloe vera as an organic coagulant for improving drinking water quality', Water (Basel), vol. 13, no. 15, p. 2024, 2021.

[15] 'ASTM D1889-00'. Accessed: Nov. 02, 2023. [Online]. Available: https://www.techstreet.com/standards/astm-d1889 00?product_id=912541

[16] P. C. Nnaji et al., 'Statistical computation and artificial neural algorithm modeling for the treatment of dye wastewater using mucuna sloanei as coagulant and study of the generated sludge', Results in Engineering, vol. 19, Sep. 2023, doi: 10.1016/j.rineng.2023.101216.

[17] A. Iqbal, G. Hussain, S. Haydar, and N. Zahara, 'Use of new local plant-based coagulants for turbid water treatment', International Journal of Environmental Science and Technology, vol. 16, no. 10, pp. 6167–6174, Oct. 2019, doi: 10.1007/S13762-018-1998-Y.

[18] S. Kumari et al., 'Enhanced physical and mechanical properties of resin added with aluminium oxyhydroxide for dental applications', Ceram Int, vol. 49, no. 19, pp. 31412–31427, Oct. 2023, doi: 10.1016/j.ceramint.2023.07.089.

[19] N. T. Hoa and C. T. Hue, 'Enhanced water treatment by moringa oleifera seeds extract as the biocoagulant: Role of the extraction method', Journal of Water Supply: Research and Technology - AQUA, vol. 67, no. 7, pp. 634–647, Nov. 2018, doi: 10.2166/AQUA.2018.070.

[20] S. N. A. Mohd-Salleh, N. S. Mohd-Zin, and N. Othman, 'A review of wastewater treatment using natural material and its potential as aid and composite coagulant', Sains Malays, vol. 48, no. 1, pp. 155–164, Jan. 2019, doi: 10.17576/JSM-2019 4801-18.

[21] H. E. Emam, 'Accessibility of green synthesized nanopalladium in water treatment', Results in Engineering, vol. 15, Sep. 2022, doi: 10.1016/j.rineng.2022.100500.

[22] W. L. Ang, A. W. Mohammad, A. Benamor, and N. Hilal, 'Chitosan as natural coagulant in hybrid coagulation-nanofiltration membrane process for water treatment', J Environ Chem Eng, vol. 4, no. 4, pp. 4857–4862, Dec. 2016, doi: 10.1016/j.jece.2016.03.029.

[23] H. Betatache, A. Aouabed, N. Drouiche, and H. Lounici, 'Conditioning of sewage sludge by prickly pear cactus (Opuntia ficus Indica) juice', Ecol Eng, vol. 70, pp. 465–469, 2014, doi: 10.1016/j.ecoleng.2014.06.031.

[24] B. Sasivarman and R. Nagalakshmi, 'Purification of household and automobiles wastewater using natural coagulant', Mater Today Proc, vol. 68, pp. 1711–1717, Jan. 2022, doi:10.1016/j.matpr.2022.08.465.

[25] S. Vigneshwaran, P. Karthikeyan, P. Sirajudheen, and S. Meenakshi, 'Optimization of sustainable chitosan/Moringa. oleifera as coagulant aid for the treatment of synthetic turbid water – A systemic study', Environmental Chemistry and Ecotoxicology, vol. 2, pp. 132–140, 2020, doi: 10.1016/j.enceco.2020.08.002.

[26] Saiful, S. Hasima, N. Kamila, and Rahmi, 'Cellulose acetate from palm oil bunch waste for forward osmosis membrane in desalination of brackish water', Results in Engineering, vol. 15, Sep. 2022, doi: 10.1016/J.RINENG.2022.100611.

[27] H. M. Kalibbala, P. W. Olupot, and O. M. Ambani, 'Synthesis and efficacy of cactus-banana peels composite as a natural coagulant for water treatment', Results in Engineering, vol. 17, p. 100945, Mar. 2023, doi: 10.1016/J.RINENG.2023.100945.

[28] Md. Asrafuzzaman, A. N. M. Fakhruddin, and Md. A. Hossain, 'Reduction of Turbidity of Water Using Locally Available Natural Coagulants', ISRN Microbiol, vol. 2011, pp. 1–6, Dec. 2011, doi:10.5402/2011/632189.

[29] H. D. Neuwinger, African ethnobotany: poisons and drugs: chemistry, pharmacology, toxicology. Crc Press, 1996.

[30] A. M. A. E. SALIH, Application of crude and extract of maerua pseudopetalosa, Boscia senegalensis and ocimum basilicum L. as natural coagulants for clarification of turbid water: A case study of almanagil canals, gezira state, Sudan. University of Gezira,. 2015.

[31] E. W. Rice, L. Bridgewater, and A. P. H. Association, Standard methods for the examination of water and wastewater, vol. 10. American public health association Washington, DC, 2012.

[32] M. H. Ng and M. S. Elshikh, 'Utilization of Moringa oleifera as natural coagulant for water purification', Industrial and Domestic Waste Management, vol. 1, no. 1, pp. 1–11, 2021.

[33] A. Benalia, K. Derbal, A. Panico, and F. Pirozzi, 'Use of Acorn Leaves as a Natural Coagulant in a Drinking Water Treatment Plant', Water 2019, Vol. 11, Page 57, vol. 11, no. 1, p. 57, Dec. 2018, doi: 10.3390/W11010057.

[34] BENALIA, Abderrezzaq et DERBAL, Keroum. Etude expérimentale et modélisation du processus de la coagulation floculation. 2015.

[35] E. de Oliveira, 'Sample preparation for atomic spectroscopy: evolution and future trends', J Braz Chem Soc, vol. 14, no. 2, pp. 174–182, 2003.

[36] G. C. Nikalje, J. Kumar, T. D. Nikam, and P. Suprasanna, 'FT-IR profiling reveals differential response of roots and leaves to salt stress in a halophyte Sesuvium portulacastrum (L.) L.', Biotechnology Reports, vol. 23, p. e00352, 2019.

[37] J. K. Fatombi, B. Lartiges, T. Aminou, O. Barres, and C. Caillet, 'A natural coagulant protein from copra (Cocos nucifera): Isolation, characterization, and potential for water purification', Sep Purif Technol, vol. 116, pp. 35–40, 2013.

[38] 'Guidelines for drinking-water quality. Vol. 2, Health criteria and other supporting information'. Accessed: Nov. 02, 2023. [Online]. Available: https://iris.who.int/handle/10665/38551

[39] C.-Y. Yin, 'Emerging usage of plant-based coagulants for water and wastewater treatment', Process Biochemistry, vol. 45, no. 9, pp. 1437–1444, 2010.

[40] B. Bina, M. H. Mehdinejad, G. Dalhammer, G. R. Nikaeen, and H. M. Attar, 'Effectiveness of Moringa oleifera coagulant protein as natural coagulant aid in removal of turbidity and bacteria from turbid waters', International Journal of Environmental and Ecological Engineering, vol. 4, no. 7, pp. 261–263, 2010.

[41] MEGERSA, Moa, BEYENE, Abebe, AMBELU, Argaw, et al. Extraction of natural coagulants from Maerua subcordata and Moringa stenopetala for use in turbid water treatment. Desalination and Water Treatment, 2017, vol. 59, p. 127-134.

[42] S. S. Thakur and S. Choubey, 'Assessment of coagulation efficiency of Moringa oleifera and Okra for treatment of turbid water', Arch Appl Sci Res, vol. 6, no. 2, pp. 24–30, 2014.

الملخص باللغة العربية

دراسة الكتلة الحيوية لنبات المخيط كمواد مسببة للتخثر لإزالة العكارة من المياه

عبد الحميد محمد عيسى
كلية الدراسات العليا، جامعة كرري، الخرطوم، السودان & قسم الكيمياء، كلية العلوم والتقنيات، جامعة آدم بركة بابشة، تشاد

التجاني هجو
قسم الهندسة الكيميائية، كلية الدراسات العليا، جامعة كرري، الخرطوم، السودان

بابكر كرامة
قسم الهندسة الكيميائية، كلية الدراسات العليا، جامعة كرري، الخرطوم، السودان

أبوذر البدري
قسم الكيمياء، كلية العلوم، جامعة القصيم، بريدة، المملكة العربية السعودية

هدفت هذه الدراسة لتقييم فعالية مسحوق نبات المخيط او البوسيا السنغالية (*Boscia Senegalensis*) كمخثر طبيعي لإزالة العكارة في المياه الخام وتحسين جودة مياه الشرب. تم إجراء اختبارات الجرة باستخدام كميات مختلفة من أوراق البوسيا السنغالية (*Boscia Senegalensis* leaves (BSL ولحاء الساق *Boscia Senegalensis* barks (BSB) لتحديد فعاليتها في تقليل مستويات العكارة، بدءًا من نطاق عكارة يتراوح بين 700-600 وحدة عكارة. أظهرت النتائج أن كل من مساحيق BSB وBSL أظهرت نشاطًا في إزالة العكارة. حقق مسحوق BSB نسب إزالة عكارة بلغت 24.74 و88.17 و87.87 و87.48% و88.33 و86.83 و82.00% لكميات مختلفة من المواد المتكتلة (0 و0.2 و0.4 و0.6 و0.8 و1.0 و1.2 جم/لتر) تم اختبارها. وبالمثل، حقق مسحوق BSL نسب إزالة عكارة بلغت 22.91 و59.94 و67.63 و65.86 و64.26 و61.53 و54.33%. تم تحديد الجرعة المثلى لـ BSB لتكون 0.8 جم/لتر، نسبة إزالة عكارة بلغت 88.33%، بينما كانت الجرعة المثلى لـ BSL هي 0.4 جم/لتر، نسبة إزالة عكارة بلغت 67.63%. كما تم تحليل مقاييس أخرى، كالرقم الهيدروجيني والقلوية والمواد الصلبة الذائبة الكلية (TDS). أظهرت قيم الرقم الهيدروجيني تغييرات طفيفة، حيث انخفضت من 8 إلى 7.7 لجميع الجرعات المختبرة من كل من BSB وBSL. زادت مستويات القلوية قليلاً، حيث تراوحت من 92 إلى 90 مجم / لتر لـ BSB ومن 86 إلى 120 مجم / لتر لـ BSL. زادت القلوية مع جرعات أعلى من BSL وBSB، مما يشير إلى وجود علاقة بين جرعة المادة المسببة للتخثر والقلوية. بشكل عام، أشارت النتائج إلى أن البوسيا السنغالية أظهر كفاءة في إزالة العكارة. أظهر مسحوق ولحاء الساق أداءً متفوقًا مقارنة بمسحوق أوراق البوسيا السنغالية ، وهو ما يتفق مع الدراسات السابقة حول هذا الموضوع.

الكلمات المفتاحية: بوسيا السنغالية، BSB، BSL، إزالة العكارة، معالجة المياه.