JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), JANUARY, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

Comparative Analysis of the use of *Citrullus Lanatus* and *Hibiscus Sabdariffa* Seeds Extracts as Natural Coagulant in Greywater Treatment

[1]Nuhu I. S., [2]Igboro S. B., [3]Adie D. B., [4]Bello A. A., [5]Jibril A.
[1,2,3&4]Department of Water Resources and Environmental Engineering.
[5]Department of Polymer and Textile Engineering,
Ahmadu Bello University Zaria Kaduna Nigeria

ABSTRACT
This research seeks to treat high turbid greywater with watermelon and Roselle seed extracts as a natural coagulant, investigate the suitability of the treated water for domestic and agricultural uses (toilet flushing, car wash and irrigation), and also investigate the potentials of combining watermelon and Roselle seed extracts as substitutes for conventional chemicals in greywater treatment, and to compare the two natural coagulants to know which one is more effective in removing the turbidity from the greywater. A stock solution of 5000mg/l of each coagulant was made and used to treat the greywater using a dosage of 50mg/l, 100mg/l, 150mg/l, 200mg/l, and 250mg/l as well as a combined ratio of 80mg/l: 20mg/l, 70mg/l: 30mg/l, 50mg/l: 50mg/l, 30mg/l: 70mg/l and 20mg/l: 80mg/l of watermelon and Roselle seeds were used. The results obtained from the jar test showed that watermelon seeds could effectively remove 89.0% of the 303 NTU turbidity while Roselle seed extracts could remove about 80% of the 303 NTU turbidity all at the same dosage of 100mg/l which is their respective optimum dosage, thus, confirming watermelon seeds to be more effective than Roselle seeds in removing the turbidity from greywater. In the case of the combined use of watermelon and Roselle seed extracts, the result revealed good coagulation properties with turbidity removal of 91% from 303NTU to 26NTU and bacterial count removal of 94.5% at a combined ratio of 70mg/: 30mg/l. It was observed that all the pH is within the recommended value of wastewater used for irrigation. Watermelon and Roselle seed extracts performed reasonably as good disinfectants (anti-microbial agents).

ARTICLE INFO
Article History
Received: August, 2025
Received in revised form: October, 2025
Accepted: December, 2025
Published online: January, 2026

KEYWORDS
Comparative Analysis, *Citrullus Lanatus, Hibiscus Sabdariffa* Seeds, Natural Coagulant, Greywater Treatment

INTRODUCTION

Greywater is water used from baths, showers, wash hand basins, and washing machines; in some cases, water from the kitchen sink while natural coagulants are good alternatives for chemical coagulants due to their availability, cost-effectiveness, safe and biodegradable natures (Osayende, 2016). Water is the most vital substance among natural resources. In Nigeria, access to clean and safe water is a critical issue, likewise drinking water which should be palatable and potable is essential to the health and welfare of a community. Thus, water from all sources should have some form of purification before consumption.

Various methods are used to make water safe and attractive to the consumers, but this method depends on the character and source of the raw water. The major problem with the treatment of surface water is the large seasonal variation in turbidity. Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky (Manal *et al*, 2017). This can raise the cost of water treatment. (Ali *et al.,* 2009). The amount of wastewater produced daily in homes,

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), JANUARY, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

restaurants and student hostels is enormous amidst the critical shortage of potable water in Nigeria. The short supply of potable water makes people reuse greywater without any form of treatment, exposing them to water-related or water-borne diseases (Ugwu *et al*, 2017).

The high cost of chemical importations results in loss of foreign exchange to nations. The effect of most chemical coagulants like Aluminum on the pH of the treated water and wastewater attracts extra cost on lime which should be added to buffer its effect (Bala, 2018). In addition, there are health concerns associated with these chemicals they are known to cause neurological diseases such as pre-senile dementia and Alzheimer's disease. Also, in the coagulation of water and wastewater, the use of chemicals comes with some problems which include cost and sludge formation (Bala, 2018).

Naturally occurring coagulants are usually presumed safe for human health. Some natural coagulants were produced or extracted from micro-organisms, animals or plants. Similarly, natural coagulants from vegetable and mineral origins were used in water treatment before chemical salts. They have not been able to compete effectively because a scientific understanding of their effectiveness and mechanism of action is still lacking. One of these alternatives is Moringa Oleifera (Zogale) seeds (Saulawa *et al*, 2010).

Limited studies exist on the use of watermelon and Roselle seed extracts as compared to the available studies on the use of alum in greywater treatment. Though there have been many studies on Moringa oleifera and Manihot palmate separately and in comparison, to alum as coagulants for domestic wastewater treatment (Adamu *et al*., 2014; Renuka & Karunyal, 2017), this necessitates the need to discover the potentials of combining watermelon (*Citrullus lanatus*) and Roselle *(Hibiscus Sabdariffa*) seeds extracts as substitutes for conventional chemicals in greywater treatment. Watermelon and Roselle seeds are biodegradable, low toxicity, low residual sludge production and are presumed safe for human health, the technologies involved are economical and easy to implement. The process being biological does not generate any non-treatable wastes. A recent study on watermelon (*Citrullus lanatus*) seeds reveals it to be a natural coagulant for water treatment because of its high protein content (Muhammad, *et al.,* 2015), but its antimicrobial properties of the seeds were not covered, hence the need to be researched. However, this work also seeks to replace artificial coagulants partially or wholly with more health-friendly natural coagulants

METHODOLOGY

Materials and Equipment.

The following materials and equipment presented below were used during the study: A four-paddle stirrer jar test (PCI Jar Test Machine), Weighing balance (Metter P160 N), Mortar and pestle, Whatman No 1 filter paper, Muslin cloth, pH Meter (HANNA MODEL), Magnetic stirrer and magnet, Turbid meter (MODEL HACH 2100N), USA, Kjeldahl flask, Fume cupboard, Soxhlet extraction apparatus, Burette, Conical flask, Crucible, Oven and Extractor.

Reagents

Concentrated Sulphuric acid, ferrous Ammonia sulphate, Potassium dichromate, Silver sulphate, Mecury (II) sulphate, Copper sulphate, Sodium sulphate, Sodium hydroxide, Boric acids, Screened methyl red indicator, Hydrochloric acid, Hydrogen sulphate, Ethanol, Phenolphthalein indicator, Eriochrome black.

METHODOLOGY

Preparation of watermelon and Roselle seeds powder

1kg watermelon and Roselle seeds were obtained from the Hunkuyi market in the Kudan local government Area of Kaduna State, Nigeria. Good quality water melon and Roselle seeds were selected, shelled by hands to remove the kernels. To ensure the efficiency of watermelon and Roselle seeds, the kernels were crushed and ground to a medium-fine powder using a domestic blender (Assparo, Model 900).

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), JANUARY, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

Plate 1: Watermelon seeds
Plate 2: Watermelon seeds powder

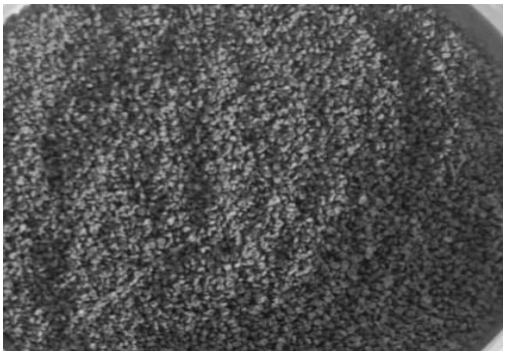

Plate 3: Roselle seeds
Plate 4: Roselle seeds powder

Preparation of watermelon coagulant stock solution

5.0 g of the watermelon seeds was added to 100ml of distilled water in a 250 ml beaker and the set up was stirred on a magnetic stirrer at high speed (10 rpm) for 15 min to obtain a suspension. The suspension was first filtered through a muslin cloth with a pore hole of 0.15 mm, then through a filter, to give a stock solution of 5000 mg/l. The stock was then measured for the required dosage of 50 mg/l, 100mg/l, 150mg/l, 200mg/l and 250 mg/l. The filtrate which contains the bio coagulant is referred to as "fresh extract"

Preparation of Roselle seeds extracts coagulant stock solution

5 g of Roselle seeds were mixed with 100 ml of distilled water, 0.5 M NaCl, and 0.05 M NaOH to extract its coagulant agent. The extraction was done by using a household food blender for 2 minutes. These solvents were chosen based on previous researches (Mun *et al,* 2016). The coagulant was filtered through a muslin cloth to remove impurities. A similar dosage was used in the subsequent jar test. To prevent the microbial decomposition of organic compounds, present in the coagulant, the coagulant was prepared and used on the same day for optimum performance (Mun *et al,* 2016).

Greywater Sample Collection

A greywater sample was collected from Suleiman Hall of Ahmadu Bello University, Zaria through the drainage outlet, by filling a 20 liters jerry can with the aid of a funnel held just beneath the surface of the water, the funnel and the gallon were sterilized and properly rinse with the sample.

Jar Test Analysis

Jar test analysis was carried out using a dose of 50, 100, 150, 200 and 250mg/l when used singly while 80mg/l:20mg/l, 70mg/l; 30mg/l, 50mg/l:50mg/,30mg/l:70mg/l, 20mg/l: 80mg/l dose ratio were used respectively for the combined watermelon and Roselle seeds for the 5-sample test containing 200ml of greywater sample. The magnetic stirrer was operated at 100 rpm for approximately 1 minute immediately after

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), JANUARY, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

each beaker was dosed. The speed of the stirrer was then reduced to 10 rpm, and allowed to stir for 15 minutes, at the end of the 15 minutes, the stirrer was switched off and gently removed. The beaker was allowed to stand for 1hr and then the supernatant was gently decanted for analysis.

pH

This gives the intensity of the acidic or basic character of the extracts. It was measured to determine the influence on the acidity/ alkalinity of the greywater sample. Samples were analyzed at ambient temperature with a pH meter model. The meter was calibrated and analysis was carried out following the standard method of water and wastewater (APHA 1999) throughout the study.

Turbidity

The Turbidity of the water sample was measured before and after treatment using a turbidity meter. The measurement was carried out according to the standard method for the examination of water and wastewater (APHA, 1999).

Biochemical Oxygen Demand (BOD)

The BOD test measures the molecular oxygen consumed during a specific incubation period for the biochemical degradation of organic matters and the oxygen used to oxidize the inorganic matters present in the greywater sample. The BOD test was carried out according to the standard method of examination of water and wastewater (APHA 1999).

Chemical Oxygen Demand

0.4g of $HgSO_4$ was placed in the refluxing flask, 20ml of the sample was mixed with the $HgSO_4$ in the refluxing flask. 10ml of standard $K_2Cr_2O_2$ solution and several size granules already preheated to 600^0C for one hour were added into the flask. The refluxing flask was then attached to the condenser. 30ml of concentrated H_2SO_4 containing $AgSO_4$ was slowly added through the open end of the condenser to mix thoroughly by swirling while adding the acid. The mixture was then refluxed for an hour followed by cooling and the condenser was washed with 25ml of distilled water. The mixture was diluted to 100ml with distilled water and cooled to room temperature. 3 drops of ferroin indicator were added and titrated with ferrous Ammonia sulphate to reddish-brown coloration as an endpoint. The same procedure as above was carried out for 20ml distilled water together with the reagent as blank was also refluxed The COD was calculated using equation (3.1).

$$COD = \frac{(a-b)\times N\times 800}{ml\ Sample} \quad (3.1)$$

Where; N = Normality of ferrous Ammonia sulphate, 'a' and 'by = volume of ferrous Ammonia sulphate used for blanks and samples respectively.

Coliform Bacteria Estimation

The bacterial count was determined by the serial dilution technique. 9ml of sterile distilled water was transferred to six test tubes. 1ml of water sample was transferred into the second tube and up to the last tube. After this time, 1ml of water from each test tube was transferred to the surface of an Eosin methylene agar (EMB agar) plate and spread evenly with a sterile bent rod, and then incubated at 37^0C for 24hours after which the colonies were counted.

RESULTS AND DISCUSSION

The parameters including, Turbidity, pH, BOD, COD, and Bacterial count were obtained for the raw samples as initial readings (before treatment) to be compared with the treated samples and these are summarized in Table 2.

Table 1: Result of Physiochemical and Bacteriological properties of the greywater before treatment

S/N	PARAMETERS	Value obtained
1	Turbidity	303NTU
2	pH	6.9
3	BOD	4.5mg/l
4	COD	1000mg/l
5	Bacterial Count	500 * 10^4 count/ml

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), JANUARY, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

From the results, some of the physicochemical and bacteriological parameters like Turbidity, Bacterial count, and COD were found to be above the standard limit of 5NTU, 1.0 × 10^2 counts/ ml, and 1000mg/l maximum mg/l this could be as a result of a high rate of student's activities in the school hostel. Hence the need for treatment.

Table 2: Results of the Physicochemical and Bacteriological Analysis after Treatment with Water Melon Seeds.

S/N	Sample	Dosage mg/L	BOD mg/L	COD mg/L	Turbidity NTU	Bacterial count 10^5	pH
1	WM	50	1.3	600	38	10	7.8
2	WM	100	1.0	500	34	5	6.9
3	WM	150	0.8	400	49	20	7.1
4	WM	200	0.6	385	86	40	6.8
5	WM	250	0.2	289	94	58	7.2

It indicates that at varying coagulant dosages, the pH was within the recommended limit of 6.4-8.5, this is similar to the finding of **(**Roseline, 2014), which shows that the pH was not affected during water treatment with the natural coagulant, while significant changes were observed in Turbidity, BOD, COD and bacterial count for the water treated with the watermelon seeds powder. However, there was a notable decrease in the turbidity and bacterial count of the water sample after treatment. This is similar to the findings of previous studies on the coagulation and flocculation ability of some seeds (Bala, 2018).

The highest decrease (89%) in turbidity was seen at the dose of 100mg/l, 99% reduction in bacterial count, 95.55% reduction in BOD and 71.11% reduction in COD, and these conform with the result of Arnoldson (2008). water treated with natural coagulants gave the highest turbidity removal (75%). In low turbid water (57 NTU). The limitation in turbidity removal recorded in this finding confirmed that it is less effective at treating water with low levels of turbidity. Greywater treated with watermelon gave the best reduction in turbidity and bacterial count compared with that of Roselle because the percentage of the active bio coagulant in watermelon is higher than that of Roselle seeds.

Table 3: Results of the Physicochemical and Bacteriological Analysis after Treatment with Roselle Seeds extracts**.**

S/N	Sample	Dosage mg/L	BOD mg/L	COD mg/L	Turbidity NTU	Bacteria x 10^5	pH
1	RS	50	2.5	800	101	33	7.6
2	RS	100	1.3	620	58	60	7.9
3	RS	150	0.9	550	115	80	7.1
4	RS	200	0.4	700	158	20	7.7
5	RS	250	0.3	770	174	90	6.6

From Table 3, greywater treated with Roselle seeds gave a turbidity removal of 80.9%, 45% of COD reduction, 93% of BOD removal, and 96% of bacterial count removal. This is proximate to the findings of Nautiyal *et al,* (2017) that revealed that water treated with Watermelon seeds gave a turbidity removal of (75%).

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), JANUARY, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

Table 4: Results of the Physicochemical and Bacteriological Analysis after Treatment with combined seeds of watermelon and Roselle Seeds extracts at different ratios.

S/N	Sample mg/l	Dosage mg/l	BOD mg/l	COD mg/l	Turbidity NTU	Bacterial count 10^4	pH
1	WM+RS	80:20	1.5	800	34	30	6.90
2	WM+RS	70:30	2.0	700	26	25	6.76
3	WM+RS	50:50	2.5	500	43	20	6.76
4	WM+RS	30:70	2.8	498	55	19	6.72
5	WM+RS	20:80	3.0	400	70	16	6.66

Tables 4 show that there is a significant change in COD, Turbidity, and bacterial count after treatment with the combined doses of watermelon and Roselle seeds Extract. The best reduction in turbidity was obtained with a ratio of 70:30. The bacterial concentration also decreases with the increasing dosage of the watermelon/Roselle seeds ratio. The best reduction in the bacterial count was also observed at 20:80 which is from 500 × 10^4 Cfu /100mls to 16× 10^4 Cfu /100mls after treatment. And the best BOD reduction was also observed at 70:30.

Comparing Effectiveness of Watermelon and Roselle Seeds When Used Singly or in Combination.

By comparison, watermelon seeds had an advantage over Roselle seeds as far as turbidity is concerned because the watermelon seeds had a higher percentage removal which is 89.0% compared to Roselle seeds with 80.9% percentage in removing the turbidity of the greywater sample. While for the combined use of watermelon and roselle seeds at a combined ratio of 70:30 revealed an optimum turbidity removal of 91% and bacterial count removal of 94.5%.

CONCLUSION

Watermelon seed used separately is more effective than Roselle in turbidity removal from 303NTU to 34NTU as it gave 89% removal while Roselle gave 80.0% removal from 303NTU to 54 NTU. On the other hand, the combined formulation revealed the best coagulation properties with turbidity removal of 91% from 303NTU to 26NTU and bacterial count removal of 94.5% at a combined ratio of 70:30, however, the optimum dosage of 100mgl was obtained in both watermelon and Roselle seeds extracts. While for the combined watermelon and Roselle seeds extract it was obtained at a combined ratio of 70:30. It was observed that all the pH is within the recommended value of wastewater used for irrigation (6.5-8.4). And it could, therefore, be concluded that both watermelon and Roselle seeds extracts could potentially serve as good coagulants with good disinfecting properties.

REFERENCES

Abu-Reidah, I.M., Arraez-Roman, D., Carretero, A.S., Fernandezgutierrez, A., (2013). Profiling of phenolic and other polar constituents from the hydro-methanolic extract of watermelon (*Citrullus lanatus*) using accurate mass spectrometry (HPLC-ESI-QTOF-MS). Food Research International 12, 0963-9969.

Abirami .M and Rohini. C (2017) comparative study on the treatment of Turbid water using Moringa Oleifera and Alum international conference on Energy trends in Engineering Science and sustainable technology vol 2 page 41-48

Arnoldson, E., Bergman, M., Matsinhe, N and Person, K (2008) *Assessment of drinking treatment using moringa oleifera natural coagulant pp 137-150.;* VATTEN

Adamu, A., Adie, B. D., & Alka, U. A. (2014). A comparative study of the use of cassava species and alum in

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.

wastewater treatment. *Nigerian Journal of Technology, 33*, 170–

Ali E.A and Ali A (2014) Physicochemical properties of Roselle seeds oil in North Kordofa Scientific and innovative research journal

Bala, S. (2018) Bio coagulation efficiency of jute in water treatment unpublished MSc thesis Department of Water Resources Ahmadu Bello University Zaria.

Egwu, G. A., Gopalsamy, P. & Muthu, N.2017 Characterization of domestic gray water from a point source to determine the potential for urban residential reuse: a short review. Appl. Water Sci.4, 39–49.

Ida, B. (2013). *Coagulant protein from plant materials*: potential water treatment agent. Royal Institute of Technology Stockholm.

Muhammad, I., AbdulSalam, S., AbdulKarim, A., & Bello, A. (2015). Watermelon seed as a potential coagulant for water treatment. Global Journal of Researches in Engineering: Chemical Engineering. Chemical Engineering. Global Journals Inc. (USA), Vol. 15, 1, pp 17-25.

Osayande I.O (2016), the use of selected plant extracts in greywater treatment unpublished the Msc thesis Department of Water Resources and Environmental engineering Ahmadu Bello University Zaria.

Ochibo O.B (2012) Greywater treatment using moringa oleifera seed extract undergraduate project department of Water Resources and Environmental Engineering Ahmadu Bello University Zaria.

Renuka, J., & Karunyal, J. (2017). A study on the assessment of water quality treated with selected plant species. *International Journal of Innovative Research in Science, Engineering and Technology, 6*, 2225–2235.

Roseline. N (2014) Investigation of the potential of watermelon seed as natural coagulant undergraduate project Department of chemical engineering Abubakar Tafawa Balewa university of technology Bauchi.

Saulawa, .S.B., Okuofu, C.A., Ismail, A., Otun, J.A., Adie, D.B., and Yakasai, I.A. (2011). Effect of Deterioration on the Turbidity Removal Potential of Moringa Oleifera Seed Extract; Paper Presented at the 7th Annual National Conference of the Society for Occupational Safety and Environmental Health (SOSEH).Nov.,16th – 19th 2011, ETF Conference Centre, University of Abuja, Abuja FCT Nigeria. *Science of the Total Environment,* 537**,** 462-469.

Mun Y. Young N, Ismail (2016) optimization of Hibiscus Sabdariffa is a Natural coagulant to treat congo red wastewater treatment *journal of* engineering *science technology* 4th eureka page 153- 165.

Corresponding author: Nuhu I. S.
ismailshafiubomo@gmail.com
Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria Kaduna Nigeria.