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Original article

Phytochemical screening of watermelon seeds *(Citrillus lanatus*) and it use as organic coagulant in water treatment

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ABSTRACT

This study investigates the use of watermelon seed extract as a natural coagulant for water treatment. Watermelon seeds (*Citrullus lanatus*) were subjected to phytochemical screening to identify bioactive compounds, using methanol and n-hexane as extraction solvents. The results showed the presence of alkaloids, tannins, saponins, carbohydrates, and flavonoids, with the methanol extract yielding a higher concentration of these compounds. A jar test was performed on water samples collected from Tagwai Dam, with the watermelon seed extract demonstrating significant turbidity reduction. The optimal dosage for effective coagulation was found to be 0.2g/L to 0.3g/L under neutral pH conditions. Compared to conventional coagulants, the watermelon seed extract offers a cost-effective, environmentally friendly alternative with minimal sludge production. This research suggests that watermelon seeds have the potential to be an effective and sustainable natural coagulant for use in rural and low-resource areas.

Keyword: Watermelon seed, coagulation, phytochemical screening, organic coagulant

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INTRODUCTION

Availability of portable quality drinking water is a challenge faced by several localities in the underdeveloped and developing countries especially with the rising cost of water treatment. This has become worse due to the instability of water bodies (streams, ponds, lakes and rivers) evidenced by the presence of dissolved colloidal particle and undissolved suspended solid caused by leach ability of heavy metals from sewage sludge [1] and land development through human and construction activities. While a careful selection of treatment system for onsite treatment of domestic wastewater is pertinent to reduce the spread of diseases originating from groundwater contamination, the excessive storm runoff that emptied itself into several water bodies during the rainy seasons is one of many factors that consistently contribute to unpredictable variations of quality of water bodies [2]. These occurrences have resulted in increased level of water turbidity as well as increased need and use of water treatment chemicals which are most often than not, expensive and

unsustainable. Based on this and coupled with the poor treatment method adopted by some water distribution companies, a few health cases which are related to poor quality drinking water distributed to consumers have been reported.

Among the plant materials that have been studied include *Moringa oleifera* seeds [3,4,5,6]. Leguminous plant seeds such as *Phaseolus vulgaris*, *Robinia pseudoacacia*, *Ceratonia siliqua* and *Amorpha fruticosa*, okra (*Abelmoschus esculentus*) and passion fruit (*Passiflora edulis*) [7], watermelon seed [8] and Peanut seeds [8,9].

Watermelon *Citrullus Lanatus* is cultivated in various parts of the world for consumption of its juicy nutritious flesh. Its waste seeds contain about protein 25–37% protein and 37.8–45.4% oil with high linoleic acid content (60%). It is rich in phytochemicals and antioxidants which protect against cancer [10]. This study focused on investigating the phytochemicals present in watermelon seeds as well as its performance as natural coagulant for water treatment.

MATERIALS AND METHODS

Extraction of oil

Fresh seeds of watermelon (*Citrullus lanatus)* of the cucurbitaceae family were purchased from lapai market Niger state. The fruits were sliced open using a clean stainless steel laboratory knife. The seeds were washed severally with distilled water, sun-dried for a week, sorted to remove bad ones, shelled, grinded with an electric blender, packed in an airtight container.

Extraction was carried out using methanol and n-hexane as solvent. The sample was weighed (100 g) and soaked in 400 ml of methanol separately in a conical flask. The mixture in the flasks was kept at room temperature for 24 hours with intermittent agitation and the sample was filtered into a beaker. The filtrate of the sample was concentrated to dryness by evaporation at 45ºC in a water bath for 3 days. On the other hand, 500ml of the n-Hexane was used to extract oil from 100g of the crushed seed in the column. The apparatus was left running for about 6hours and stopped when the extraction was complete. The oil extracted seeds were then dried to remove residual n-Hexane and then sieved. The finer particles were then used as the coagulant.

Phytochemical screening

The phytochemical screening was carried out accoding to the methods described by [11].

Test for alkaloids: To 2ml of plant extract, 2ml of concentrated hydrochloric acid was added. Then a few drops of Mayer's reagent were added. The presence of green colour or white precipitate indicated the presence of alkaloids.

Test for flavonoids: To 2ml of plant extract, 1ml of 2N sodium hydroxide was added. The presence of yellow colour indicated the presence of flavonoids.

Test for proteins: To 2ml of plant extract, a few drops of 0.2% Ninhydrin were added and heated for 5 minutes. Formation of blue colour indicated the presence of proteins.

Test for saponins: To 2ml of plant extract, 2ml of distilled water was added and shaken in a graduated cylinder for 15minutes lengthwise. Formation of 1cm layer of foam indicated the presence of saponins.

Test for terpenoids: To 0.5ml of extract, 2ml of chloroform was added and concentrated sulphuric acid was added carefully. Formation of red brown colour at

the interface indicated the presence of terpenoids.

Water sample collection

The raw water sample was collected from Tagwai dam Chanchaga Niger state, North-East of Nigeria. The water was collected from the side of river by immersing a plastic container until it was full. The cap was inserted while it was still underway. The water was then treated using watermelon seed.

Determination of Water quality parameters

Turbidity: Turbidity of the water sample was carried out before and after treatment using a turbidity meter. A control sample of water was poured into one of the test containers and filled to the 10ml mark. The water sample to be tested was then poured into a second container and filled to the 10ml mark. The turbidity meter was then zeroed and the control sample tested to ensure its turbidity was as zero. The sample was then placed in the meter and the resulting measurement recorded.

Total dissolve solid (TDS): This was obtained by taking the difference between the two-thirds of the conductivity using the conductivity meter.

pH: The pH of the samples was taken using an electronic pH meter. The sensor of the meter was dipped into the sample ensuring that the sensor did not touch the sides of the container. A new reading was then shown on the screen and the value recorded. The sensor of the meter was rinsed off using distilled water and placed in a beaker with distilled water.

Jar Test

The jar test apparatus was used to carry out coagulation and flocculation on the water samples. Six 1litre beakers were used to study the effect of coagulant dosage on coagulation, the effect of pH on coagulation and the effect of stirring time and speed on coagulation.

The following parameters were then measured on the filtrate after the coagulation was completed: Turbidity, pH, TDS and Conductivity. Six different weights of the coagulant were placed in six beakers of I litre each, the first having 0.2g, and the remaining five varying from 0.2g to 1.0g at interval to determine the optimum dosage. The jars were placed in the jar test kit with stirrers lowered into each.

The stirring speed was set at 150rpm of rapid mixing for 2 minutes and 80rpm for 8minutes of slow mixing. After this was completed, the samples were allowed to settle and the flocs filtered using a filter paper and these parameters (Turbidity, Colour, Flocs weight, TDS and Conductivity) were measured on the filtrate. From the results obtained the dosage with the best results in colour and turbidity removal was taken as the optimum [12].

Data Analysis

One-way Analysis of variance (ANOVA) was used to compare means of water quality parameters and coagulation efficiency between the multiple groups, different watermelon seed dosages, pH conditions to determine the significance differences.

RESULTS

Phytochemical analysis of watermelon seed

The results of the phytochemical screening of watermelon seed extracts using two different solvents (methanol and n-hexane) are presented in Table 1. It was revealed that carbohydrates and alkaloids were present in

both extract but stronger in n-hexane. Tannins, saponins, glycoside cardiac and phenols were present in both extracts. Flavonoid was present in the methanol extract and absent in n-hexane. While quinones were strongly present in the methanol extract and absent in n-hexane. Glycoside, terpenoid and steroids were absent in both extracts

.

Table 1. Phytochemical analysis of watermelon seed extract

Parameters	Methanol Extract	n-Hexane Extract
Carbohydrate	+	++
Tannins	+	+
Saponins	+	+
Alkaloids	+	++
Flavonoids	++	_
Glycoside	_	_
Glycoside cardiac	+	+
Terpenoids	_	_
Phenols	+	+
Quinones	+	
Steroids	-	_

The presence or absence of various bioactive compounds in the extracts is indicated by positive (+) or negative (-) signs, with (++) showing a stronger presence of the compound.

Results on the effect of coagulant dosage on coagulation are presented in Table 2. The dosage varied from 0.1g/L - 0.6g/L for each sample treated. At varying coagulant dosages, the effect on the water quality parameters revealed that the temperature ranged from 26.3±0.20 (0.2 and 0.4g/l) to 26.7±0.01 (0.3g/l); pH ranged from 6.36±0.03 (0.2g/l) to 6.54±0.04 (0.3g/l); conductivity ranged from 324±4.00 (0.3g/l) to 387±2.00 (0.6g/l); Total dissolved solid (TDS) ranged from 167±2.00 (0.4g/l) to 1.95±5.00 (0.6g/l) and Turbidity ranged from 7.61±0.01 (0.2g/l)to 14.99±0.03 (0.6g/l). At varying dosage no significant changes were observed on pH, temperature, conductivity and TDS for the water sample treated with watermelon seed cake as coagulant.

Table 2 effect on the coagulation of dosages of water samples

Concentration g/l	Temperature °C	Ph	Conductivity µs/cm	TDS Mg/l	Turbidity NTU
Control	26.7±0.20^{a}	6.84±0.02^{c}	349±3.00^{ab}	173±3.00^{ab}	63.7±0.20^{c}
0.1	26.6±0.10^{a}	6.46±0.02^{a}	358±2.00^{b}	180±5.00^{b}	8.41±0.01^{a}
0.2	26.3±0.20^{a}	6.36±0.03^{a}	344±4.00^{ab}	172±2.00^{ab}	7.61±0.01^{a}
0.3	26.7±0.01^{a}	6.54±0.04^{a}	324±4.00^{a}	169±3.00^{a}	10.71±0.01^{b}
0.4	26.3±0.20^{a}	6.51±0.01^{b}	336±2.00^{a}	167±2.00^{a}	11.70±0.05^{b}
0.5	26.5±0.01^{a}	6.42±0.03^{a}	375±5.00^{bc}	168±4.00^{a}	12.73±0.03^{b}
0.6	26.4±0.01^{a}	6.37±2.00^{a}	387±2.00^{c}	1.95±5.00^{c}	14.99±0.03^{a}

Values are presented as mean ± standard deviation. Values with different superscript letters across the column are significantly different at P<0.05.

Results on the effect of pH on the coagulation dose of 0.2g/l are shown in Table 3. It was revealed that the pH ranged from 6.0±0.30 to 8.5±0.50; temperature ranged from 24.06±0.54 (pH of 8.5) to 26.00±0.10 (pH of 6.0); conductivity ranged from 175±5.00 (pH of 6.0) to 423±3.00 (pH of 8.5); TDS ranged from 177±2.00 (pH of 7.5) to 371±1.00 (pH of 6.5) and Turbidity ranged from 4.25±0.02 (pH of 6.0 to 7.49±0.04 (pH of 6.5). There were no significant differences in the tubidity level at 6.0, 7.5 and 8.5 pH. However, significant differences were observed at 6.5, 7.1 and 7.0 pH.

Table 3 effect of pH at coagulation of 0.2g/l dosage.

pH	Temperature °C	Conductivity µs/cm	TDS Mg/l	Turbidity NTU
6.0±0.30^{a}	26.00±0.10^{b}	175±5.00^{a}	272±2.00^{b}	5.30±0.5^{b}
6.5±0.05 ^{a}	24.900±0.01^{a}	272±3.00^{b}	371±1.00^{c}	7.49±0.04^{c}
7.1±0.01^{ab}	24.600±0.01^{a}	233±3.00^{b}	242±2.00^{b}	4.25±0.02^{a}
7.5±0.50^{ab}	24.900±0.01^{a}	351±1.00^{c}	177±2.00^{a}	5.15±0.05^{b}
7.0±0.01^{ab}	25.06±0.55^{ab}	401±2.00^{d}	203±3.00^{b}	4.71±0.01^{a}
8.5±0.50 ^{b}	24.06±0.54^{a}	423±3.00^{d}	201±3.00^{b}	5.75±0.02^{b}

Values are presented as mean ± standard deviation. Values with different superscript letters across the column are significantly different at P<0.05.

Table 4 shows the results obtained when the effect of stirring time on coagulation was studied by varying the stirring time at a constant coagulant dosage of 0.2g/l. The pH value ranged from 7.21±0.01 (12mins) to 7.78±0.02 (10mins); temperature ranged from 23.4±0.40 (5mins) to 23.7±0.20 (2, 10 and 15 mins); conductivity ranged from 409±1.00 (12 mins.) to 460±5.00 (15 mins.); TDS ranged from 206±2.00 (12 mins.) to 230±5.00 (15 mins.) while turbidity ranged from 3.77±0.02 (8 mins.) to 5.25±0.04 (15

mins.). There were no significant differences in pH, temperature, conductivity and TDS at 0.2g/l coagulant dosage on a 2-15 minute range. However, significant differences were observed in the turbidity level at 8 and 15 minutes.

Table 4 effect of time on coagulation at 0.2g/l coagulant dosage

TIME Minute	pH	Temperature °C	Conductivity µs/cm	TDS Mg/l	Turbidity NTU
2.0	7.50±0.50[a]	23.7±0.02[a]	419±4.00[a]	214±6.00[a]	4.62±0.04[b]
5.0	7.57±0.02[a]	23.4±0.40[a]	422±3.00[a]	212±6.00[a]	4.99±0.03[b]
8.0	7.61±0.01[a]	23.5±0.30[a]	416±2.00[a]	209±5.00[a]	3.77±0.02[a]
10.0	7.78±0.02[a]	23.7±0.20[a]	422±1.00[a]	211±6.00[a]	4.08±0.01[b]
12.0	7.21±0.01[a]	23.6±0.10[a]	409±1.00[a]	206±2.00[a]	4.15±0.05[b]
15.0	7.26±0.02[a]	23.7±0.20[a]	460±5.00[ab]	230±5.00[ab]	5.25±0.04[c]

Values are presented as mean ± standard deviation. Values with different superscript letters across the column are significantly different at P<0.05.

Table 5 shows the effect of stirring time on coagulation and as with the effect of dosage, the results obtained show no significant changes in pH or temperature. It was observed that the pH ranged from 7.21±0.01 (50rpm) to 7.59±0.04 (250rpm); temperature ranged from 26.3±0.300 (150rpm) to 26.6±0.200 (50 and 300rpm); conductivity ranged from 366±1.00 (250rpm) to 431±1.00 (300rpm); TDS ranged from 182±300 (250rpm) to 241±2.00 (300rpm) and Turbdity ranged from 5.21±0.03 (100rpm) to 7.89±0.03 (250rpm). There were no significant differences ($p<0.05$) in the pH, temperature and TDS at 50-300rpm speed. However, significant differences were observed in the conductivity and turbidity level at 250 rpm speed.

Table 5 effect of mixing speed on coagulation at dosage 0.2g/l

SPEED (rpm)	pH	Temperature °C	Conductivity µs/cm	TDS Mg/l	Turbidity NTU
50	7.21±0.01[a]	26.6±0.300[a]	385±5.00[a]	192±7.00[a]	5.28±0.03[a]
100	7.34±0.04[a]	26.4±0.200[a]	402±4.00[b]	199±6.00[a]	5.21±0.03[a]
150	7.41±0.06[a]	26.3±0.300[a]	402±3.00[b]	200±5.00[b]	5.55±0.05[a]
200	7.58±0.05[a]	26.5±0.200[a]	416±2.00[b]	207±4.00[b]	6.15±0.04[ab]
250	7.59±0.04[a]	26.5±0.100[a]	366±1.00[a]	182±300[a]	7.89±0.03[b]
300	7.58±0.03[a]	26.6±0.200[a]	431±1.00[b]	241±2.00[b]	6.03±0.03[ab]

Values are presented as mean ± standard deviation. Values with different superscript letters across the column are significantly different at P<0.05.

DISCUSSION

The results of the phytochemical screening revealed that watermelon seed extract contains important bioactive compounds, including carbohydrates, tannins, saponins, alkaloids, flavonoids, and phenols which are similar with the findings of [13]. This implies that watermelon seeds have some medicinal value and can also be served as food [14]. These compounds play a crucial role in the water treatment process by enhancing coagulation, flocculation, and water purification. The medical properties of plants are primarily attributed to the presence of bioactive phyto-constituent groups therefore, the presence of various phyto-constituents is basis for potential biological activities. The presence of saponins in natural products has been associated with improving nutrient uptake by the intestine. Tannins bind to proline rich proteins and interfere with the protein synthesis [15].

The results obtained in this study are in accordance with previous studies conducted by [16] on the fluctuating ability of watermelon seeds. The highest decrease which was observed at the dose of 0.2g/l is contrary with the findings of [8] who observed the highest decrease at 0.1g/L. The observed decrease in this study is still above the WHO recommended level of 5NTU. However, according to [17] the optimal dosage for a specific water is defined as the dosage which gives the lowest turbidity in the treated water. Therefore, the optimum dosage in this study is 0.2g/l. The conductivity level increased with an increase in the coagulant dose. This agrees with studies conducted by [18,19,8].

Watermelon seed extract performs best at neutral pH (around 7), where coagulation is most efficient. pH outside this range (either acidic or alkaline) reduces the effectiveness of the coagulation process. This suggests that maintaining a neutral pH optimizes the coagulation effect. [20]. Studies on the stirring time revealed no significant differences in the pH and temperature. The temperature remained constant, over a range of stirring times. Stirring time of 2-15mins was used to show this. The TDS values obtained are still below 300, which is still within the standard range. It has its highest value at the highest stirring time. This would indicate that significantly increased stirring time at 15mins and above can cause increase in the TDS and conductivity content in the treated water. At the stirring time of 2, 5, 8, 10 and 12 mins a turbidity value below the WHO standard was obtained. However, in 15mins, a slightly higher value was obtained. These are also similar with the findings of [7]. Optimal mixing speeds for coagulation are around 150 rpm. Higher speeds disrupt the formation of flocs and cause re-suspension of particles, which counteracts the coagulation effect. The study demonstrates that watermelon seeds can significantly reduce turbidity in water and improve water quality under optimal conditions, such as neutral pH, moderate stirring time, and mixing speed. The use of watermelon seeds as a coagulant offers several advantages, such as cost effectiveness, its sustainability as well as health benefits. Thus, it holds great potential as an eco-friendly alternative to chemical coagulants in water treatment, particularly in developing countries where access to clean water is limited.

Authors' Contribution

YA and IG designed the study, IG carried out the fieldwork and data collection. YA and IG performed the data analysis, HMO prepared the first draft of the manuscript reviewed by YA. All authors contributed to the development of the final manuscript and approved its submission.

Disclosure of Conflict of Interest

None

Ethics Approval and Informed Consent

The study did not use any human or animal subjects. Therefore, ethical consideration was not applicable.

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