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Original article

Potential of *Citrullus lanatus* (Watermelon) seed varieties as a natural coagulant for water treatment

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ABSTRACT

This research was conducted to assess the potential of two (2) varieties of watermelon seed (picnic and kaolack) as a natural coagulant in the treatment of water. Water samples were collected from River Chanchaga located in Minna Niger State for the evaluation of the efficiency of the two seed varieties. A laboratory study using a jar test was conducted on the water samples collected. The coagulant was added to varying dosages to determine the optimum seed dosage to be purified. Results obtained revealed that the values of turbidity ranged between 40.00±6.00 to 289.00±47.00 for picnic variety and 51.00±2.00 to 133.00±4.00 for kaolack variety; pH ranged between 7.22±0.21 to 8.04±0.49 and 7.57±2.07 to 8.00±1.00; conductivity ranged between 29.40±1.83 to 35.80 ±1.24 and 29.90±2.00 to 36.50±2.00; total dissolved solid ranged between 42.07±4.80 to 53.17±1.21 and 46.20±3.00 to 55.80±4.00; while temperature ranged between 25.00± 0.10 to 25.80± 0.10 and 25.20±2.00 to 25.60±4.00 respectively. The highest decrease was observed at the dose of 0.5 g/l with the picnic variety recording a higher turbidity removal level of 40 g/l when compared with kaolack variety which recorded 51 g/l. It can therefore be concluded that watermelon seeds can serve as a natural coagulant for household-level water treatment.

Keyword; Natural coagulant, raw water, turbidity, watermelon seed, water treatment.

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INTRODUCTION

The vitality of water as a resource cannot be overemphasized, but its depletion recently has presented a troubling challenge for humanity. Increase in population size, urbanization and the subsequent misuse of these natural non-renewable resources have caused a sudden increase in the need for portable water. In Africa, one third of the population (over 780 million people) have no access to safe water, and almost two thirds have no access to sanitation, in spite of the wide recognition of the importance of improved water and sanitation and the heavy investment by international donors and governments in extending water supply systems, thus, leading to widespread of waterborne diseases that cause loss of productivity [1]. In addition, a large portion of the populace in developing countries are dependent on raw water without any treatment for drinking purposes [2[and this water source can be polluted by chemicals, agricultural runoff as well as human and animal feaces. Additionally, previously safe water might become contaminated by unsanitary water handling practices in the home or during transportation [3]. Although the World Health Organization estimates that up to 80% of all illnesses and diseases worldwide are brought on by poor sanitation, contaminated water, or a lack of water, 10% of these illnesses can be avoided by making improvements to drinking water, sanitation, and water resource management [4].

However, coagulants are formulated to help separate suspended particles into solids and liquids to purify water that is safe for human consumption. These particles are known to be very small, and their electrical charge between them and their small size contributes to their suspended stability (colloidal complex) [5]. Therefore, a few methods, including solar water disinfection (SODIS), chemical disinfection, chlorination, and filtration (ceramic and bio-sand), are commonly employed household water treatment methods in underdeveloped nations [6], and they all have associated health impacts.

Natural coagulants are generally thought to be safe for human health, and using natural plant-based coagulants for water treatment has several benefits, including being less expensive to buy, not producing treated water with extreme pH, and being highly biodegradable [7]. As a result, natural coagulants and disinfectants can play a crucial role in easing the challenges facing the water sector regarding how more people can access clean drinking water in a cost-effective manner, especially the rural poor who cannot afford any water treatment chemicals, without harming their environment. This research, therefore, aim at investigating the effectiveness of 2 varieties of watermelon (*Citrullus lanatus*) seed as a potential water coagulant in water purification.

MATERIALS AND METHODS

Collection of Water sample

Water samples were collected from chanchaga water works located in minna Niger State. The water was collected by dipping a plastic container into the river, filling it up and screwed immediately to avoid external contamination. The water collected was then transported to the lab for further testing and treatments.

Collection of watermelon seed

The watermelon seeds, picnic and kaolack (varieties) were purchased from a refined seed seller at kasuwan gwari market minna, Niger State. And transported to the herbarium of the department of biology Ibrahim Badamasi Babangida University Lapai for identification (IBBU210525).

Preparation of watermelon seed powder

The two watermelon seeds were thoroughly washed with distilled water, sun dried for 7 days, sorted and shelled. About 100g of the dried seeds were ground with a high-speed laboratory electric blender. The crushed seeds were then packed in a thimble and placed in a soxhlet extraction apparatus, 500ml of the n-Hexane was used to extract oil from the crushed seed in the column. The apparatus was left running for about six hours and stopped when the extraction was complete. The cake was later washed with distilled water to remove n-Hexane residual, dried in an oven and sieved. The fine particles were then weighed into 0.5g, 1.0g, 1.5g, 2.0g and 2.5g and 2.5g and used as the coagulant.

Jar test procedure

The Jar test apparatus was used to carry out the effectiveness of watermelon seed coagulant. Six beakers containing one liter of each of the water samples were placed in the jar test kit. Five different portions of the coagulant of varying weights were then added in each beaker and labelled, the first being blank, and the remaining five varying from 0.5g-2.5g at 0.5g interval to determine the optimum dosage. The stirrers were then lowered into each beaker and turned on, the stirring speed was set at 300rpm, 100 rpm for 30 secs, 150 secs (2 mins and 3 secs) indicating for rapid mixing and at 40rpm, 10 rpm for 4 minutes, 14 secs indicating slow mixing. After which, the samples were allowed to settle for 30minutes, flocs filtered using a filter paper, following parameters were then measured on the treated water after the jar test: turbidity, pH, conductivity, TDS and temperature. From the results obtained, the water sample with the lowest turbidity and pH value in conformity with Nigerian Standard for Drinking Water Quality (6.5-8.5) was taken as the optimum. The procedure above was used again repeated for the second variety (kaolack), using the same experimental conditions as above [8].

Determination of water quality parameters

Water quality parameters such as turbidity, pH, conductivity, total dissolved solid (TDS), and temperature was determined according to standard procedure. Turbidity of the water samples were measured before and after treatment using a hach/TL2310 turbidity meter in accordance with the international method of water quality measurement and the results recorded. Temperature and pH of the samples were measured using Oakion/ION700 pH/temperature meter. The electrode was inserted directly into the water sample, the reading where recorded after it had stabilized. Total dissolved solids and conductivity values were determined simultaneously using OAKION/CON 550 conductivity/TDS meter [9].

Data Analysis

Data obtained were subjected to mean $\pm$ standard error. All data was analyzed using one way analysis of variance and individual mean was compared using Duncan multiple range test.

RESULTS

The result on the effect of coagulant dose using *Citrullus lanatus* picnic variety is shown in Table 1. For each sample treated, the dosage varied from 0 - 2.5g/l. At varying dose, there were significant and non-significant differences in the values of turbidity, pH, conductivity, total dissolved solid and temperature across the dose when compared with the control. The values of turbidity ranged from 40.00$\pm$6.00 (0.5g/l) to 289.00$\pm$47.00 (2.5g/l); pH ranged from 7.22$\pm$0.21 (2.5g/l) to 8.04$\pm$0.49 (0.5g/l);

conductivity ranged from 29.40±1.83 (0.5g/l) to 35.80 ±1.24 (2.5g/l); TDS ranged from 42.07±4.80 (1.5g/l) to 53.17±1.21 (2.5g/l) and temperature ranged from 25.00± 0.10 (1.5g/l) to 25.80± 0.10 (0.5g/l) respectively. There were no significant differences ($p<0.05$) in the turbidity level at 2g/l and 2.5g/l compared with the blank. However, significant differences were observed at 0.5g/l, 1g/l and 1.5g/l. There were no significant differences in the pH, temperature and total dissolved solids across all dosages. Significant differences were observed in the conductivity level at 2g/l and 2.5g/l respectively

.Table 1. Effect of coagulant dose using (*Citrullus lanatus*) **Seeds (Picnic) Variety Powder.**

Sample	Dosage (g/l)	Turbidity (NTU)	pH	Electrical Conductivity (μS/cm)	Total dissolved solid(mg/l)	Temp. (°C)
Blank	0g/l	263.00±21.52^{c}	8.29±0.46^{a}	28.06±0.50^{a}	45.67±6.51^{a}	25.08± 0.13^{a}
1	0.5g/l	40.00±6.00^{a}	8.04±0.49^{a}	29.40±1.83^{ab}	50.33±2.52^{a}	25.80± 0.10^{a}
2	1g/l	153.67±6.03^{b}	7.64±0.43^{a}	29.50±0.58^{ab}	46.31±3.98^{a}	25.50±0.10^{a}
3	1.5g/l	166.00±15.00^{b}	7.46±0.55^{a}	30.80±1.00^{ab}	42.07±4.80^{a}	25.20±0.10^{a}
4	2g/l	239.00±10.00^{c}	7.30±0.29^{a}	32.13 ±1.90^{b}	47.47±6.50^{a}	25.00± 0.10^{a}
5	2.5g/l	289.00±47.00^{c}	7.22±0.21^{a}	35.80 ±1.24^{c}	53.17±1.21^{a}	25.27± 0.21^{a}

Mean with the same superscript along a column are not significantly different at $p<0.05$.

The result on the effect of coagulant dose using *Citrullus lanatus* kaolack variety is shown in Table 2. The values of turbidity ranged from 51.00±2.00 (0.5g/l) to 133.00±4.00 (2.5g/l); pH ranged from 7.57±2.07 (2.5g/l) to 8.00±1.00 (0.5g/l); conductivity ranged from 29.90±2.00 (1.0 g/l) to 36.50±2.00 (0.5g/l); TDS ranged from 46.20±3.00 (1 g/l) to 55.80±4.00 (2.5g/l) and temperature ranged from 25.20±2.00 (2.5g/l) to 25.60±4.00 (0.5g/l) respectively. There were significant differences ($p<0.05$) in the turbidity level across all dosages compared with the blank. However, no significant differences were observed in the pH and temperature of all the dosages compared with the blank. There were significant and non-significant differences in the conductivity and TDS across all dosages compared with the blank.

Table 2 Effect of coagulant dose using (*Citrullus lanatus*) Seeds (Kaolack) Powder Variety

Sample	Dosage (g/l)	Turbidity (NTU)	pH	Electrical Conductivity (μS/cm)	TDS (mg/l)	Temp. (°C)
Blank	0 g/l	264.00±31.00^{d}	8.05±1.00^{a}	28.10±3.00^{a}	46.00±4.00^{a}	25.10±3.00^{a}
1	0.5 g/l	51.00±2.00^{a}	8.00±1.00^{a}	36.50±2.00^{c}	55.80±3.00^{b}	25.60±4.00^{a}
2	1 g/l	81.00 ±2.00^{b}	7.92± 0.12^{a}	29.90±2.00^{a}	46.20±3.00^{a}	25.40±6.00^{a}
3	1.5 g/l	96.00 ±4.00^{b}	7.73±2.08^{a}	35.00±2.00^{bc}	53.10±2.00^{ab}	25.20±5.00^{a}
4	2 g/l	122.00 ±12.00^{c}	7.65±3.00^{a}	33.30±1.00^{bc}	51.70±2.00^{ab}	25.0±3.00^{a}
5	2.5 g/l	133.00±4.00^{c}	7.57±2.07^{a}	36.20±2.00^{c}	55.80±4.00^{b}	25.20±2.00^{a}

Mean with the same superscript along a column are not significantly different at $p<0.05$.

DISCUSSION

The turbidity value of the untreated water was higher than the range of 50-150NTU which is classified as high turbidity water [10] hence, the need for the treatment. At varying dosage, there were significant and no significant differences in the turbidity, pH, conductivity, total dissolved solid and temperature of the water treated with both varieties (picnic and kaolack).

There was a notable decrease in the turbidity and pH of water samples treated with both varieties which is in accordance with previous studies conducted by [11,9,12]. The highest decrease in turbidity in each variety was observed at the dose of 0.5 g/l which reduced the turbdity from 263 to 40NTU for the picnic variety and 264 to 51NTU for the kaolack variety respectively. The observed decrease is still above the NSDWQ recommended level of 5 NTU. However, according to [9], 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 is 0.5g/L. This result differs with the findings of [9] who reported an optimum dosage of 0.1 g/L. Changes were observed on the pH values at varying dosages. The pH value dropped from 8.04 at 0.5g/l to 7.22 at 2.5g/l which is within the range of the recommended level. The observation on pH and conductivity in this study were in accordance with previous studies on coagulation and flocculation ability of some seeds. The values of conductivity increased with increase in the coagulant dosage which is also similar with the findings of [13,14]. The results on the effects of watermelon seeds on some water quality parameters revealed that watermelon seed could serve as a natural coagulant for surface water treatment. The picnic seeds had higher turbidity removal potential than kaolack variety in treating river Chanchaga water. Since watermelon seed is readily available to the people living in the urban areas who utilize surface water for their domestic chores, it could be used a natural coagulant in water treatment which could reduce the health impact associated with inorganic coagulant like aluminium sulphate in Nigeria.

Authors' Contribution

YA and IG designed the study, IG, AIT and AMR participated in the fieldwork and data collection. YA and IG performed the data analysis, MHO 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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