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Coagulant Capacity of Moringa (*Moringa Oleifera*) Seed on NaCl Solution

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Abstract

Moringa seeds are one of the natural coagulant ingredients that contain protein and carbohydrates that can be used in water purification, especially in reducing turbidity. This study aims to determine the level of NaCl coagulated by Moringa seed powder. The capacity or coagulation ability of Moringa seed powder is measured by the percentage of NaCl in the solution coagulated by Moringa seed powder. To achieve this purpose, several experiments have been used, namely variations in the concentration of NaCl as samples including; 0.5 %, 1 %, 3%, and 5% with treatment using Moringa seed powder as much as 1 g, 3 g and 5 g—determination of NaCl content using Flame Photometers BWB Technologies. The results of this study indicate that the optimum level of NaCl coagulated by Moringa seed powder is 3 %. The concentration can increase the effectiveness of reducing NaCl levels by obtaining a coagulated percentage value of 95.30 %.

Keywords: Moringa seed powder, concentration, coagulation, NaCl

Introduction

Moringa *(Moringa oleifera)* is a tropical plant that grows and develops in tropical areas such as Indonesia. The Moringa tree has edible leaves, seeds, roots, and flowers, and is rich in protein, minerals, and antioxidant compounds. Seed (Moringa Oleifera) is a plant that can decrease water turbidity. Moringa seed (*Moringa Oleifera*) is a natural coagulant because it contains positively charged proteins acting as polyelectrolyte cations (Nugroho et al., 2014).

Moringa seeds contain high carbohydrates, fat, and protein, whereas carbohydrates in Moringa seeds are 11 – 15 %, fat 10 – 43 %, and protein 29 – 38 % (Sakinah et al., 2019). Moringa seeds can be used as a natural coagulant based on the high protein content. The coagulant is a compound that can destabilise colloids by neutralising the electric charge on the colloid surface so that colloids can combine, form larger flocs, and be easily settled. Coagulation generally reduces turbidity, taste, colour, organic compounds, etc. Commonly used coagulants are inorganic salts such as aluminium sulphate ($Al_2(SO_4)_3$), ferrous sulphate ($FeSO_4$), and sodium chloride (NaCl), while organic coagulants used are moringa seeds *(Moringa oleifera)* and other grain plants. Like tamarind seeds. Natural coagulation also has advantages: microorganisms can easily decompose, are available in large quantities, have relatively cheap prices, have less volume, are stronger and more stable (Choy et al., 2014).

The basic principle of the coagulation process is the attraction between negative and positive ions. Coagulation reduces turbidity caused by inorganic and organic colloidal particles in the water and reduces the colour, taste, and odour caused by colloidal particles (Bangun et al., 2013).

Moringa seeds contain the active substance *4-alpha-4-rhamnosyloxy-benzyl-isothiocyanate*, which acts as an effective coagulant. The active substance can absorb wastewater particles when the water content in Moringa seeds is reduced, and can absorb greater liquid waste. Because of the small water content, the active substance from Moringa seeds can play a role in changing the shape to be small, so that the surface area of the Moringa seeds will be even greater. On the other hand, when the water content in the seeds of Moringa seeds is getting bigger, they can have the ability to absorb liquid waste that is getting smaller, therefore there is no active substance so that the surface area of Moringa seeds will be covered with water so that the moisture of Moringa seeds must be small (Bangun et al., 2013).

Research on Moringa seeds as a coagulant has been carried out, including: Moringa seeds extracted using 2 M NaCl solution can reduce turbidity up to 99.97 % (Camacho et al., 2018) while other studies also used Moringa seeds

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extracted with 1 M NaCl solution to reduce turbidity 80.7 % (Aslamiah et al., 2013). Based on this, researchers are interested in conducting research in extracting the active ingredient of Moringa seed coagulant *(Moringa Oleifera)* using NaCl solution with various concentrations of 0.5 %, 1 %, 3 %, and 5 %. Based on the above background, the NaCl coagulation process using Moringa seed powder was carried out in this study; more details can be described below.

Methods

This research was conducted at the Chemistry Laboratory of the Faculty of Teacher Training and Education and the Laboratory of the Faculty of Agriculture, Tadulako University.

The tools used in this research are blender, 80 mesh sieve, oven, gutter, 250 ml beaker; 100 ml, Erlenmeyer 100 ml, volumetric flask 100 ml; 50 ml; 25 ml; 10 ml, centrifuge, ependorf, 5 ml injection, magnetic stirrer, spatula, stirring rod, porcelain cup, mash/tear, dropper, funnel, filter paper, digital balance, analytical balance, compact, desiccator, measuring pipette, dropper, container, bottle, stopwatch, BWB Technologies Flame Photometer and knife (for using Moringa seed sampling) (Nurhayati et al., 2018).

The materials used in this study were Moringa seeds, aquades, NaCl (Salt) solution, aluminium foil, and tissue (Kristianto et al., 2019).

Several stages, namely primary, secondary, and tertiary, are used to determine the capacity of the optimum levels of Moringa seed coagulant in the solution. As for the primary process, it can be done by sample preparation, including;

1) Moringa fruit that is ripe (blackish brown) and naturally dried on the tree is taken and then separated from the flesh using a mortar to remove the flesh from the seeds. After separating the pulp from the seeds, the Moringa seeds are washed thoroughly using running water, then dried in the sun.
2) Furthermore, the dried moringa seeds were blended until smooth, and then the blended moringa seed samples were dried in a hot oven and sieved using 80 mesh to obtain moringa seed flour.

Make NaCl solution with various concentrations (0.5 %, 1 %, 3 %, and 5 %). The first treatment made a NaCl solution with a concentration variation of 0.5 %, 1 %, 3 %, and 5 % by weighing the NaCl solids with each NaCl mass, which was calculated using the solution dilution formula. When weighing the NaCl solids whose mass has been calculated, you can use a spatula to take them and then weigh them using a digital balance. After that, each NaCl solid is inserted into a 100 ml volumetric flask, and distilled water is added to the mark. Then, shake until homogeneous, then put the NaCl solution into the bottle.

The secondary process can be carried out by extracting the coagulant's active ingredient, where the coagulant's active ingredient is protein. The extraction process can be done by extracting the protein with a salt solution. So the purpose of this study is to extract protein with a salt solution, where the salt solution used in this study is NaCl with variations in concentration, namely, 0.5 %, 1 %, 3 %, and 5 %. The first treatment weighed 1 gram, 3 grams, and 5 grams of Moringa seed flour using a digital balance, then put 100 ml of NaCl solution with a concentration of 0.5 % into a 250 ml beaker. Then, it was stirred using a magnetic stirrer for 2 minutes with a stirring speed of 200 rpm, and continued with stirring for 5 minutes with a stirring speed of 60 rpm until homogeneous. Furthermore, repeated treatment for NaCl solution with a concentration of 1 %, 3 %, and 5 % (Kristianto et al., 2019).

Furthermore, the tertiary process, where the purification stage is to obtain the active ingredient isolate, is carried out by precipitation, analysis, or ion exchange treatment. The subsequent treatment is the centrifuge process. The purpose of the centrifuge in this study is to separate the fat. In the centrifuge process, each sample was put into an Eppendorf tube until the limit mark and centrifuged at 2000 rpm for 15 minutes. In doing the centrifuge, the number of ependorfs must be even; the volume must be the same to be balanced. After being centrifuged, the supernatant was taken and observed whether two layers were formed, then the layer above it or the filtrate was taken using a 5 ml injection, and then the Na content was measured using a Flame Photometer (Kristianto et al., 2019).

The data can be calculated using the equation based on the measurement results obtained using a Flame Photometer.

$$Y = X \times fp \quad (1)$$

Description:
Y = Metal content in the sample (mg/L);
X = sample concentration (mg/L)
fp = dilution factor
(Ma'ruf et al., 2017)

Results and Discussion

Data on the results of NaCl levels coagulated by Moringa seed powder can be seen in **Table 1.**

Table 1. Coagulated NaCl level result data

BBBK (gram)	% (mg/L)	NaCl (mg/L)	Content Na (mg/L) Repetition 1	2	3	Content Rest Na (mg/L)	NaCl Coagulated (mg/L)	% NaCl Coagulated
1	0.5	5000	279.3	293.5	299.7			
3	0.5	5000	284.8	312.2	298.9	295.31	4.704.69	94.09
5	0.5	5000	276.2	297.3	315.9			
1	1	10000	627.1	626.7	625.7			
3	1	10000	578.9	498.1	594.1	581.92	9.418.08	94.18
5	1	10000	576.8	558.5	551.4			
1	3	30000	1731	1626	1446			
3	3	30000	1526	1449	1336	1.409.78	28.590.22	95.30
5	3	30000	1237	1228	1109			
1	5	50000	1875	1809	1736			
3	5	50000	1749	1845	1751	1.825.67	48.174.33	96.35
5	5	50000	1915	1926	1825			

Note: (BBBK) = Weight of Moringa Seed Powder (gr)

From **Table 1,** the measurement data of NaCl concentration before and after the coagulation process by Moringa seed powder can be obtained by varying the concentration of NaCl solution. The remaining Na concentration data can be obtained from repeated measurements using the Flame tool Photometer from BWB Technologies. The results of the remaining Na concentration were averaged to be used for data analysis of coagulated NaCl levels.

Flame Photometric BWB Technologies measurements aim to measure Na levels in Moringa seed coagulant. Determination of coagulant capacity using NaCl solution can be done by extracting the active ingredient of the coagulant, where the active ingredient in this study is protein from Moringa seeds extracted with a salt solution. The salt solution used in this study is NaCl, which can extract Moringa seed powder. The residual Na data was obtained from the average value of measurements using the Flame Photometers from BWB Technologies. Attached 4 of them; for a concentration of 0.5 %, obtained a value of 295.31 mg / L; for a concentration of 1 %, obtained a value of 581.92 mg / L; for a concentration of 3 %, obtained a value of 1.409.78 mg / L; for a concentration of 5 %, obtained a value of 1.825.67 mg / L. The results of these data can be used to calculate the value of coagulated NaCl levels. The results of each concentration coagulated by Moringa seed powder can be seen after adding Moringa seed powder and allowing it to stand for 30 minutes, after being stirred for 2 minutes at 200 rpm, and then for 5 minutes at 60 rpm. This aims to produce water turbulence to disperse the coagulant in the water. In addition, fast stirring can help the fine particles in the water collide with each other and form microflocs, while slow stirring can help combine flocs.

Based on the method used in this study, namely the coagulation-froth flotation method. From the coagulation method, namely the process of changing small particles into floc form. This coagulation is a rapid stirring process capable of absorbing pollutants, such as heavy metals, organic substances, and other contaminants. The flocculation method is a slow stirring process where the method forms larger flocs that cause a difference in specific gravity to water, so the flocs settle more easily (Kusdarini, 2016).

From the results of the measurement of the value of the remaining Na content, it is possible to obtain data on the concentration of NaCl coagulated in solution, for a concentration of 0.5 %, the value of NaCl content is 4.704.69 mg / L; Concentration of 1 % obtained the value of NaCl content of 9.418.08 mg / L; Concentration of 3% obtained the value of NaCl content of 28.590.22 mg / L and concentration of 5 % obtained the value of NaCl content of 48.174.33 mg / L. Based on these data, almost all variations of Moringa seed powder coagulant 1, 3.5 g at each NaCl concentration resulted in almost the same coagulation value. However, the concentration of 3 % tends to decrease more than when moringa seed powder is added 1, 3, or 5 grams. From the results of the data obtained, it can be related to previous researchers that coagulation occurs through the destabilisation of colloidal compound particles in liquid waste. There is an attractive force between negative ions on the one hand and positive ions on the other (Setyawati et al., 2017), where the chemical content in Moringa seeds contains several active compounds such as positively charged proteins that act as polyelectrolyte cations, calcium, carbohydrates, fats, and galactose compounds.

Each sample's concentration affects the NaCl level decrease after adding Moringa seed coagulant at different concentrations of 0.5 %, 1 %, 3 %, and 5 %, allowing it to stand for 30 minutes. There was a decrease in NaCl of 3 %, which could coagulate NaCl levels as much as 95.30 %.

A coagulant is considered optimum because the concentration dose is given correctly, so the removal of sample turbidity will be more significant. Hence, it can reduce turbidity and the turbidity value of about 99.7 %, so this Moringa seed powder coagulant can be more effective in coagulating (Hestiningsih, 2014). The increasing effectiveness of the decrease along with the increase in the concentration of the given biocoagulant and shows the higher the concentration of the given polyelectrolyte (Sun et al., 2019), the better the effectiveness of decreasing the concentration of the resulting sample because the addition of the concentration of polyelectrolyte will result in reduced colloid stability which will reduce the repulsive force between the particles to support the deposition process (Akbar et al., 2015).

Polyelectrolytes are polymers that carry a positive or negative charge from ionized groups (Dobrynin, 2020). In polar solvents such as water, these groups can dissociate, leaving a charge on the polymer chain and releasing the opposite ion in solution (Desta & Bote, 2021).

Based on these data, it can be concluded that at each concentration and percentage of NaCl, coagulation occurs between 94.09 % and 96.35 %. The results of the percentage of optimum concentration capacity data on Moringa seeds, namely, concentration of 3 %, where the data obtained were 28.590.22 mg / L. The data results show that the concentration of 3 % after adding Moringa seed coagulant can show a decrease in effectiveness as the concentration of bio-coagulants increases.

All colloidal particles generally have the same charge, so there is a repulsive force between colloidal particles. This is because the colloidal particles cannot combine to stabilise the colloidal system (Banetta & Zaccone, 2020). The dissolved protein from Moringa seeds contains a group (–COO-) that will bind harmful metal ions in the water. Based on these contents, Moringa seeds can function as a natural coagulant (Akbar et al., 2015).

Conclusions

Based on the results of the research on the coagulation capacity of Moringa seed powder with several variations of 0.5 %, 1 %, 3 % and 5 % NaCl solutions, the percentage of coagulated NaCl was around 94.09 % - 96.35 %, where in each addition of Moringa seed powder, the percentage of coagulated NaCl was increased. Decreased and tended, so that the more likely a decrease occurred at a concentration of 3 % by showing the capacity according to the amount of coagulated NaCl level of 28,590.22 mg / L from the average results obtained, where the concentration was able to increase the effectiveness of the decrease with the percentage of coagulated NaCl of 95.30 %.

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