

## Conference Paper

# The Implementation of Chemical Project Learning Model Integrated with Ethno-Stem Approach on Water Treatment Topic Using Kelor (*Moringa oleifera*) Seed Extract As Bio-Coagulant

S. Sudarmin<sup>1</sup>, Cepi Kurniawan<sup>1</sup>, Puji N<sup>2</sup>, Musyarofah<sup>2</sup>, Ariyatun<sup>2</sup>, and Nurul I<sup>2</sup>

<sup>1</sup>Chemistry Department, Mathematics and Natural Science Faculty Universitas Negeri Semarang, D6 Building 2nd Floor, Sekaran Gunungpati Semarang, Indonesia 50229

<sup>2</sup>Graduate School of Chemistry education UNNES, Universitas Negeri Semarang

## Abstract

Water is one of the natural wealth that is absolutely needed by living things to survive and maintain health. In facts, water treatment is carried out on the raw water that does not meet the standards of clean water quality, therefore, the non-standardized elements need to be eliminated or reduced so that all water meets the applicable standards. One alternative which is available locally is the use of natural coagulants from plants living around us. This research was conducted by students of the UNNES Postgraduate Chemistry Education Magister Program. The process for water treatment employed the potential natural coagulant of moringa seed extract using an Ethno-STEM approach. This research was carried out as a chemical project task, namely the project of using potential bio-coagulant of *Moringa oleifera* seeds or *Moringa* plant. In this study, tests were carried out on the use of bio coagulant of moringa seeds extract with various varieties to purify turbid water. The research results concluded that the magisters of chemistry education have been able to design and implement the integrated Ethno-STEM chemical project learning on water purification topic using moringa seed extract (*Moringa oleifera*). In addition, the findings indicated that the students were able to reconstruct ethnical-based scientific knowledge in the context of STEM; and water purification experiments with bio-coagulant of *Moringa* seed extracts.

**Keywords:** Ethno-STEM approach, water treatment, *Moringa Oleifera* seed extract

Corresponding Author:

S. Sudarmin

sudarmin@mail.unnes.ac.id

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## 1. Introduction

Current water problem frequently occurs is related to the quality of water. Water is one of the natural resources that is absolutely needed by living things to sustain and maintain health. As matter of fact, water treatment is carried out on the raw water that does not meet the standards of clean water quality. Hence, the non-standardized elements must

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be eliminated or reduced, so that all water meets the applicable standards. In terms of water purification, there are actually a lot of plants in Indonesia that are potentially be used as a bio-coagulant. One of which is *Moringa oleifera*; a plant from the Moringaceae family (Dimas K.W et al, 2017). Therefore, this study focused on the process of water purification employing the bio-coagulant substances of *Moringa* seed powder (*Moringa oleifera*) which is available naturally. *Moringa* seeds are easily obtained around us which usually found in the countryside. It is a living fence whose young flowers and fruits are consumed and belonged to vegetables. Some research showed that these *Moringa* seed powders can be used as wastewater treatment which is more economical and environmentally friendly. *Moringa* seeds have a significant influence in terms of water purification as scientifically, the rhamnossyloxy-benzyl isothiocyanate compounds are capable of absorbing wastewater particles (Hendrawati, 2016).

Previous research from The Environmental Engineering Group at the University of Leicester, UK, has long studied the potential use of various natural coagulants in small, medium and large scale water treatment processes (Ndabigengesere et al, 1995). Based on various research references and observations of several locations in Indonesia, this research was conducted to experiment the use of *Moringa* seed powder as the raw bio-coagulant to purify turbid river water. This research was a chemistry project done by the Postgraduate School students of Chemistry Education Program at Universitas Negeri Semarang (UNNES). This was a collaborative research of chemistry lecturers' scientific development grant research. *Moringa oleifera* is a sub-native Himalayan Plant grows in India, Pakistan, Bangladesh and Afghanistan (Ramachandran, 1980, Soleh H, 2009). At this time, *Moringa* seeds are used as traditional medicine by several countries in the world, while the discussion of compounds found in *Moringa* seed includes the secondary metabolites field of natural materials and organic chemistry (Sudarmin et al, 2018).

This study categorized as a research in the field of integration between Ethnoscience and aspects of Science Technology Engineering and Mathematics or so-called the Ethno-STEM (Sudarmin, 2018). An Ethno-STEM-based research is a research related to scientific concepts contained in a certain community culture that integrates the aspects of Science, Technology, Engineering, and Mathematics in discussing a particular topic, in this case, the *Moringa* seed powder as the bio-coagulant. The postgraduate chemistry education students were assigned to create a chemical project by observing a community to explore the aspects of Science (S) related to the benefits and usage of *Moringa* seeds. Moreover, they were urged to investigate the technology aspects (T) about the extraction techniques and methods of *Moringa* seeds as bio-coagulant. Furthermore,

the students were asked to observe the community's innovative and creative ideas in obtaining quality water through the use of Moringa bio-coagulant (E); also, to calculate mathematically (M) how much the Moringa seed extract is needed to purify water.

There has been much research on the use of Moringa seeds as the coagulant in water purification (Yulisatri, I.R, 2010). Therefore, it has given a bright spot of the water purification issue. The compounds contained in the Moringa seed powder have antimicrobial properties especially towards the E. Colli bacteria (reduced or eliminated). Other than that, Moringa seeds have proven to be able to sediment the relatively high heavy metal elements in water to achieve the standard of drinking water. Referring to the information about the Moringa seed powder as bio-coagulant, this research aimed at investigating deeply the use of Moringa seed powder as a water purification method in the context of Ethno-STEM. This research would have declared successful if the Moringa seed powder caused the coagulation of dirt contained in water.

## 2. Research Methods

This research was a qualitative one adopting the Ethno-STEM approach. The Postgraduate School students of Chemistry Education Program at Universitas Negeri Semarang (UNNES) were assigned the following: (1) to observe and interview the people about the use of Moringa seed powder as bio-coagulant in water purification and their knowledge of Moringa plant's benefits in life; (2) to design an Ethno-STEM-based chemical project for water purification experiment using Moringa seed powder as bio-coagulant; (3) to reconstruct the indigenous knowledge into scientific knowledge related to the research results; and (4) to analyze the experimental results of water purification. The reconstruction of scientific knowledge was carried out through several stages; exploration, verification and reduction, validation, and data conceptualization. Meanwhile, the research data of the experimental results were analyzed descriptive-qualitatively.

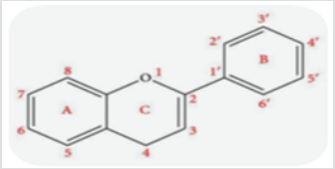
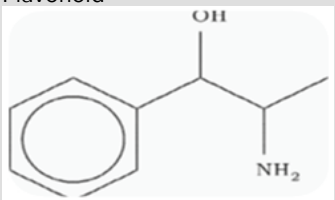
## 3. Results and Discussion

### 3.1. The reconstruction of indigenous knowledge into scientific knowledge

The reconstruction of indigenous knowledge was carried out in this study by the research team with a focus on the Ethno-STEM of community knowledge related to

Moringa plants, benefits, use, and dose in water purification. There were four respondents involved in this stage; Supiyah (83 years old), Arifin (39 years old), Kasmadi (70 years old), and Suwito (85 years old). The interview took place in Piangpus, Semarang Regency, and Batang Regency. The interview results were recapitulated by the research team and presented in Table 1.

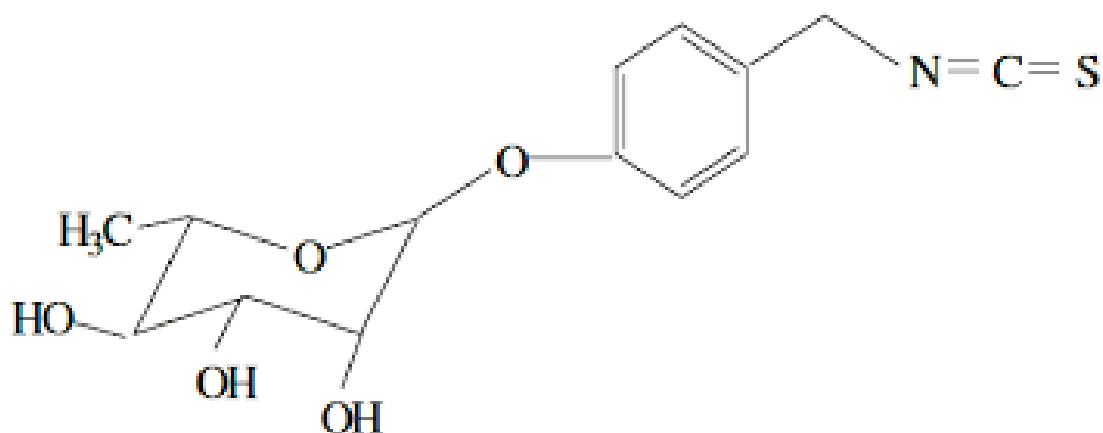
TABLE 1: The Reconstruction Results of Indigenous Knowledge into Scientific Knowledge.

No	Questions in STEM Context	Indigenous Knowledge (Respondents' Answers)	Scientific Knowledge
1	<b>Science</b> : What do you know about Moringa?	R1 : Moringa lives in <i>ndahah</i> . R2: You can use Moringa as herb and medicine R3 : Moringa <i>godhong</i> (leaves) means <i>jembar</i> (wide). R4 : -	<i>Ndadah</i> = a quite large land to plant crops, field  <b>Kelor, merunggai, or Moring (Moringa oleifera)</b> comes from Moringaceae family. It grows between 7–11 meters in height. It has oval-shaped leaves with a small size stack in one stalk. Moringa leaves are edible and used as medicine.  <a href="https://id.wikipedia.org/wiki/Kelor">https://id.wikipedia.org/wiki/Kelor</a>
2	In your opinion, what are the benefits of Moringa?	R1 : It is beneficial for relieving cough, or baby febrifuge R2 : It is also useful for decreasing cholesterol and diabetes. R3 : - R4 : cough medicine	Moringa seeds ( <i>Moringa oleifera</i> ) are advantagous for health. Widely used as a natural, energetic health supplement, and supports the body's endurance. Moringa contains 90 protective compounds including: isothiocyanates, flavonoids and phenolic acids. Moringa extract is known for its efficacy against inflammation and the aging process.
3	What compounds are found in Moringa?	R1: It contains <i>blendog</i> . R2: I don't know, I did not go to school. R3 : - R4 : <i>Blendog</i>	<i>Blendog</i> (Javanese) is a gum that has turned brown. Moringa, especially the leaves contain a lot of important compounds for body, including: antioxidants, folate (folic acid), Biotin, Minerals, Essential Amino Acids, Non-Essential Amino Acids, and secondary metabolites of flavonoids and alkaloids   Flavonoid   alkaloid

No	Questions in STEM Context	Indigenous Knowledge (Respondents' Answers)	Scientific Knowledge
4.	Do you think that Moringa plant is able to purify turbid water?	R1 : I don't think so. We usually used <i>trawas</i> to purify water. R2 : No idea. I have never tried R3 : No, I don't. R4 : <i>Mboten saget</i> (I don't think it can)	<i>Trawas</i> = a compound whose chemical formula is $KAl(SO_4)_2 \cdot 12H_2O$ . Moringa seeds can be used as a coagulant in water purification. During the purification process, granules of moringa extract that have been dissolved will bind and agglomerate solid particles in the water along with microbes and disease germs contained in it to form larger lumps that will easily fall and settle to the bottom of the water. Moringa seed extract contains secondary metabolite compound namely phenol and phenolic, alkaloids, and essential oils having antibacterial properties.
5.	Technology What are the techniques of making Moringa powder to make it handy?	R1 : R2 : it should be dried but no need to place under the sunlight. Otherwise, just take it home and let it dry. R3 : - R4 :-	Some simple steps to process Moringa seeds into Moringa powder: (1) Dry Moringa seeds; (2) Mash the dried seeds; (3) Pack in a sealed container; and the powder is ready to use.
6.	<i>Mathematics</i> How much Moringa is needed to be consumed as herb or medicine?	R1 : Sufficiently 3 stalks only R2 : - R3 : - R4 : 3 stalks of leave and 3 pieces of root	The daily dosage of Moringa consumption has not been found. However, some studies proved that consuming 29 mg/kg could support optimal health.

### 3.2. Scientific explanation about Moringa Seed Biokoagulant extract

Moringa plants will absorb colloidal molecules in water since it has an active substance of rhamnosyloxy-benzyl-isothiocyanate, which is able to absorb and neutralize the mud particles and metals contained in the suspension wastewater having dirt particles floating in the water. This plant was taken from the Pringapus area of Semarang Regency. The initial preparation was carried out so that the plants used in the study had optimal conditions during the absorption process. The sufficiently old plants were selected to get the complete inorganic substances as the maximum metabolism occurred in old plants. In addition, the quite old seeds were obtained (as a minimum indicator) and then dried to reduce its water content (Hidayat. 2006, 2009, and Widyaningsih, T.S, 2015). The active ingredient of rhamnosyloxy - benzyl - isothiocyanate in seeds is larger than those in other parts. Thus, this allows more absorption. The structure of bio-coagulant, rhamnosyloxy-benzyl-isothiocyanate, is as seen in Figure 1.



**Figure 1:** Molecular structure of rhamnosyloxy-benzyl-isothiocyanate bio-coagulant.

### 3.3. The results of chemistry learning project integrated with Ethno-STEM

The Postgraduate School students of Chemistry Education Program at Universitas Negeri Semarang (UNNES) have designed the Chemistry Project Integrated with Ethno-STEM on the use of Moringa seed extract as a bio-coagulant in water purification. The stages of project-based learning and evaluation tools to assess the chemistry project were as follows: (1) determining the basic or essential questions, in this case, why Moringa seeds are capable of purifying water and how it works; (2) project design including planning, implementation, monitoring, and evaluation. The lecturers/teachers' assistance was needed to maintain the logic and rationality of the project; (3) arranging schedule, this was to have the research finished on time; also, to perform the critical-thinking skill; (4) monitoring the project progress; (5) testing the process and learning outcomes of water purification using Moringa seed extract; and (f) evaluating the project.

The colloid and environmental pollution materials are related to project-based learning (PjBL) with Ethno-STEM on water purification using Moringa seed extract (Kurikulum Kimia, 2013). According to Woro Sumarni (2018), the PjBL helps students in studying the strong knowledge and skills built through various assignments and authentic works. Learning situation, content, learning environment, relevant and authentic assignment, a complex and realistic situation would provide a personal experience to the students. Other than that, the obtained information would also bring vigorous suggestive messages to them.

## 4. The Water Purification Results Using Moringa Seed Extract

This section presents the results of chemical project experiment performed by the students of Postgraduate School of Chemistry Education Program at Universitas Negeri Semarang (UNNES). The experimental design is described as follows:

### 4.1. Objective

To know the water purification process using Moringa seed extract

### 4.2. Tools and materials

Tools: Glasswares (1000 ml), stirring rods, pH meter, measuring cups (1000 ml), filter paper, mortar, and pestle.

Materials: Moringa seeds, chlorine, activated charcoal, clean sand, and dirty water.

### 4.3. Experimental steps

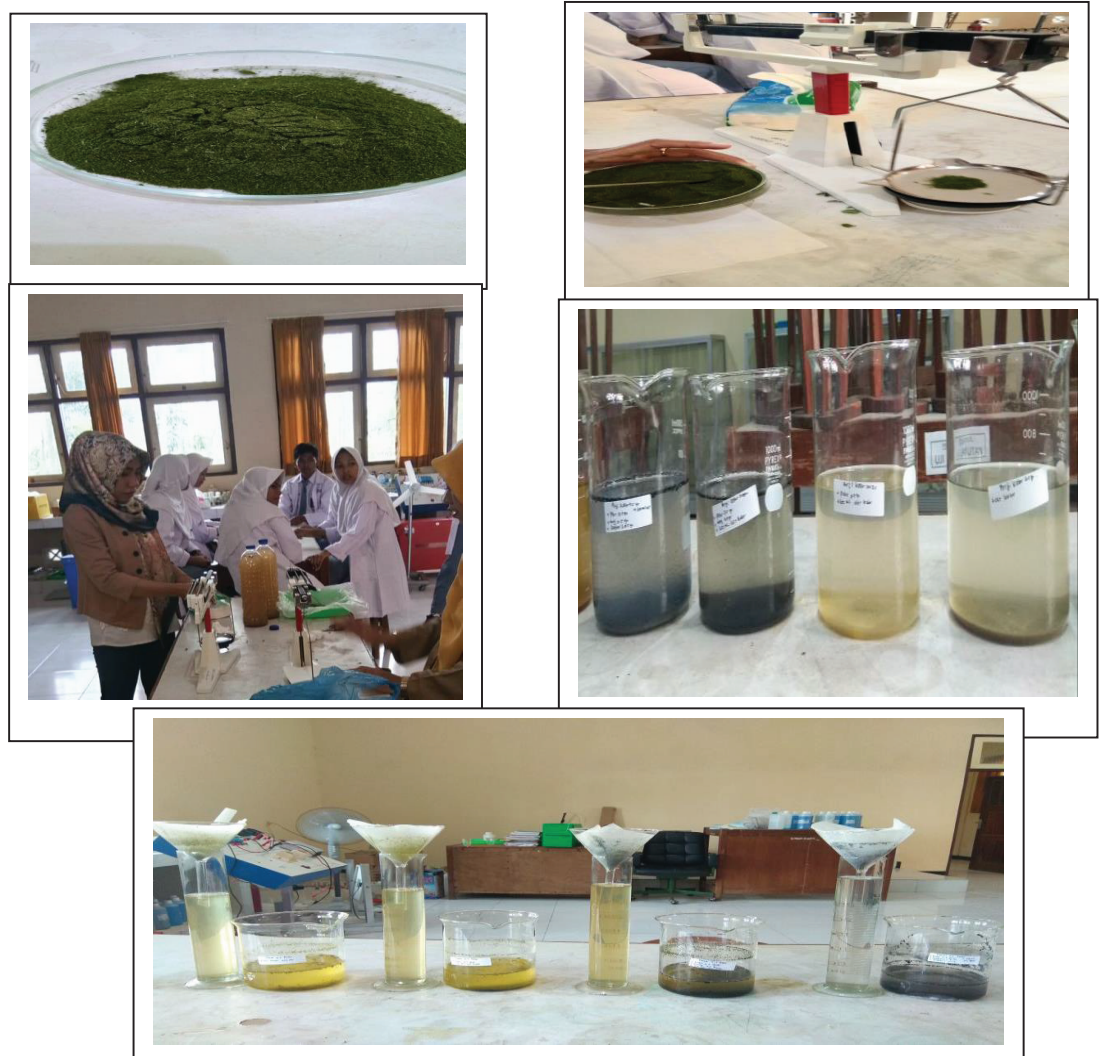
The water was taken from Kaligarang river which is frequently used by people to wash dishes and other household activities through the water is not worthy to use. One liter of turbid water was taken for each experiment. Prior to that, the water was measured using turbidimeter. There were three trials; the first trial put 0,5 gr of Moringa seed in a liter of sample water, the second trial added 0,2 gr of Moringa seed in a liter of sample water, and the third trial put 0,1 gr of Moringa seed in a liter of sample water. Each liter of sample water was placed in a plastic bottle. The Moringa seed powder was added in it and stirred in 30 seconds using certain techniques. The water clarity level was observed in every 6, 12, 24 hours. After being rested for a day, two layers would be formed; the first was the dirt layer, and the second was the water. The next step was filtering the water employing the filter paper. The purified water then was re-tested using turbidimeter. The clarity, pH, acidity level, and odor were tested and recorded.

The results of purification practicum obtained 8.67 NTU for 0.5 gram Moringa seed powder, 4.29 NTU for 0.2 gram and 3.07 NTU for 0.1 gram. This means that the water was getting clearer and met the standard of clear water. The longer the deposition process with Moringa seed extract, the clearer the water obtained. Therefore, it concluded that 0.1 gram of Moringa seed powder was ideal to purify 1 liter of turbid water; further, the



coagulation, as well as flocculation method, was effective to purify water. These results are in accordance with Hendrawati's (2016) study. One of the ways to find out whether the water has met the requirements of clean water quality is the level of acidity, and and it was known that the acidity of the water was in a neutral position ie pH between 7.2 and 7.4.

The use of Moringa seeds as a water purifier is one of the most effective and efficient ways due to the convenient yet cheap materials and purification techniques. Moringa truly appears to be a "Miracle" plant having countless benefits for humanity; thus, it should be taken as a high quality gift of nature at very low price (Mahmood et al, 2010). Moringa seeds must be peeled well from its coat and finely grounded so as not to affect the results of the purification and the deposition should not be more than a day or 24 hours. The below Figure 2 are some photos of water purification experiments with bio-coagulants from Moringa seed extract.



**Figure 2:** The Activities of Water Purification Experiment with Moringa Seed Bio-Coagulant Extract.



Based on the results of the water purification practicum with Moringa seeds, the water was clearer than before. Thus, it concluded that the use of Moringa seeds for water purification is effective since Moringa seeds are coagulant in floc deposition. Moringa coagulum has an additional advantage for its antimicrobial properties. Considering the fact that Moringa coagulum can be locally produced, its use in water purification should be encouraged (Amagloh & Amos, 2009). The organoleptic test on the results of water purification also concluded that the water was clearer, odorless, and neutral.

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