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# Potential Utilization of Lamtoro Leaves (*Leucaena leucocephala*) as Natural Coagulants

**Riva Ismawati[1a)], Rina Rahayu[1], Rizqa Puspitarini[2]**
[1]Universitas Tidar, Jalan Kapten Suparman Nomor 39 Magelang, 56116
[2]Politeknik Muhammadiyah Magelang, Jalan Tentara Pelajar, Tamanagung, Muntilan, 56413
e-mail: [a)]rivaismawati@untidar.ac.id

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## ABSTRACT

Water is a vital element for human beings. However, there are still limited clean water services in Indonesia. Raw water treatment is needed to ensure the availability of clean water. One of the methods is by using the coagulation process. The coagulant functions to speed up the coagulation process. Although effective in water treatment, chemical coagulants have some disadvantages. Therefore, it is necessary to develop natural coagulants to overcome the weakness of chemical ones. Natural ingredients can be used as coagulants if they have many macromolecules. Lamtoro leaves are one of the natural materials that are only used to feed the animal. This research aims to examine the potential of lamtoro leaf as a natural coagulant in terms of its content. The research is conducted by testing lamtoro leaf powder using Fourier Transform Infrared Spectroscopy and proximate test. Infrared spectra of lamtoro leaves show the presence of absorption peaks for specific groups of carbohydrate and protein compounds. The proximate test results show that lamtoro leaves contain 24.7% protein and 53.71% carbohydrates. The high protein and carbohydrate contents in lamtoro leaves enable them to be used as a natural coagulant.

**Keywords:** lamtoro leaves, coagulant, infrared spectra, proximate test

## INTRODUCTION

Water is a vital element to maintain the survival of creatures on earth, especially humans. The need for clean water continues to increase with the increase in the human population on earth. Unfortunately, the amount of water on earth remains, and is in the hydrological cycle (Ismawati, Ngirfani, & Rinarni, 2018).

There are still limited clean water services in Indonesia. Regional water producers (PAM and PDAM) can only provide clean water in urban areas. Meanwhile, some areas have difficulty getting clean water (Ismawati, Ngirfani, & Rinarni, 2018). Clean water used for sanitation hygiene must meet quality standards (Ismawati, 2020). Consumption of surface water that does not meet the standards may cause various diseases.

The raw water treatment uses the coagulation process. Coagulation is the process of floc formation which then coagulates and settles. The clotting process is accelerated by the addition of a coagulant. The coagulant is usually a multivalent compound and has a positive charge. This is necessary for the neutralization of the waste which is mostly negatively charged (Mustafiah et al., 2018).

The most commonly used coagulants in wastewater and water treatment are inorganic salts (Verma, Dash, & Bhunia, 2012). However, the inorganic coagulants have weaknesses, namely (a) low efficiency in the application at low temperatures, especially in four seasons countries; (b) decreasing pH of the water after treatment; (c) expensive prices; (d) large sludge volume, and; (e) causing health problems (dementia, Alzheimer's) (Srinivasan, Viraraghavan, & Subramanian, 1999; Yin, 2010; Theodoro et al., 2013).

Natural coagulants (bio-coagulants) have some advantages, such as (a) they are biodegradable; (b) they are non-toxic; (c) having relatively affordable prices; (c) having less sludge volume; (d) being stable and strong floc, and (e) are abundant (Verma, Dash, & Bhunia, 2012). Natural coagulants can be obtained from extracts of microorganisms, animals, and plants. Natural coagulants include tamarind seeds (tamarindus indica), tapioca flour, chickpeas, and chitosan (Poerwanto, Hadisantoso, & Isnaini, 2015; Effendi, 2018; Putra et al., 2020; Meicahayanti, Marwah & Setiawan, 2018 ; Ihsani & Widyastuti, 2014).

Plants rich in macromolecular contents can be the source of coagulants (Kristianto, Prasetyo, & Sugih, 2019). As a natural ingredient and is easily found, lamtoro leaves have the potential as a natural coagulant. Therefore, it is necessary to test the content of lamtoro leaves to identify their potential.

## RESEARCH METHODS

### *Materials and Tools*

This research uses several types of equipment, namely glassware, blender, and Fourier Transform Infrared Spectroscopy (FTIR). The raw material used is lamtoro leaves.

### *Research Procedure*

Old and dry lamtoro leaves are mashed using a blender to obtain a fine powder. The lamtoro leaf samples are analyzed for functional groups using FTIR and proximate analysis. The FTIR analysis of lamtoro leaves is carried out at the Laboratory of Organic Chemistry, Faculty of Mathematics and Natural Sciences of UGM. Meanwhile, the proximate analysis is done at the Center for Food and Nutrition Studies of UGM.

## RESULTS AND DISCUSSIONS

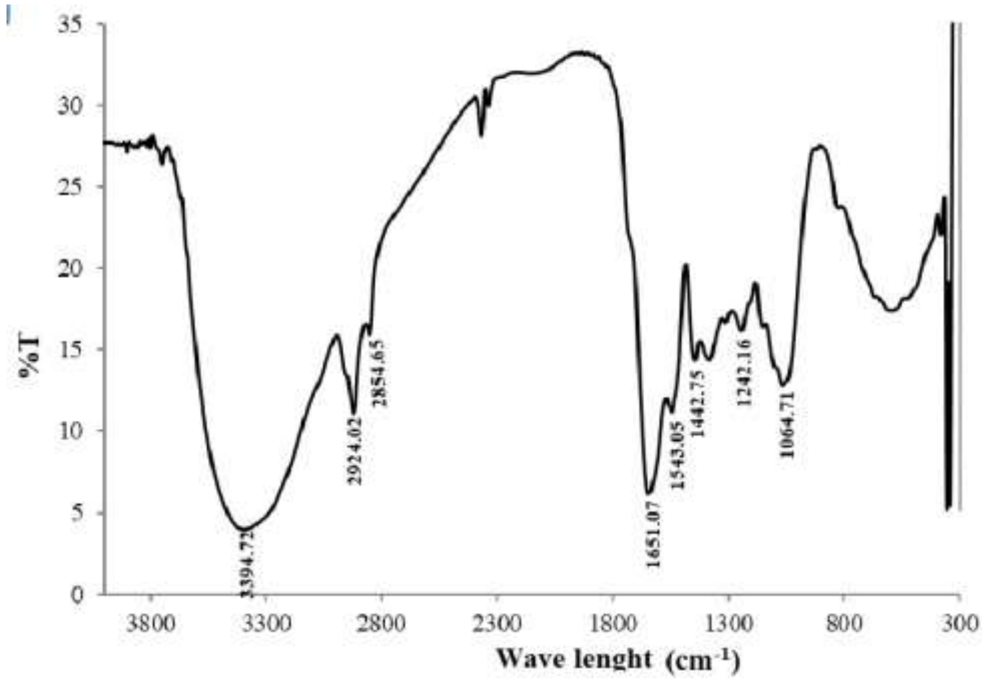
### *Results of Characterization of Lamtoro Leaves using Fourier Transform Infrared Spectroscopy (FTIR)*

The characterization of lamtoro leaves using infrared spectroscopy aims to identify the functional groups of the molecules. Kumar, Othman, and Asharuddin (2017) stated that natural coagulants have -COOH and -NH functional groups which allow intramolecular interactions among particles in solution and polymers. The infrared spectra of lamtoro leaves are presented in Figure 1.

Sharp and strong absorption at wave number 3600-3200 $cm^{-1}$ indicates an overlapping region of -OH and -NH stretching vibrations (Betatache et al., 2014), with an absorption peak of 3394.72 $cm^{-1}$ observed in the infrared spectra of lamtoro leaves. The absorption peaks of 2924.02, 2854.65, and 1442.7 $cm^{-1}$ show the presence of symmetric and asymmetric stretching vibrations, and C-H bending vibrations, respectively. These findings are similar to Shak & Wu (2014), Fatombi et al. (2013), and Janakiraman & Johnson (2015). The absorption peaks at wave numbers 2950, 2850, and 1460 $cm^{-1}$ are for symmetric and symmetrical stretching, and C-H bending vibrations.

The absorption peak in wave number 1651.07 shows the absorption peak for the stretching vibration of C=O. Meanwhile, the absorption peaks of 1543.05 and 1242.16 $cm^{-1}$ indicate secondary and tertiary amide uptakes. These results are consistent with the results of previous studies, namely the absorption peak of 1540, and 1240 $cm^{-1}$ is the absorption peak for secondary and tertiary amides (Fatombi et al., 2013; Wang et al., 2009). C-O-C glycoside bonds in infrared spectra can be found in the absorption of wave number 1050-1170 $cm^{-1}$ (Lammers, Arbuckle-Keil, & Dighton, 2009), and the absorption peak in infrared spectra of lamtoro leaves can be found at wave number 1064.71 $cm^{-1}$.

The results of infrared spectroscopy characterization have shown the presence of specific groups of carbohydrate compounds (-OH, C=O, C-H, C-O-C) and proteins (-NH, C=O, amides). The carbohydrate and protein compounds in lamtoro leaves must be examined further using the proximate test.




Gambar 1. Spektra Inframerah Lamtoro Leaves

*Results of Proximate Test*

The proximate test aims to determine the various contents contained in lamtoro leaves. The results of the lamtoro leaves proximate test are shown in Table 1.

Table 1 Proximate Test Results of Lamtoro Leaves

| Content | Analysis Result (%) |
|---|---|
| Water | 11,36 |
| Ash | 5,135 |
| Fat | 5,095 |
| Protein | 24,7 |
| Carbohydrate | 53,71 |

Table 1 shows that lamtoro leaves contain 11.36% water, 5.135% ash, 5.095% fat, 24.7% protein, and 53.71% carbohydrates. The results of the proximate test are similar to the characterization of the absorption peaks in the infrared spectra.

*Potential Utilization of Lamtoro Leaves as a Coagulant*

The content of protein and carbohydrates in lamtoro leaves allows its use as a natural coagulant. Coagulants can be extracted from natural ingredients. The natural ingredients must contain macromolecular compounds such as polyphenols, polysaccharides, and proteins (Kristanto, Prasetyo, & Sugih, 2019). A coagulant is a positively charged multivalent compound. The positive charge of the coagulant aims to neutralize the negative charge of the waste (Mustafiah et al., 2018).

Lamtoro leaves contain high protein (24.7%). Protein chains are made up of sequences of amino acids. Amino acids contain a carboxyl group and an amine group. These groups are responsible for the charge of the amino acids. A large number of cationic amino acids in the protein chain will make the protein more positively charged. It will have better performance as a coagulant (Purnomo & Surodjo, 2012).

There are three steps in utilizing protein in natural ingredients as a coagulant. The first step is physical treatment: washing, drying and reducing the size of natural materials. The second step is the extraction of the active ingredients of the coagulant to achieve the effectiveness of the coagulation process. The last is the purification stage to obtain isolates. The last step is difficult to implement and requires a lot of money. Therefore, it is better for commercialization purposes only (Yin, 2010).

Lamtoro leaves contain high carbohydrates level (53.71%). The common carbohydrate in leaves is cellulose, and it is a polysaccharide. Polysaccharides are polymers composed of a series of monosaccharides linked to one another through glycosidic bonds (Guo et al., 2017).

Polysaccharides can be used as coagulants, but cannot be applied directly. Polysaccharides must be modified first before being used as coagulants. Teh, Wu, & Juan (2014) and Choy et al. (2016) studied starch polysaccharides as the coagulant. Starch must be gelatinized at 121$^{o}$C temperature and 17 psi pressure for 20 minutes. Unfortunately, the use of starch as a coagulant causes turbidity in the water due to the formation of a starch suspension. There are some efforts to optimize the performance of polysaccharides, such as adding copolymers in the polysaccharide chain. The copolymers can increase the polysaccharide load (Oladoja et al., 2017). Some of these copolymers include polyacrylamide, polyacrylonitrile, and polymethyl methacrylate (Rath and Singh, 1997; Mishra et al., 2004; Kumar et al., 2013).

The modified polysaccharide will have better performance as a coagulant, but there are still some weaknesses found. The modification of polysaccharides will go through complicated processes. It also requires high production costs and can release toxic reactants that do not react to the environment (Lee et al., 2014).

Lamtoro leaves contain protein and polysaccharides that can be used as coagulants. However, it is necessary to consider the treatment carried out to use the active substance in lamtoro leaves as a coagulant. Based on the literature study, the treatment carried out to utilize the active protein substance as a natural coagulant is simpler than that of the polysaccharides.

## CONCLUSIONS

The results of the infrared spectroscopy test of lamtoro leaves show some specific groups of carbohydrate and protein compounds. The results of the infrared spectroscopy test are in line with the results of the proximate test (lamtoro leaves contain high protein (24.7%) and carbohydrates (53.71%)). The high protein and carbohydrate content in lamtoro leaves allows its use as a natural coagulant. It is necessary to consider the treatment to utilize the active substance in lamtoro leaves as a coagulant. Besides, further research should identify the effectiveness of protein and carbohydrates contained in lamtoro leaves as a coagulant.

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