Introduction of nanoparticle magnetic development as transfer medium at mung bean seeds (*virginia radiata* l.) using soaking method

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**Abstract** It has been done research about a nanoparticle magnetic distribution into seeds of Vigna radiata L. seeds and the growth of their sprouts including their roots and stems using the soaking method. their nanoparticle magnetics are the synthesis result of natural iron sands using co-precipitation method. The truth of the nanoparticle magnetic has been shown through the function of bonding groups at wavenumber 698 cm\(^{-1}\). This research has been done as a foundation for further development in the genetical modification. Next, the experimental results show a good diffusion in the seeds, so that, along the development, the nanoparticle magnetic could be found in the roots and stems. Therefore, this research study is possible to be advanced to control plant growths and their genetical modifications.

1. Introduction

Nowadays, the development of nano-science and technology has been advanced rapidly since it has become a promising and important role in the advancement of science. The magnetic nanoparticles are a kind of nanomaterials that has been applying on some nanoscience discipline such as medicine [1-2] biosensor [3-5]. They also work as a genetical transfer mechanism agent as well as the conjugated particles with other organic materials [2,6]. Next, another development of this study can be used as a fine microwave absorber for a military system [7]. As for the understanding of magnetic-nanoparticle roles is necessary for the development of science and nanoscience technology because it makes the magnetic nanoparticle becoming multi applicational materials.

Lately, the expansion concepts of oxide materials have been applied in agricultural applications i.e an injection of ZnO nanoparticles into seeds of Vigna Radiata and Gram Cicer Arietinum using plants-agar methods [8], iron oxide nanoparticles and ferric ions which were used as Citrus Maxima growth controller[9]. [10] reported via their study result, known as a fine and effective decision, about a transgenetic system using the magnetic nanoparticles. The fundamental theory about the development
of the genetical engineering system utilizes magnetism properties of magnetic nanoparticles via conjugated system bioactive materials. The function of the magnetic nanoparticles is as conjugated-materials carrier i.e gen to the local-targeted area. The strength of the magnetism properties of the materials has become an accelerator of the microbiological transport mechanism inside cells [11].

The genetical conjugation brought by magnetic nanoparticle in the target will be transferred to all tissues and theoretically, it will genetically affect them. The favorable transfer mechanism will change appropriate gens as what the researchers expect. This process is extremely determined by the genetical conjugation used in the magnetic nanoparticle [12]. This research would investigate the magnetic-nanoparticle transport mechanism in the cells of the mung bean seeds assumed as an initial study for future development as a transgenetic system using magnetic nanoparticles.

The applications of the magnetic nanoparticles in this paper are based on some prior progressive-researches. Magnetic nanoparticle can be used in a genetical modification system and tissues-tracking of the stem cells [13]. Next, this research will be focused on the distribution of the magnetic nanoparticles in the mung bean seeds until they grow as sprouts.

In general, the magnetic nanoparticles have been synthesized using commercial-chemical-salt-sourced precursors such as FeSO4 [14] and FeCl [15-16]. However, the magnetic-nanoparticle precursors in this research are found in Indonesian natural iron sands even though the methods are developed step by step between chemical ablation, co-precipitation and hydrothermal.

2. Materials and Methods

2.1 Synthesis Magnetic Nanoparticle
2.0 grams of the natural iron sands extracted by a permanent magnet were poured into a bottle glass that contained 100 ml of the concentrated HCl (chemical ablation method), then it was saved for 2x24 hours until it became a concentrated dark solution. Next, it is called as magnetic nanoparticle precursors.

In the later steps, the magnetic nanoparticle precursors 10 ml were poured into the glass bottle with a size of 250 ml and placed on the hotplate with 80 oC stirred using a magnetic stirrer. It was stirred and, at the same time, NaOH solution with 1 M concentration was dropped to the precursors until it reached pH 12. Next, it was necessary to certain that the precursors had been dark sediment.

Next, the samples should be separated using a permanent magnet to make the washing process become faster. This process should be done repeatedly using non-mineral water until they reach pH 7. Then, the samples were dried on the hotplate in the temperature of 100 oC until they were perfectly dry.

2.2 Magnetic Nanoparticle Substitution into Mung Bean Seeds
0.1 grams of magnetic nanoparticle powder was poured into 10 ml of non-mineral water. Next, the mung bean seeds were soaked into magnetic nanoparticle solution for 60 minutes. They were leaked into a humid container and leave them until they grow becoming sprouts. Later, the sprouts were analyzed using a scanning electron microscope, this tool was used to see a spreading process of the magnetic nanoparticle in the sprouts.

3. Results and Discussion

3.1 The Morphology of the Magnetic Nanoparticle
The SEM investigation result shows a nonhomogenic structure form of the magnetic nanoparticle. However, it can be seen from figure 1 that the magnetic nanoparticles are in a bar form. The synthesis result still displays unpure level, this is illustrated by Cl and C that are the residue results of the perfectly lost reaction after the washing process, as seen from EDS result measurement. The size dimension of the magnetic nanoparticles as an outcome of SEM size imaging has approximately 2μm.
This size makes the magnetic nanoparticle going to the cells of the mung bean seeds. It can be known that cells’ or tissues’ size of the seeds is in the microsize. This statement supported by a direct analyzing of cells’ or tissues’ size of the mung bean seeds using the SEM image. At figure 2 illustrates that the size of cotyledon cells [17] of the mung bean is roughly 50 μm. This size certainly makes the magnetic nanoparticle entering the cells to be distributed to all cells.

The infrared spectroscopy analysis of the magnetic nanoparticles can be seen from the functional group bond at the wavenumber in the form of peaks. The functional group bonds that show specific aromatic from the magnetic nanoparticles (Fe-O) are at the wavenumber of 698 cm$^{-1}$ [18]. On the other hand, the wave numbers of 864 (C-H bend), 1406 (O-H bend) and 1624 cm$^{-1}$ (N-H bend) have
bonding form of aromatic bending group that are carbocyclic acids (−COOH) and amine group. All of the resulted-bonding groups have been synchronized to the table from chemistry.msu.edu and from other researches a wide wave absorption is the wavenumber of 3200-3500 cm\(^{-1}\) (O-H stretch) that is a yield of alcohol/phenol or water substance [19]. The optical properties of the magnetic nanoparticles using FTIR spectroscopy can be shown in figure 3.

![FTIR Spectrum](image)

**Figure 3.** Optical properties of the magnetic nanoparticles using FTIR spectroscopy where the magnetic properties are shown from the bond of Fe-O metal at the wavenumber of 698 cm\(^{-1}\).

The magnetic properties of the experimental results show a characteristic of the supermagnetic form. This is based on the strength of the magnetic field or saturation-magnetism-hysterical loop producing 58 emu/g, as shown on the y-axis. The higher the results of the deviation (in emu/g) is, the more strength the magnetism properties is and in the x-axis is the opposite of this condition, the more strength the magnetism properties are, the tighter the magnetic field that is used. Based on the research report [20-22], that is the reduction of the magnetic saturation number is affecte by the size of the particle. Wheter strength or not of the magnetism properties really affects the mechanism of the intraselluler transport system [11]. While the information about the strength of the magnetic properties of the synthesized materials especially is shown in figure 4.

Based on this information about absorption properties of the magnetic nanoparticle to a molecule of DNA has shown that there is interaction by electrostatic and hydrophobic. Both interactions are really influenced y the surface of magnetic nanoparticles [23].

### 3.2 Distribution Analysis of the Magnetic Nanoparticle Spreading of the Mung Bean Seeds and Their Sprouts

As discussed before from the morphological analysis of the magnetic nanoparticles, it has illustrated that the size of the magnetic nanoparticles is possibly to be distributed into the cells of the tissues of the seeds and sporouts of the mung beans. Based on the analysis through SEM image that is the magnetic nanoparticle can perfectly goto the seeds where the taken point of the seeds is done randomly, including the seeds, roots, and the stems of the sprouts.
Figure 4. Hysteresis loop of magnetic nanoparticles that is synthesized from natural iron sands.

The SEM image result of the seeds is obviously shown in figure 5. In this picture, the magnetic nanoparticles are distributed excellently in the cotyledon cells in the size of 2μm.

Figure 5. The distribution of magnetic nanoparticles in the cotyledon cells of the mung bean seeds

Furthermore, after the soak process using the magnetic nanoparticles, the seeds are abandoned to grow and become the sprouts. Analysis of the sprout roots using SEM image can be seen visually in figure 6 which show the distribution of the magnetic nanoparticles in the root cells. This distribution shown by the bright white color that has yellow circle addressed in the right-bottom side. The root tissues are strengthened by the xylem tissues as shown transversally by the red cycle section while the position of the particles is located on the phloem vessel that shown longitudinally in the right-bottom corner [24].
Figure 6. The SEM Image visualization of the magnetic nanoparticle distribution in the roots of the sprouts.

Next, the stem analysis of the magnetic nanoparticle distribution using SEM image is visually shown in figure 7.

Figure 7. The SEM image visualization of the magnetic nanoparticle distribution in the stem of the mung bean sprouts

Figure 7 transversally illustrates the magnetic nanoparticles in the stem tissues which show that magnetic particles was occupied transversally on phloem tissue. This condition biological was prognosticed transferring mechanism of magnetic particles and mung been sprouts tissue.

4. Conclusion
Using soak method, the result of this study was shown biological mechanism transfer between magnetic particles and Mung been sprout via xylem and phloem tissue. Mechanism transfer on mung
been sprout including roots and and stem. So, from this result make possible to next study genetical engineering use principle of nanoparticles.

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