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To cite this article: Hendra Susanto *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **276** 012005

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The Characterization of Green Materials of *Moringa oleifera* Leaf Powder (MOLP) from Madura Island with Different Preparation Methods

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Abstract. Recently, the exploration of biomaterials offers a potential property as the essential target for advanced bioengineering and its application. The local biodiversity of the Indonesian archipelago, *Moringa oleifera* grows and is spread quickly in the Madura island. *Moringa oleifera* ingredients show to be promising biodiversity for green materials development particularly in biomedical engineering. Importantly, *Moringa oleifera* leaf powder (MOLP) consists of some essential minerals including potassium, calcium, magnesium, sodium, iron, manganese, zinc, copper, and phosphor. However, it still lacks information about the exact minerals content within this local Moringa. This study aimed to characterize the basic minerals compound in the dried leaf or Moringa leaf powder (MOLP) from Madura Island varieties. In this study, two samples of Moringa leaf powder (MOLP) were used, and the mineral content was measured by X-ray fluorescence spectroscopy (XRF) analysis. Both samples were collected from the conventional/traditional dried method and advanced preparation. Significantly, the essential pattern of minerals concentration was found in both Moringa leaf powder (MOLP) samples. The higher level of calcium, potassium, copper, zinc, and sulfur was observed while the lower level of iron, phosphor, and magnesium was recorded by modern method. On the other hand, the different data were reported from conventional leaf powder preparation which was the higher-level minerals were dominated by calcium, potassium, zinc, copper, and iron while the lower concentration of phosphor was found. Hence, the baseline data of minerals levels provide primary information for the future development of these green materials related to the medical application and nanomaterials synthesis.

Keywords: *Moringa oleifera*, biomaterials, Madura variety, leaf powder, preparation method



1. Introduction

The development of advanced materials origin from the local biodiversity has an opportunity to explore several green resources with potential bioproperties. In the current exploration of nanotechnology, the utilization of renewable ingredients for synthesizing nanomaterials still faces significant challenges and stimulates the future development of this technology [1]. The biocompatibility of the green materials was addressed to maintain the sustainability of this substance and eco-friendly orientation [2]. The new era for green nanotechnology had been started since the experts tried to synthesize the nanomaterials by involving plant, microorganism, and another precursor [3].

The product of green technology was considered less hazardous and promising an alternative way for nanomaterials production with higher biocompatibility [3,4]. In addition, to fabricate nanomaterials, the application of stabilizing agent from the plant and several natural resources offers more advantages to building a wide-scale production related to green synthesis materials for biomedical and biotechnological sciences [5]. The improvement of integrated technology for nanomaterials by involving several fields such as physical science, molecular biology related engineering, biotechnology and chemistry, is the primary factor of nanobiotechnology development [6].

Nowadays, several studies pay attention to local biodiversity for green materials and nanotechnology. Based on the fundamental characteristics of the minerals, protein, and other essential ingredients, *Moringa oleifera* was proposed as the unique source for green materials with significant biocompatible activity in the living things [7]. *Moringa oleifera* was also shown as a chelating agent, the source of vitamins, phenolic acid, flavonoids, coagulating factor, and some beneficial nutrients [8,9]. The critical characteristics of green materials of *Moringa oleifera* leaf and the seed were reported associated with the non-toxic property, biocompatible, low cost, natural to extract, and eco-friendly [10].

Based on some previous researches it have been suggested that *Moringa oleifera* can be proposed as the anti hyperlipidemia and hyperglycemia [10–15], nanoparticles against cancer [12,15–17], antibacterial agent [10], water purificator [19–21], electrochemical and bioenergy [22–24], and green materials against malnutrition [14,17,22,25–32]. Importantly, the presence of *Moringa oleifera* plantation in some areas of the South East Asia countries is the primary concern for the next plan of green materials exploration of this miracle plant. Hence, *Moringa oleifera* leaf powder (MOLP) may become the next target for the advanced development of nanotechnology related to metabolic disease, green nanomaterials, biofuel, biofertilizer, bioremediation agent, and starvation or the lack of nutrition in the global population.

Naturally, this plant has grown easily in Indonesia especially some regions with lower rain intensity, low humidity, and dry soil. Madura island is the specific area in East Java Province with unique topography, flora, fauna, and land characteristics. *Moringa oleifera* is the tropical plant that can be found in the majority of areas/regions of this Island. According to our preliminary study, the natural organic ingredients of the Moringa leaf powder from this Island have shown a better concentration compared to another area in Indonesia [26]. The results of those studies proved that Moringa leaf powder from Madura island may also the new candidate for local natural resources in the future development of nanomaterials based Indonesian biodiversity. Even though some previous investigations have been done with the preliminary research for Moringa nanomaterials synthesis and its application, however, there are lack baseline data of the whole essential minerals ingredients within Moringa leaf powder from Madura island. Therefore, the characterization of its component is crucial for the future application of this local Moringa in bionanotechnology.

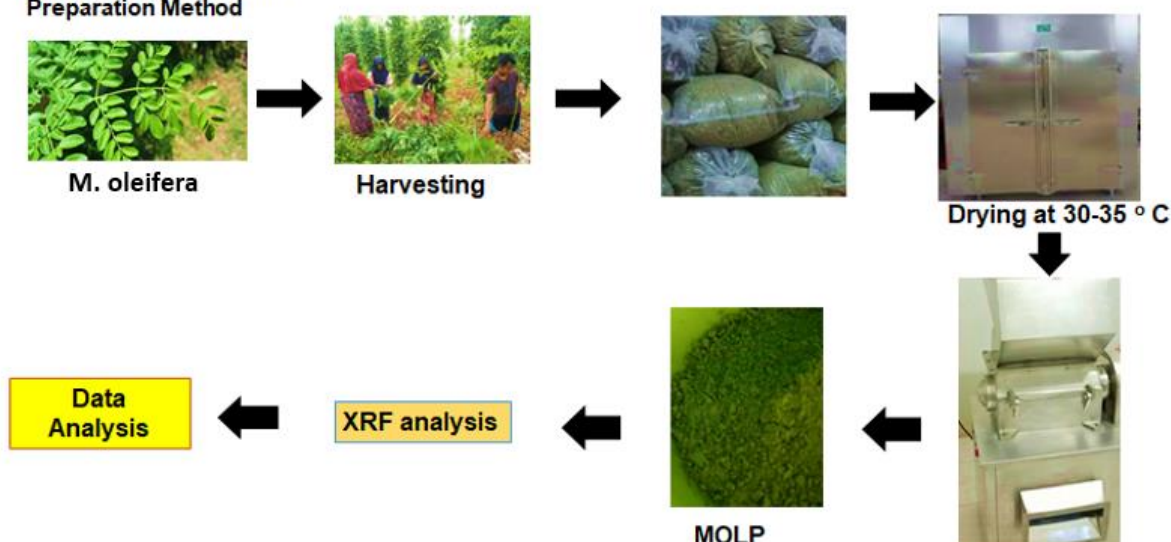
2. Methods

2.1. The preparation of the Moringa leaf powder sample

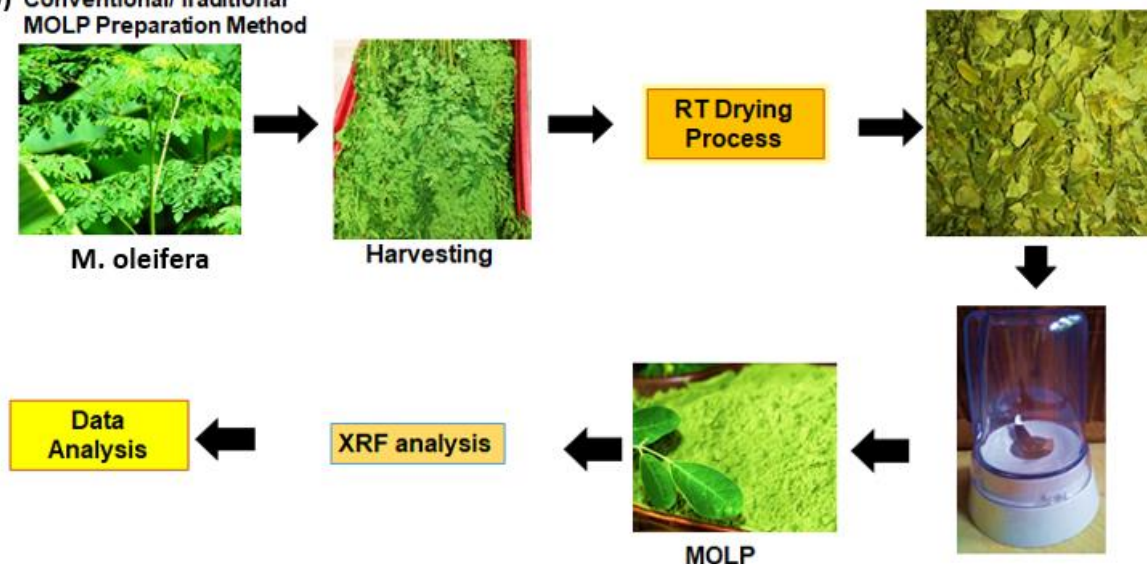
The *Moringa oleifera* leaf powder (MOLP) samples were obtained from Madura islands. They were being harvested from the local farm. The leaves were then washed with clean water. Two different preparation methods were conducted to produce MOLP. In the conventional method, the Moringa

leaves were dried by room temperature for 2-3 days. Then, the leaves were ground with a simple machine (commercial blender). The utilization of the drying machine was applied for another method (non-conventional protocol). The leaves were dried by using the oven with a temperature ranging from 30 °C to 35 °C. The product from the previous step was ground with the standard factory machine.

(a) Non Conventional MOLP Preparation Method



(b) Conventional/Traditional MOLP Preparation Method



Scheme 1. (a) Non-Conventional MOLP (b) Conventional/Traditional MOLP Preparation Method

2.2. The characterization of green materials of *Moringa oleifera* leaf powder (MOLP)

To characterize the bioproperty among both samples, the mineral contents of MOLP were analyzed by applying PANalytical Minipal 4 XRF (X-Ray Fluorescence) measurement at Central Laboratory of Universitas Negeri Malang, Indonesia. The MOLP samples were inserted into the holder of the device, and the quantifying process was being run in the Minipal program. The result of MOLP mineral contents test could be further analysed.

3. Results and Discussion

The main goal of this study was to obtain the minerals profile of MOLP Madura variety processed with two different preparation methods. Based on the XRF analysis, MOLP Madura variety prepared with two different methods showed a different small property for their minerals concentration (**Table 1**).

Table 1. Mineral contents of MOLP Madura variety from two different preparation methods

Compound	Concentration (%)	
	Conventional	Non-Conventional
P	1.6	1.4
S	3.0	4.8
K	14.7	17.3
Ca	68.5	73.0
Ti	0.2	Not found
Mn	0.37	0.42
Fe	2.14	0.87
Ni	0.06	0.04
Cu	0.29	0.28
Mo	8.3	1
Eu	0.3	0.3
Yb	0.5	0.5

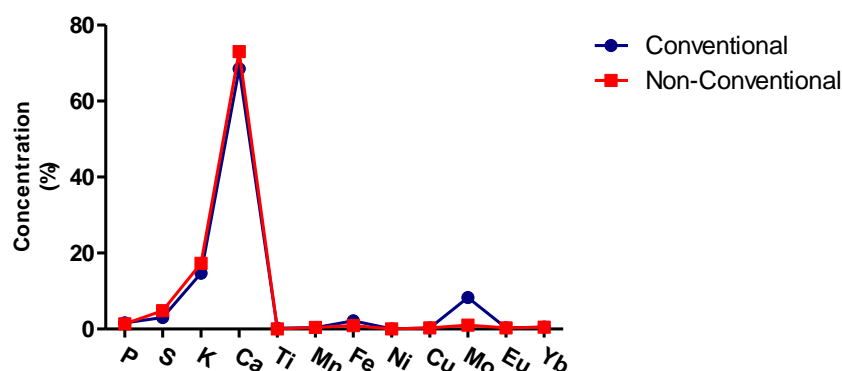


Figure 1. The comparison of MOLP minerals level

The amount of phosphor, iron, nickel, copper, and molybdenum concentrations was higher in conventional preparation than those in the non-conventional method. On the other hand, the sulfur, potassium, calcium, and manganese concentrations were higher in the non-conventional samples. Interestingly, it was also found that a small amount of Titanium (0.2%) within MOLP with conventional preparation while it could not show in the other preparation. In brief, the results of the conventional method showed 0.2% higher concentration on phosphor, 1.27% iron, 0.02% nickel, 0.01% copper, and 7.3% molybdenum while the non-conventional preparation had 1.8% higher on sulphur, 2.6% potassium, 4.5% calcium and 0.05% manganese (Figure 1).

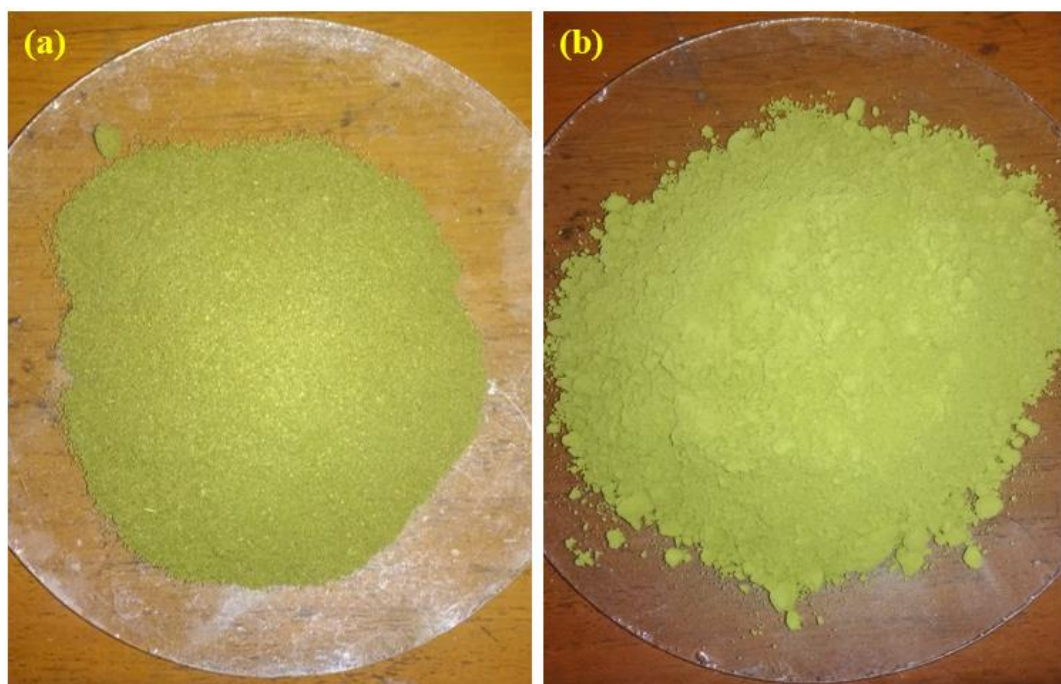


Figure 2. The morphological feature of MOLP Madura Island. (A). Conventional preparation method, and (B) non-conventional method.

According to the MOLP preparation process (Figure 2), the MOLP from conventional and non-conventional preparation methods had a different color spectrum and textures. MOLP of the traditional method had a dark green color while MOLP of the non-conventional method had a light green color. The mineral characteristics of Moringa leaf powder from Madura islands were different from other regions due to different geographical conditions especially background geochemical and geochemistry cycles of the element in the environment [33]. Madura island, as one of the low-altitude areas in Indonesia may produce more mineral contents in MOLP.

In this research, the difference in mineral concentrations within *Moringa oleifera* leaf may be correlated to the drying process. The MOLP using conventional method was dried at the room temperature while the another sample was dried at a temperature range of 30-35 °C in two times. This temperature difference is considered to be the cause of the MOLP using non-conventional method that had mineral essential contents higher than MOLP using conventional method. It is suggested to associate that result with the temperature results in the denaturation of an element of the MOLP rough materials [34]. Importantly, the harvesting process for Moringa leaves was recommended in the early morning to reduce the loss of moisture and some essential ingredients within the leave. During the preparation of fresh Moringa leaf samples, the leaves should be washed and cleaned by running fresh tap water to reduce some pathogens and dust. The drying method can be arranged at room temperature for four days to collect dried leaves entirely in the dark condition. The simple difference in minerals concentration in the MOLP Madura samples was suggested that it was significantly associated with drying method. Linear to this hypothesis, it was reported that the primary process for drying and grinding method significantly associated with the fundamental characteristic of nutrients and flowability related particle morphology [35]. We suggest that the MOLP is better dried using the non-conventional method. This is because of the amount mineral essential of sulfur, potassium, calcium, and manganese higher than using the conventional method. Also, it needed a shorter time to dry compared to the traditional method. Nevertheless, the limitation of our study was that we could not fully elucidate the primary contribution of temperature in the drying process to the whole characteristics of minerals within the MOLP of Madura variety. Hence, the expanded investigation is necessary to clarify the basic profile of MOLP as wholly deeply.

4. Conclusion

In summary, our study employed fundamental preliminary data for future investigation on *Moringa oleifera* leaf which has a potential in biomaterials development in biomedical and engineering. A non-conventional method using temperature 30-35 °C is the best choice for the drying process from MOLP because it can improve the essential mineral contents for biomedical development material. The non-conventional method also can produce large quantities of MOLP in a shorter time, so that MOLP has the potential to be produced in the industry.

Acknowledgments

We thank FMIPA Universitas Negeri Malang for the research grant through PNPB program 2018. Also, we would like thank PT ALAMI Moringa Sejahtera and CV Nurul Jannah for the technical support.

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