**Characteristics of Nano-size MgO Prepared Using Aqueous Extract of Different Parts of *Moringa Oleifera* Plant as Green Synthesis Agents (Times New Roman, Bold, 18 Pt)**

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**AUTHOR CONTIBUTIONS**

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, X.X. and Y.Y.; Methodology, X.X.; Software, X.X.; Validation, X.X., Y.Y. and Z.Z.; Formal Analysis, X.X.; Investigation, X.X.; Resources, X.X.; Data Curation, X.X.; Writing – Original Draft Preparation, X.X.; Writing – Review & Editing, X.X.; Visualization, X.X.; Supervision, X.X.; Project Administration, X.X.; Funding Acquisition, Y.Y.”.

**CONFLICT OF INTEREST**

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**Abstract.** Plant-based green synthesis approach is increasingly popular because of its simple process, cost-effectiveness, environmentally friendly, expandability to commercial level, efficiency in large-scale synthesis, and flexibility in utilizing various value-added products. This work focuses on the synthesis and characterization of nano-size MgO prepared using water-soluble compounds extracted from different parts of *Moringa oleifera* (*M. oleifera*) plant, including woody vascular, the bark of woody, twigs, and leaves. To examine the efficacy of the aqueous extracts as a reducing agent and stabilizing agent, they were applied in mixing extract and solution of magnesium chloride. The precipitate product calcined at 600 ℃; for 5 h. The characteristics of the MgO obtained were evaluated using various techniques. UV-visible (UV-Vis) spectroscopy shows …………………………. (Times New Roman, 12 Pt)

**Keywords:** keyword 1; keyword 2; keyword 3;….. (Times New Roman, 12 Pt)

**1. INTRODUCTION (Times New Roman, Bold, 14 Pt)**

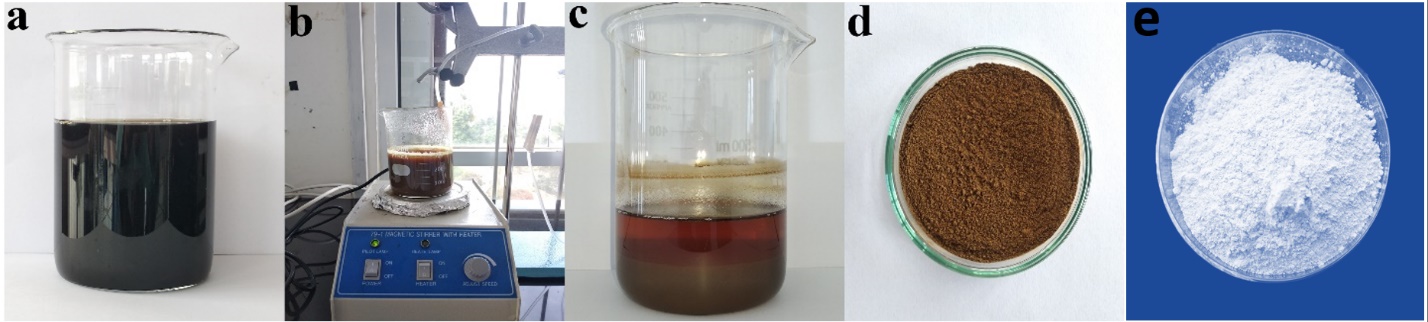
Magnesium oxide (MgO) is acknowledged as a multifunction oxide with an array of applications, such as catalyst and catalyst support for various organic reactions [1], adsorbent for removing textile dyes [2] and heavy metals in waste [3], antibacterial [4], and electrochemical biosensors [5]. Conventionally, MgO is produced through thermal decomposition of various magnesium salts [6][7]. This method is known to produce MgO with large crystal size, resulted in very small ratio of surface area to volume and therefore limits the application of MgO involving surface. Some MgO properties, such as catalytic activity, can be improved by reducing the size of particle to nano scale. Therefore, preparation of MgO with crystallite size less than 100 nm and has homogeneous particle morphology continuously attracts interest of many researchers because of its unique physicochemical properties, including high surface area to volume ratio………………. (Times New Roman, 12 Pt)

**2. MATERIALS AND METHODS**

*2.1. Materials. M. oleifera* samples (woody vascular, the bark of woody, twigs, and leaves) were collected from Metro, Lampung and Palembang, South Sumatera, Indonesia during September 2019. Laboratory grade magnesium chloride hexahydrate (MgCl2.6H2O), Folin-Ciocalteu reagents, sodium carbonate (Na2CO3), gallic acid, catechin, aluminum chloride (AlCl3), sodium nitrite (NaNO2), and sodium hydroxide (NaOH) were purchased from Merck Sigma-Aldrich Reagent Pte, Singapore.

*2.2. Methods* (Times New Roman, Italic, 12 Pt)

*2.2.1. Preparation of Aqueous Extract*. Extraction method refers to the research byElumalai, et al. [24] and Das, et al. [4] with some modification. Moringa (woody vascular, the bark of woody, twigs, and leaves) powder samples of 4 grams were mixed with 100 mL of distilled water. The mixture was then heated to 60 oCfor 20 minutes until all the Moringa sample powder was completely mixed. After heating, the solution was allowed to cool and filtered using filter paper (Whatman filter paper), and then the filtrate was collected. The resulting filtrate was used as a stock solution for the synthesis of MgO nanoparticles. For each experiment, a fresh extract was used……………



**Figure 1.** Synthesis MgO nanoparticles process (a) Moringa extract sample; (b) addition of NaOH; (c) aging process; (d) Mg(OH)2; (e) MgO nanoparticles

*2.2.2. MgO nanoparticles characterization*. The synthesis of MgO nanoparticles was followed by UV-Visible spectrophotometer (Analytic Jena Specord 200 Plus) analysis. The MgO nanoparticles produced are characterized using different instrument techniques. The crystal structure of nanoparticles was studied using X-ray diffraction (XRD, PANAnalytical Expert Pro) techniques. The morphology of nanoparticles was studied using scanning electron microscopy (SEM, FEI Inspect-S50) and transmission electron microscopy (TEM, Jeol Jem 1400). Particle size analyzer (PSA, Horiba SZ 100z) used for the rough estimation of particle size.

**3. RESULTS AND DISCUSSIONS**

*3.1. Total phenolic and flavonoid content*. Total phenolic levels were determined using spectroscopic technique, by measuring the absorbance of a mixture of extract samples with Folin-Ciocalteu and Sodium Carbonate reagents at 765 nm using a UV-Vis spectrophotometer [4]. Table 1. shows all the Moringa extract samples (woody vascular, the bark of woody, twigs, and leaves) containing phenolic compounds with levels, 5.21 ± 1.20; 112.04 ± 5.38; 628.38 ± 26.63; and 683.95 ± 16.74 μg Gallic Acid ml-1 respectively. From these data, it can be concluded that all the Moringa sample extracts used contain phenolic compounds which later function as reducing agents or chelating agents in the process of forming MgO nanoparticles [18]………………………….

**Table 1**. Total phenolic and flavonoid content of *M. oleifera* aqueous extract

|  |  |  |
| --- | --- | --- |
| **Sample** | **Total phenolic and flavonoid content of *M. oleifera* aqueous extract** | |
| **Total phenolic content**  **(µg Gallic acid ml-1)** | **Total flavonoid content**  **(µg Catechin ml-1)** |
| Woody vascular | 5.21 ± 1.20 | 8.92 ± 3.98 |
| The bark of woody | 112.04 ± 5.38 | 38.41 ± 5.43 |
| Twigs | 628.38 ± 26.63 | 78.97 ± 9.87 |
| Leaves | 683.95 ± 16.74 | 514.08 ± 26.12 |

The crystalline phase and structure of the synthesized MgO nanoparticles were investigated using x-ray diffraction techniques to properly study the position of the atoms in the lattice structure. Figure 3 shows the XRD patterns of MgO nanoparticles produced from all Moringa aqueous extract. All samples of MgO nanoparticles show two peaks with the highest intensity at 2 = 42.915 and 62.304 and three small peaks (at 2Ɵ = 31.636, 74.729, 78.629). The results obtained were verified using the JCPDS standard XRD data (No: 78-0430). No significant characteristic peaks appear from Mg or other impurities detected on the diffractogram indicating the high purity of the synthesized MgO nanoparticles. The average diameter of crystalline (D) was measured using the Scherrer's formula (equation 1) for (200) planes obtained at 20 – 30 nm.

**(1)**

Where K is a constant dimension depending on the specific geometry of the object, λ is the wavelength of X-ray radiation, β is the full width at half maximum (FWHM) of the significant peaks in radians, and θ is the Bragg’s

**4. CONCLUSIONS**

MgO nanoparticles was successfully synthesized using aqueous extracts of different parts of *M. oleifera* as green agents. The characteristic UV-Vis absorption peak at 290 nm confirmed the formation of MgO nanoparticles………………..

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