Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(10):518-521

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Synthesis of Zinc Aluminate ($ZnAl_2O_4$) by using water extract of *Impatiens balsamina L.*

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ABSTRACT

$ZnAl_2O_4$was synthesized by coprecipitation method with and without using water extract of Impatiens balsamina L. The aim of this work was to evaluate the influence of water extract of Impatiens balsamina L to crystallinity, crystallite size, and morphology of $ZnAl_2O_4$. The weight variation of Impatiens balsamina L that used was 8 g, 12 g, and 20 g in 50 mL of demineralized water. The XRD pattern showed $ZnAl_2O_4$ which was synthesized by using water extract of Impatiens balsamina L had better crystallinity than without using water extract of Impatiens balsamina L. The best crystallinity of $ZnAl_2O_4$was obtained by using 12 g of water extract of Impatiens balsamina Lafter calcination at 800^oC. The average crystallite size of various $ZnAl_2O_4$ by using 0 g (without extract), 8 g, 12 g, and 20 g of extract variation using Sherrer formula were 20.42 nm, 23.01 nm, 25,70 nm, and 25,57 nm, respectively. The SEM micrograph showed that $ZnAl_2O_4$which was synthesized using water extract of Impatiens balsamina L have irregular shape and almost similar to the morphology of $ZnAl_2O_4$ without using extract, but its particles more evenly distributed with similar size than $ZnAl_2O_4$ without using extract.

Keywords: $ZnAl_2O_4$, coprecipitation method, water extracts, *Impatiens balsamina L.*

INTRODUCTION

Zinc Aluminate ($ZnAl_2O_4$) with a normal spinel AB_2O_4structure is an important transition metal oxide. $ZnAl_2O_4$ becomes interest due to its combination of desirable properties such as high chemical and thermal stability, high mechanical resistance, low surface acidity, and better diffusion [1-3]. Therefore, $ZnAl_2O_4$ have been widely used as catalyst or catalyst support, semiconductor, optical coating, and solar cells [3-6]. In order to provide materials with desired chemical and physical properties such as crystalinity, size, and morphologies, the different routes to synthesis $ZnAl_2O_4$has become an essential part in research and development [7]. There are many experimental procedure have been developed such as ceramic method (CM), mechanochemical synthesis in humid medium (HMS) [8], coprecipitation (COPR) [8,9], sol gel [10], hydrothermal methods [1], molten salts synthesis [11], ext.

Nowadays, due to environmental reason, the using of extract plant has been growth in synthesis of material. The content of plant extract such as flavonoids, tannins, and terpenoids has been used as reducing, capping, and chelating agents for the synthesis of materials. The content of plant extract also provides materials with different size and morphologies. Hence, employing plant extract for preparation materials have drawn attention as a simple and viable alternative to chemicals procedure [7]. There are many reports about using extract plant for synthesis materials. The Sesamum (*Sesamun indicum* L.) plant extract has used for synthesis $ZnAl_2O_4$. Sesamum which contains flavonoids, tannins, coumarins, curcumanoid, xanthons, phenolics, lignans, and terpenoid was used for preparation $ZnAl_2O_4$. Sesamun extract simplifies the process and provides an alternative method for simple and economical way of synthesis of nano $ZnAl_2O_4$[12].

In line with the development of alternative environmental friendly method for synthesis of materials, the water extract of *Impatiens balsamina L* was used for synthesis $ZnAl_2O_4$. Leaves extract of *Impatiens balsamina L* contains

flavonoids, coumarins, saponins,phenolics, terpenoids, and steroids [13]. In the present work, *Impatiens balsamina L* water extract role as capping agent and to the best of our knowledge has not been reported. The influence of weight variation of *Impatiens balsamina L* and calcination temperature in crystalinity, crystallite size, and morphology of $ZnAl_2O_4$ obtained was investigated.

EXPERIMENTAL SECTION

Zinc Acetate (>99.5% of purity), Aluminum Nitrate (≥95% of purity), ammonia solution (25% of purity) was purchased from Merck as precursor. The *Impatiens balsamina L* leaves was collected from Pematang Indah Alley, Kandang Limun, Bengkulu. The X-Ray Diffraction pattern was obtained by a PAN-analytical PW3373 X-Ray Diffractometer using Cu Kα radiation at λ=0.154 nm, powered at 40 kV and 30 mA. The micrograph of samples were examined by Scanning Electron Microscope (JEOL, JSM 5360LA). The average of crystallite size was calculated using the Scherrer's equation.

2.1 Preparation of Plant Extract

The fresh leaves of *Impatiens balsamina L* were washed with demineralized water. The leaf extract used for synthesis was prepared in variation of weight 8, 12, and 20 gram. Each variation of mass was extracted in 50 mL of demineralized water and stirred for 45 minutes. The mixture was filtered using Whatman paper No. 42 to obtain the plant extract. All of the plant extract of each variation was used to synthesis of $ZnAl_2O_4$.

2.2 Synthesis of $ZnAl_2O_4$ without plant extract

$ZnAl_2O_4$ was synthesized by coprecipitation method. Aqueous solutions of 1M Zinc acetate (25 mL) and 1M Aluminum nitrate (50 mL) was mixed under stirring (molar ratio of Zn/Al was 1:2). The pH of mixture was increased between 10 until 11 by adding the ammonia solution (25%). The mixture was stirred for 30 minutes at 80^{o}C and then the white precipitate was obtained after filtration. The resulting white precipitates was washed three times using demineralized water and dried in oven for 13 hours at 120^{o}C. The obtained powder was calcinated at 400^{o}C, 600^{o}C, and 800^{o}C, for 4 hours and characterized using XRD and SEM.

2.3 Synthesis of $ZnAl_2O_4$ with plant extract

The amount of Zinc acetate and Aluminum nitrate were same with procedure 2.2. After Zinc acetate and Aluminum nitrate mixed under stirring, 10 mL of plant extract was slowly added to the mixture and stirred for 5 minute. Then, the ammonia solution was added until the pH of mixture between 10 until11. The next steps were same with procedure 2.2.The $ZnAl_2O_4$ obtained with and without plant extract were compared to know the crystallinity, crystallite size, and morphology of $ZnAl_2O_4$.

RESULTS AND DISCUSSION

The X-Ray Diffraction pattern for $ZnAl_2O_4$ prepared with and without using water extract of *Impatiens balsamina L* is shown in Figure 1. The XRD pattern for both $ZnAl_2O_4$ was prepared with calcination temperature at 800^{o}C as the best condition in this work. The observed diffraction peak in all the XRD pattern for both $ZnAl_2O_4$ correspond to the characteristic peaks of the cubic spinel-phase $ZnAl_2O_4$, namely, the peaks at 2θ of 31.34º, 36.89º, 44.72º, 49.02º, 55.71º, 59.30º, 65.37º, 74.31º, and 77.34º. These XRD pattern are in accordance with the JCPDS No. 05-0669. These peak can be indexed as (220), (311), (400), (331), (422), (511), (440), (620), and (533) diffraction.

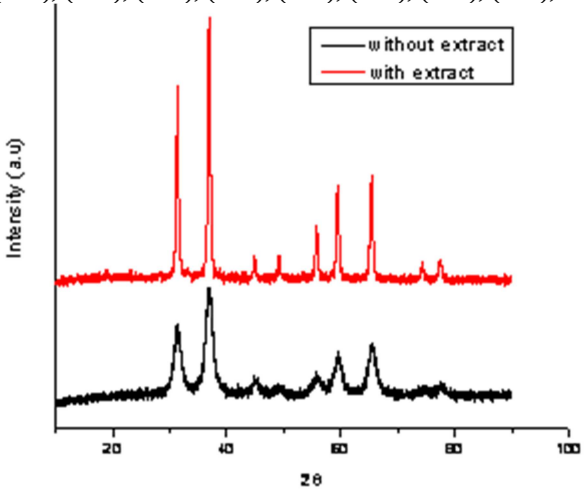


Figure 1. XRD pattern of $ZnAl_2O_4$ with and without using water extract of *Impatiens balsamina* after calcinated at 800^{o}C

The XRD pattern in Figure 1 showed the diffraction peak of $ZnAl_2O_4$ prepared with using water extract of *Impatiens balsamina L* was very sharp and high intensity. These peaks indicate that obtained $ZnAl_2O_4$has good crystalinity. But, the diffraction peak of $ZnAl_2O_4$ prepared without using water extract of *Impatiens balsamina L* was broaden bases and low intensity, indicating ithas not good crystalinity. These result indicated that the presence of water extract of *Impatiens balsamina L* increase the crystalinity of $ZnAl_2O_4$. The chemicals compound in extract such as flavonoids, coumarins, saponins, and phenolics may affect to increase the crystalinity of $ZnAl_2O_4$. These compounds have active OH functional groups that may inhibit the formation of $ZnAl_2O_4$ by complex compound formation and produce the $ZnAl_2O_4$ in specific shape of lattice [14]. Furthermore observations, no other crystalline diffraction peaks were present in the XRD pattern, indicating the formation of highly pure $ZnAl_2O_4$.

The XRD pattern of $ZnAl_2O_4$which were calcinated at 400^{o}C, 600^{o}C, and 800^{o}C with weight variation of extract were shown in Figure 2. The increasing of calcination temperature leads to the formation of a spinel phase, thus the crystallinity of $ZnAl_2O_4$ increased [15]. The increasing of mass extract also influences the crystallinity of obtained $ZnAl_2O_4$. The sharpest peak and highest intensity of diffraction peaks indicated the best crystallinity was achieved using 12 gram of extract which calcinated at 800^{o}C. Otherwise, the crystallinity of $ZnAl_2O_4$decreased when massextract was increased to 20 gram. It was clear the chemicals compound in extract affect the crystallinity of $ZnAl_2O_4$. The average crystallite size of various $ZnAl_2O_4$ by using 0 g (without extract), 8 g, 12 g, and 20 g of extract variation using Sherrer formula were 20.42 nm, 23.01 nm, 25,70 nm, and 25,57 nm, respectively. Its mean, the chemicals compound in extract also affect the crystallite size of $ZnAl_2O_4$.

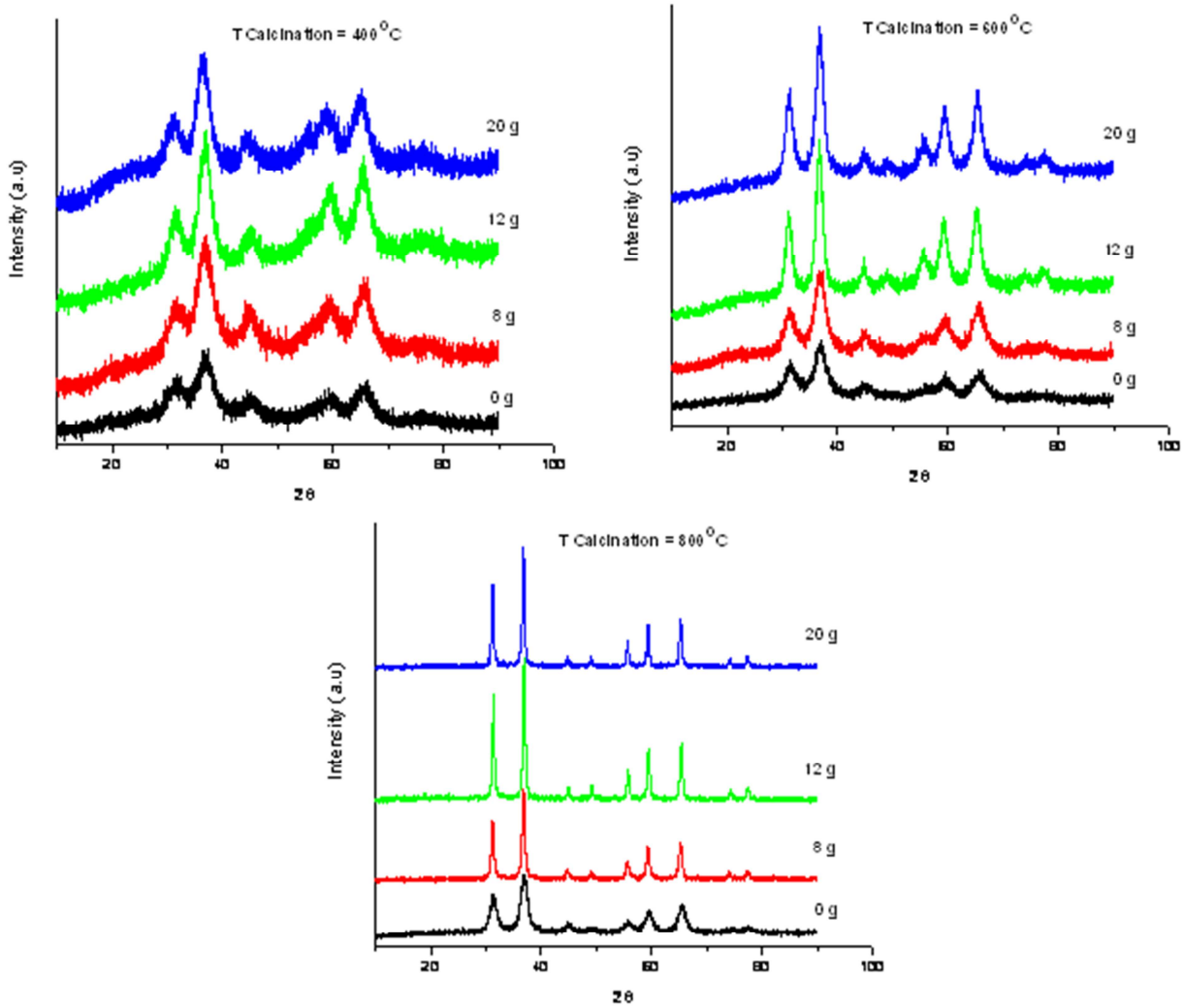
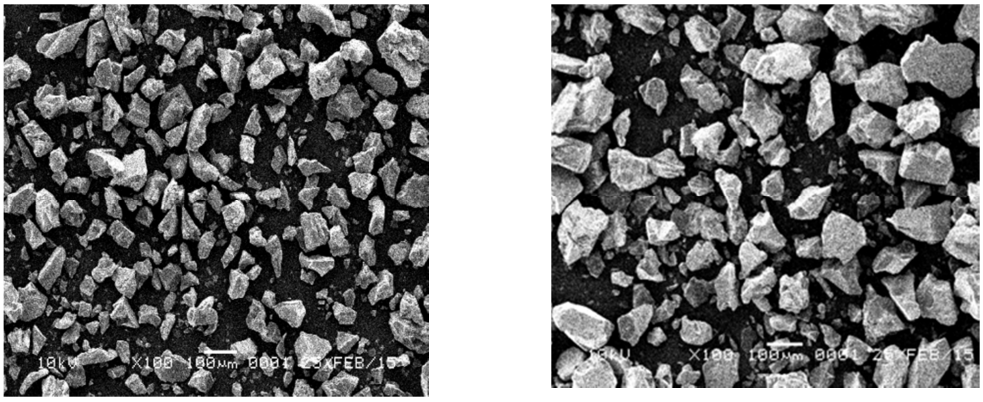


Figure 2. The XRD pattern of $ZnAl_2O_4$calcinated at 400^{o}C, 600^{o}C, and 800^{o}C with weight variation of extract

The SEM microphotographs of $ZnAl_2O_4$calcinated at 800^{o}C using 12 gram of extract as the best condition to obtain the best crystallinity of $ZnAl_2O_4$ was shown in Figure 3a. Figure 3a shows irregular shape and almost similar to the morphology of $ZnAl_2O_4$ without extract addition (Figure 3b), but its particles more evenly distributed with similar size than $ZnAl_2O_4$ without extract addition. This result also confirms that presence of *Impatiens balsamina L* extract

affect the morphology of $ZnAl_2O_4$. The morphology of materials can be varied based on the method of preparation [16].



(a) **(b)**

Figure 3. SEM images of $ZnAl_2O_4$: (a) $ZnAl_2O_4$calcinated at 800^{o}C using 12 grams of extract variation (b) $ZnAl_2O_4$calcinated at 800^{o}C without using extract

CONCLUSION

In summary, we have successfully synthesized $ZnAl_2O_4$ using water extract of *Impatiens balsamina L*. The water extracts of *Impatiens balsamina L* increase the crystallinity of $ZnAl_2O_4$ and also affect crystallite size and morphology of $ZnAl_2O_4$. The best condition to result in good crystallinity was achieved in temperature calcination at 800^{o}C using 12 grams of extract variation.

Acknowledgements
The authors are grateful to Directorate General of Higher Education of Indonesia (DIKTI) for the financial support of this research.

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