



## Free Fatty Acids Esterification on Palm Oil Sludge using Zirconia-supported Indonesian Natural Zeolite as Heterogeneous Catalyst

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### ABSTRACT

Biodiesel production has been attracted more intense study because of the growing interest in finding the alternative renewable energy resources. Commonly biodiesel production is produced using refined vegetable oils as feedstocks which catalyzed by a homogeneous catalyst. However, the homogeneous catalyst has many disadvantages such as complex products separation and environmental problem. In this research, the esterification of Palm Oil Sludge (POS) using zirconia supported Indonesian natural zeolite as a heterogeneous catalyst was studied. The POS is low feedstock price and available abundantly. The catalysts were analyzed in term of porosity analysis (Gas Sorption Analysis method), XRD and FTIR. The FFAs conversion as high as was 84.2% achieved at following reaction conditions: 2 h reaction time, 65°C reaction temperature, 1:10 POS to methanol mole ratio, and catalyst amount 10 wt.% of POS. The FFA conversion was decreased after three consecutive of esterification reaction.

**Keywords:** Esterification, Sludge palm oil, Biodiesel, Natural zeolite, Free fatty acids, Sulfated zirconia

### INTRODUCTION

The biodiesel development as the sources of alternative renewable energy to substitute diesel fuel from crude oil has gained more attention in the last few decades due to the decreasing of fossil fuel reserves and environmental concern. It has several benefits such as biodegradable, environment friendly, and less toxic. Biodiesel can be generated from animal fat or vegetable oil through a transesterification reaction. Conventionally, a base

catalyst, such as potassium and sodium hydroxides, is used to catalyze the transesterification in biodiesel production. The transesterification esterification reactions are expressed in Figure 1.

Many types of vegetable oil sources such as soybean<sup>1</sup>, corn<sup>2,3</sup>, palm oil<sup>4,5</sup>, coconut<sup>6</sup>, sunflower<sup>7</sup>, canola<sup>8</sup>, and bran<sup>9</sup> can be utilized as feedstocks to produce biodiesel. However, the utilization of vegetable oil as a feedstock for biodiesel production



has many drawbacks i.e. less economic prospect and impractical due to high feedstock price and competition as a food supply<sup>10</sup>. To solve the problem, low-grade oil or non-edible oil which has low price can be used as biodiesel feedstocks<sup>11</sup>. This type of feedstocks contains high free fatty acids (FFAs) so that lead to saponification when using base catalysts. To overcome the problem, the acid catalysts should be applied for converting FFAs to biodiesel when using these feedstocks.

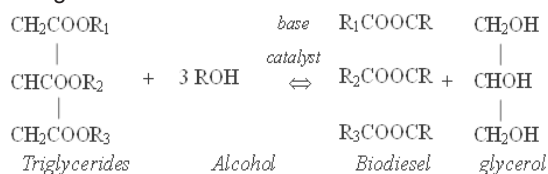


Fig. 1. Transesterification reactions

In 2017, the palm oil industries in Indonesia has generated 2,4 million tons of palm oil which means generating low-grade oil in large amounts such as palm oil sludge (POS) as wastes<sup>12</sup>. The POS has a large amount of free fatty acids (FFAs) that be reacted with an alcohol using acid catalyst to form biodiesel. Utilization of POS can be replaced the refined vegetable oils feedstocks in order to enhance the production of biodiesel potential economically.

Biodiesel can be synthesized by esterification reactions of FFAs on POS with an alcohol to produce methyl esters and water. Sulfuric acid, as well as hydrochloric acid or nitric acid, are commonly employed as homogeneous catalysts to accelerate the reaction. Fig. 2. is expressed the esterification reactions for producing esters or biodiesel.

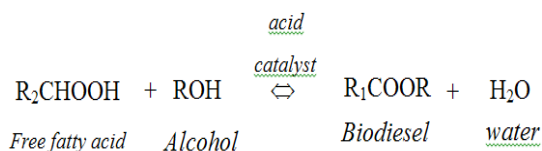


Fig. 2. Esterification reactions

The esterification reactions have many limitations, i.e. requires advances process for purification of products, further separation of catalyst, and furthermore the homogeneous catalysts are not reusable<sup>13</sup>. In order to eliminate the limitations related to using homogeneous catalysts, the heterogeneous catalyst is applied in biodiesel production. The heterogeneous catalysts offer

several benefits such as produce fewer amounts of chemical waste and wastewater, not necessary advances process separation, has a hydrophobic surface, and less corrosion. Many studies have been reported the using of heterogeneous catalyst for biodiesel production, such as sulphated zirconia ( $\text{SO}_4^{2-}/\text{ZrO}_2$ )<sup>14-16</sup>, zeolite<sup>17, 18, 19, 20</sup>, Lanthanum ( $\text{La}^{3+}$ ) and HZSM-5<sup>21</sup>, Natural clay<sup>22-24</sup>, Amberlyst 15<sup>25</sup>, alumina ( $\text{Al}_2\text{O}_3$ )<sup>26</sup>, silica<sup>27</sup>, hydroxyapatite<sup>28</sup>, Tungsten supported titania-silica composite<sup>29</sup>, Tin oxide<sup>30</sup>, niobic<sup>31</sup>, SBA-15<sup>32, 33</sup>, Titania<sup>34</sup> and biomass waste biomass wastes<sup>10, 12, 35-37</sup>.

However, most of the heterogeneous catalysts as reported have complex preparation steps and expensive synthesis routes. The heterogeneous catalysts should be synthesized by simple preparation steps, available abundantly and low in price to reduce the catalyst production cost. Zeolite is an aluminosilicate natural mineral which has a crystalline framework three-dimensional structure to form pores with uniform size. Zeolite has been applied in many industrial applications, such as adsorbent in wastewater treatment, molecular sieve, catalyst, etc. The study related to the Indonesia natural zeolite application for biodiesel production as a solid catalyst is still limited. The esterification reactions of FFAs with methanol, using zirconia supported on Indonesia natural zeolite, were an investigation in this research. The natural zeolite catalyst activity to convert FFAs to biodiesel was tested in terms of the reaction temperatures, POS to methanol mole ratio, catalyst amounts and reaction time. The catalyst reusability for consecutive reactions was also investigated in this work.

## EXPERIMENTAL

### Preparation of Catalyst

Prior to use, natural zeolite collected from Gunung Kidul province, Indonesia was crushed to obtain small particle with a size of 200 mesh. Then, to remove the organic impurities from the internal pores, the zeolite was activated by mixing with sulfuric acid 0.5 N solutions. The activation was performed by heating the solution containing natural zeolite at 80°C for 4 h while vigorous stirring. Subsequently, the activated natural zeolite was separated from solutions by filtration and rinsed with distilled water until the wash water free from sulfate ions. Then, the activated natural zeolite was dried in an oven

to remove remaining water from internal pores for overnight at 110°C. The catalyst was prepared by impregnation of Zirconia metals on the activated natural zeolite. The catalyst synthesis procedure is described as follows: (i) 10 gr of Zirconium (IV) oxychloride octahydrate ( $ZrOCl_2 \cdot 8H_2O$ ) was added into 100 mL distilled water and mixed well, (ii) followed by the addition of activated natural zeolite into the  $ZrOCl_2 \cdot 8H_2O$  salt solutions, (iii) the mixture was agitated at 60°C for 8 h, after completing the impregnation procedure, the mixture was dried to remove remaining water in an oven at 130°C for 8 hours. Finally, the sample was calcined in a furnace at 550°C for 3 hours.

The BET (Brunauer–Emmet–Teller) method was applied to determine specific surface area of catalysts. BET method was based on the physical adsorption of nitrogen between relative pressures (P/P<sub>0</sub>) of 0.05–0.35 at 77 K. The surface functional groups were characterized using Fourier Transform Infrared (FT-IR) spectroscopy which performed in the wavelength number between ranges of 400–4000  $cm^{-1}$ . The materials crystalline structures were determined using X-Ray Diffraction at operating condition 40 kV and 40 mA with 2 $\theta$  measurements between the ranges of 5° to 80°.

### Activity Test

Esterification of FFA on POS was run in a 250 mL two-neck flat-bottom flask as a batch reactor. A hot plate equipped a magnetic stirrer was used to stir the reactant at the batch reactor. The batch reactor was connected to a condenser and equip with a thermometer to indicate reaction temperature. Firstly, a certain amount of catalyst was mixed to a known volume of methanol and raised to the selected temperature under continuous stirring. Subsequently, POS was poured slowly into the reactor. The reaction was conducted till the completion of the reaction (2 h reaction time). The reaction conditions were varied in terms of POS to methanol mole ratio, catalyst amount, and reaction temperature to obtain optimum conditions. When the reaction was completed, the biodiesel product was separated from the catalyst by filtration. The product mixture was put into a separating funnel and kept at room temperature for overnight, after which two liquid phases appeared. The upper layer consists of the biodiesel product, and whiles the remaining

methanol and water were in the bottom. The acid value (AV) of the upper layer was measured by titration method. The AV is described as the weight of potassium hydroxide in mg required to neutralize 1 g of oil contains of the FFAs. Initially, the samples were heated in the oven at 110°C in order to eliminate the remaining of methanol and water. The titration technique was carried out by using 0.1 M KOH solution as the titrant, while phenolphthalein as indicator. The volume of alkaline solution consumed was noted, and the AV of sample was determined using Equation 1.

$$AV = \frac{V \cdot 0.1 \cdot 56.1}{m} \quad (1)$$

where AV is the sample acid value (mg KOH/g), V is the KOH solution volume used in the titration (mL), 0.1 is the KOH solution concentration (mol/L), m is the sample weight (g), and 56.1 is the KOH molecular weight. The FFAs conversion ( $X_F$ ) was calculated using Equation 2.

$$X_F (\%) = \left( 1 - \frac{\text{acid value after reaction}}{\text{initial acid value}} \right) \times 100 \quad (2)$$

The catalyst reusability test was performed under the same optimum reaction conditions in the experiment with the fresh catalyst. The reused catalysts were washed with n-hexane and dried in an oven at 100°C for 4 h prior to reuse. Three consecutive of esterification reactions were carried out to evaluate the catalyst reusability.

## RESULTS AND DISCUSSION

### Catalyst Characterization

The crystalline structure of activated natural zeolite and zirconia catalyst were presented in Fig. 3 (a) and (b). As presented in Fig. 3 (a), the activated natural zeolite diffraction peaks shows the characteristics of mordenite and clinoptile zeolites which appears at 2 $\theta$  = 9.76 (2 0 0), 19.68 (4 0 0), 22.38 (1 5 0), 25.78 (2 0 2), 27.68 (5 1 1), and 30.05 (1 5 1). In the other hand, the catalyst presents characteristic peaks of zirconia oxide at 2 $\theta$  = 30.47 (2 2 1), 30.87 (1 1 1) and 50.55 (2 2 0). It can be observed that the catalysts retained the ordered structure. The intensity decreasing could be attributed the loading of zirconia on the solid surface. The shifting of diffraction peaks corresponds to the cell parameters due to the shrinkage of pores framework after the impregnation of zirconia.

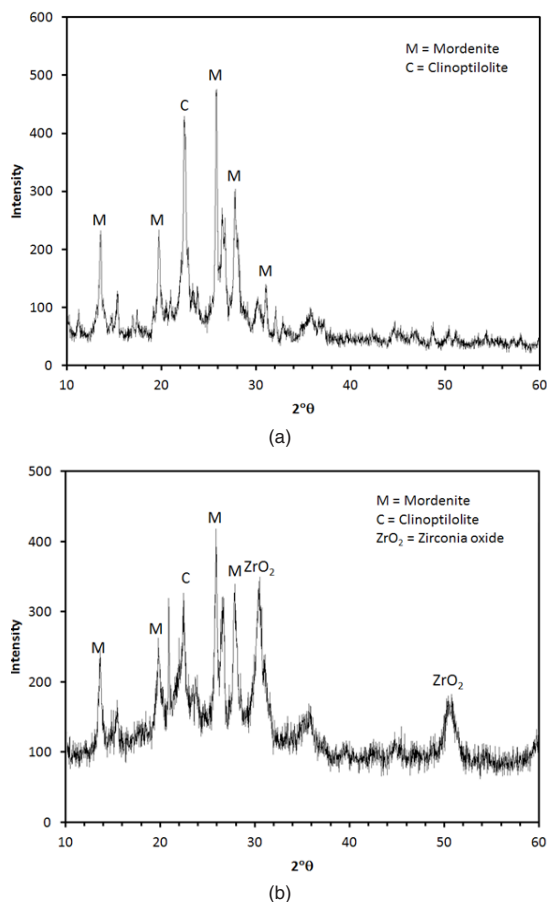


Fig. 3. The XRD characteristics of activated natural zeolite and zirconia catalyst

The activated natural zeolite and zirconia catalyst  $N_2$  adsorption–desorption isotherms were exhibited in Fig. 4. As presented in Fig. 4, the activated natural zeolite as well as zirconia catalyst exhibited the type IV of isotherms with H4 hysteresis loops which associated with the characteristic of mesoporous materials with narrow slit-like pores, internal voids of irregular shape while the pore size distribution is broad. A decrease in the volume of nitrogen adsorption indicates a reduction in surface area after zirconia impregnation on the activated natural zeolite.

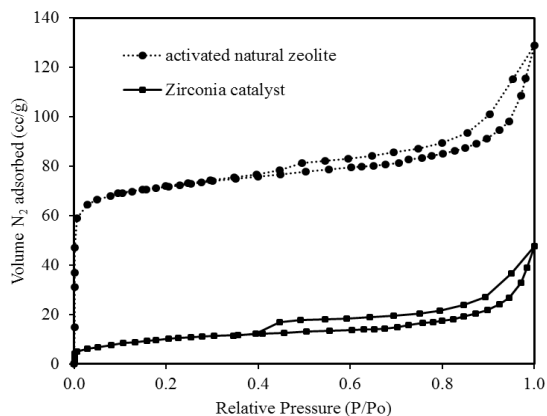


Fig. 4. The activated natural zeolite and zirconia catalyst  $N_2$  adsorption–desorption isotherms

The BET surface area, pore volume, and average pore size diameter of the activated natural zeolite and zirconia catalyst are shown in Table 1. The activation process was successful in increasing of the natural zeolite surface area from 177.542 to 213.421  $m^2 \cdot g^{-1}$ . The pore volume also increased from 0.2005 to 0.2107  $cm^3 \cdot g^{-1}$ . The increasing of surface area and pore volume is due to the removal of impurities on the natural zeolite internal pores by activation process using chemical treatment. Furthermore, the impregnation of zirconia metal as active sites would reduce the surface area to 115.348  $m^2 \cdot g^{-1}$  as well as pore volume (0.07892  $cm^3 \cdot g^{-1}$ ). The average pore diameter widened from 3.74 to 8.28 nm after impregnation of Zirconia metal on the surface of the catalyst. An increase in mean pore diameter will facilitate accessing of free fatty acid compounds to penetrate into the internal pores of catalyst materials.

The successful of incorporated of zirconia metals on catalyst surface was determined using Energy Dispersive X-ray Spectroscopy (EDS) to calculate elemental composition. Before impregnation step, the activated natural consist of Na (0.62% w/w), Al (6.13% w/w) and Si (27.83% w/w) respectively. While after impregnation, the zirconia catalyst

Table 1: Physicochemical characteristics of samples

Sample	BET surface area ( $m^2 \cdot g^{-1}$ )	Average pore size diameter (nm)	total pore volume ( $cm^3 \cdot g^{-1}$ )
Natural zeolite	177.542	2.26	0.2005
Activated natural zeolite	213.421	3.74	0.2107
Zirconia catalyst	115.348	8.28	0.07892

containing Na (6.13% w/w), Al (6.13% w/w), Si (6.13% w/w) and Zr (6.13% w/w). The FT-IR spectra for both activated natural zeolite and zirconia catalyst were presented in Fig. 4. In natural zeolite FT-IR spectra, the wavelength between 2600 and 3700  $\text{cm}^{-1}$  corresponds to the OH bond stretching vibration of  $\text{H}_2\text{O}$  is clearly visible. The peak between 1000 and 1300  $\text{cm}^{-1}$  indicate the asymmetric Si–O–Si. The Si–O–Si bending bond occurs at a wavelength of 458  $\text{cm}^{-1}$ . Meanwhile, the peak of 757 and 811  $\text{cm}^{-1}$  shows the symmetric vibration of Si–O–Si bonds. In the zirconia catalyst spectra, the OH stretching vibration of water was at 3426  $\text{cm}^{-1}$ . The wavelength number at 1090 and 1216  $\text{cm}^{-1}$  correspond to asymmetric Si–O–Si vibrations which are seen to reduced in intensity compared to activated natural zeolite. The appearance of the bands between from The T–O–T bonds (T = Si or Al) appears at 1088 and 1230  $\text{cm}^{-1}$  which correspond to Si–OH vibrations. The intensity of this band tends to increase when several metals are incorporated of the metals into the surface of materials.

### Activity Test

#### Mole Ratio Effect

The important parameter that affects the conversion of FFAs is the oil to methanol mole ratio. Mole ratio is the ratio between the mole number of oil to the mole number of alcohol that used in the experiment. Theoretically, the FFAs esterification reaction requires one mole of alcohol for each mole of oil that reacted. However, in practice, the mole ratio must be provided more than the stoichiometric ratio requirement to drive the equilibrium to the methyl ester product. The POS to methanol mole ratio is varied at a number value of 1:4, 1:6, 1:8, and 1:10, while the reaction was kept constant at the identical operating conditions (reaction temperature of 60°C, catalyst amount of 5%wt. of oil, dan reaction time of 4 h). It was concluded that an enhancement of methanol mole number leads to an increasing of conversion of FFAs as shown in Fig. 5. Initially, the FFA conversion was obtained at 67.2% as the POS to methanol mole ratio was 1:4. Furthermore, the FFA conversion increased from 77.3% to 80.7% at the POS to methanol mole ratio of 1:6 to 1:8 molar ratio respectively. Furthermore, the FFA conversion increases to 84.22% in the oil to methanol mole ratio of 1:10.

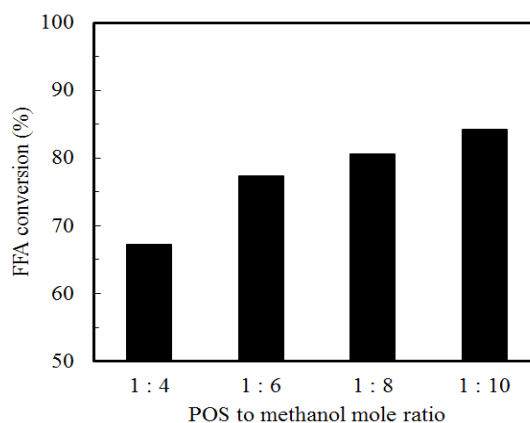


Fig. 5. POS to methanol mole ratio

#### Reaction Temperature Effect

The reaction temperature effect on the conversion of FFAs was investigated by conducting esterification reactions at different temperatures (35, 45, 55, and 65°C), while the POS to methanol mole ratio and catalyst amount was maintained constantly at 1:10 and 10 wt. % of POS, respectively. Fig. 6 exhibits the conversion of FFAs at different reaction temperatures. As illustrated in Fig. 6, the results indicated that the reaction temperatures had an effect on FFA conversion during the esterification reaction. The FFA conversion achieves at 64.2% after time reaction of 2 h and reaction temperature of 35°C. Subsequently, the FFA conversion reached to 74.4 and 80.4% at reaction temperature of 45 and 55°C, respectively. Noteworthy, the maximum FFA conversion acquired at 84.2% when the reaction temperature of 65°C. It was can be summarized that the FFA conversion on the product increased with the rising of reaction temperatures. The high of FFAs conversion was due to the acceleration of reaction rate which caused more methyl ester produced. The solubility of the oil in methanol will increase at higher temperatures, thus the problems associated with mass transfer limits will be reduced.

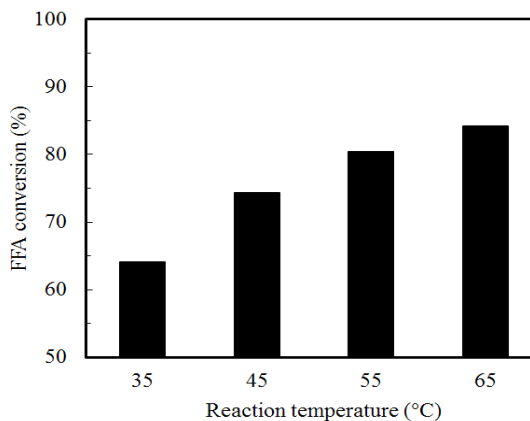


Fig. 6. POS to methanol mole ratio

### Catalyst Amount Effect

The catalyst amount is the important parameter in the biodiesel production using a heterogeneous catalyst. The heterogeneous catalysts preferably are employed due to easy separation from product mixture and regenerable. The appropriate catalyst amount to achieve maximum FFA conversion is investigated by varying in the range of 2.5, 5, 7.5 and 10 wt.% of POS. The percentage values were the mass fractions of the POS applied to the reactant mixture. The experiments were conducted with a reaction temperature of 60°C and a fixed POS to methanol mole ratio of 1:10, respectively. The conversion of FFAs at different reaction temperatures was presented in Figure 7.

Increasing the catalyst amount from 2.5 to 5 wt.% of POS increased the FFA conversion from 66.9 to 72.3%. Among the catalyst amount variations studied, the highest FFA conversion was 84.2% at the catalyst amount of 10 wt.% of POS. The results exhibited the improvement of FFA conversion when the catalyst amount was increased. The increase in FFA conversion is due to the addition of catalysts amount will lead the more of active sites available in catalyst surface. Hence, the optimum amount for FFA conversion is considered at the catalyst amount of 10 wt.% of POS.

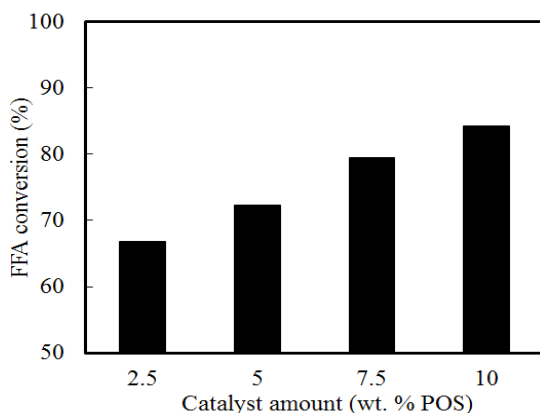


Fig. 7. POS to methanol mole ratio

### Catalyst Reusability

The catalyst performance associated with repeated use is investigated by subsequent reaction cycles. Prior to reuse, the catalysts were activated

by washing them with hexane to remove residual oil and impurities on the catalyst surface. After that, the catalysts were further dried in the oven at 120°C in the oven for 4 hours. Then the catalysts were applied for an esterification reaction under the identical reaction conditions as before. The result of reusability test is depicted in Fig. 8. As shown in Fig. 8, the FFA conversion was reduced in the second and third consecutive reactions.

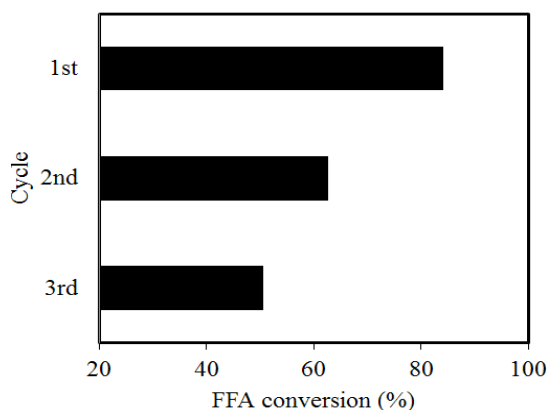


Fig. 8. POS to methanol mole ratio

### CONCLUSION

The biodiesel production from Palm oil sludge (POS) containing high free fatty acids (FFA) using Zirconia natural zeolite catalyst was studied. The catalyst was prepared by impregnation of Zirconia metal on the activated natural zeolite surface. The physico-chemical characteristics of catalysts were analyzed in term of porosity analysis, XRD, elemental composition and FTIR. The optimum operation conditions of esterification reaction was POS to methanol mole ratio of 1:10, catalyst amount of 10 wt.% POS, and reaction temperature of 65°C. At this optimum condition, the FFA conversion achieves 84.2%.

### ACKNOWLEDGEMENT

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## Volume 34, Number 5

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21 Oct, 2018 [Volume 34, Number 5](#)

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## Structure Activity Relationship Analysis of Antioxidant Activity of Simple Benzene Carboxylic Acids Group Based on Multiple Linear Regression

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Phenolic compounds are secondary metabolites in plants with a common aromatic ring bearing one or more hydroxyl groups. More than 8000 natural phenolic compounds have been identified to date. These phenolic compounds are...

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## Analysis of Arsenic in Rice in Medan, North Sumatera Indonesia by Atomic Absorption Spectrophotometer

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Introduction Arsenic is one of the most toxic metals found in nature because it can cause toxicity and carcinogenicity, even at low concentration. Long-term exposure may lead to an increased risk for various cancers,...

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## Novel Cinchona Alkaloid Derivatives as Potential Antimalarial Agents through Receptor-Inhibitor Interaction Fingerprint and Biosynthesis Design

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Malaria is an endemic disease caused by parasitic infection which influencing over than 224 million people and effecting mortality approximately 700,000 every year in the world.1 According to 41% of total world's population,...

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## Synthesis, Characterization of SiO<sub>2</sub>/TiO<sub>2</sub> and SiO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub> Nano-Composites for the Photo-Degradation of Acid Brown- 43 dye with Irradiation of Solar Light

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Now a days, photocatalysis of semiconductors having concerned a countless deals of investigation owing to its possible application to solve environmental difficulties. Subsequently a photocatalytic practice is based on the generation of electron/hole pairs by...

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## Infrared Spectroscopic and Scanning Electron Microscopy Study of Ibuprofen Loading onto the Molecular Sieve Mesoporous Silica SBA-15 Material

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Many industrial fields have applied using mesoporous material due to their unique characteristics such as structure uniformity, large space of pore, high surface area, inert and high thermal stability.1 The structure of mesoporous material...

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## Effect of Hindon River Water on Seed Germination of Mung Bean (*Vigna radiata*), Black Gram (*Vigna mungo*) and Wheat (*Triticum aestivum*) In-vitro

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction The Hindon River, is a potential source of water for different activities in the highly populated rural area of Western Uttar Pradesh region, is also utilized in different industrial activities taking place along...

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## The Influence of Fertilizer on Nitrate, Nitrite and Vitamin C Contents in Vegetables

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Vegetables are the main source of nitrates and nitrites in human diet which contribute to around 80-92% of average daily intake. Plants and vegetables absorb nitrates which are naturally available in soil and...

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## Evaluation of Natural Pigments as Antioxidant and Antibacterial Agents from *Tagetes Erecta* Flowers Extracts

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Several plants, parts of plants or plants extracts comprises a number of natural products that have some association with medical properties and are used in healthcare or in combating disease. From the last...

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## Gadolinium-Mesoporous Silica as a Potential Magnetic Resonance Imaging Contrast Agents

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Introduction In recent years, magnetic resonance imaging (MRI) has emerged as one of the best techniques in medical diagnosis. MRI has been widely used and promotes the development of pharmaceutical compounds called contrast agents...

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## Zeolite-Templated NiO Nanostructure for Methanol Oxidation Reaction

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Porous solids are categorized in three classes: Microporous materials with a pore diameter (< 2nm), mesoporous materials are materials with a pore diameter of 2-50 nm and macroporous materials with a pore diameter...

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## Investigation on Al Doped Zn Thin Films and its N-Alzno/P-Si Junction Diodes Via Dip Coating and JNSP Techniques

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Introduction Nowadays, forming a p-n junction diode by transition metal oxide (TMO) as an n-type layer and silicon (Si) wafer as a p-type is convincing method for electronics industry. The recent survey concludes that...

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## Green Synthesis and Characterization of Iron Oxide Nanoparticles Using Phyllanthus Niruri Extract

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Introduction In a broad sense, the term biosynthesis includes a wide range of possible applications from nanotechnology enabled, environmentally friendly manufacturing processes that reduce waste products; the use of nanomaterials as catalysts for greater...

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## Microwave Assisted-Hydrothermal Synthesis of Nickel Ferrite Nanoparticles

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Synthesis of nano and functional materials and their doping with rare and noble metals have attracted attention of many researchers.1,2 Magnetic nano-materials are characterized by their enormous physical properties, ease of preparation and low...

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## Synergistic Effect Between Gum Exudates of Eucalyptus Globes and 2,6-Diphenyl-3-Methylpiperidin-4-one on Corrosion Inhibition of MS in 1N HCl

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Introduction In many industries corrosion is a major problem for materials during acid pickling or chemical cleaning. Recently plant gum exudates are found to be non-toxic green corrosion inhibitors for various metals in different...

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## Macro Coumarins as Novel Antioxidants

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Coumarin is a simple molecule that originates from lactones family. As it possesses a benzopyrone system, it isolates itself from plants. Also, it can undergo total synthesis that is conducted in the laboratory...

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## Novel Stress Indicating RP-HPLC Method Development and Validation for the Simultaneous Estimation of Ertugliflozin and Sitagliptin in Bulk and its Formulation

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction A novel class of anti-diabetic drugs, which are inhibitors of dipeptidyl-peptidase IV (DPP4), which included sitagliptin, vildagliptin and saxagliptin.1,2,3,4,5 Type 2 diabetes mellitus (T2DM) is a progressive disease, for the treatment of many...

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## Utilization of Waste Leaves Biomass of Myrica Esculenta for the Removal of Pb (II), Cd (II) and Zn (II) Ions from Waste Waters

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Since from last two or three decades, the exposure of heavy metals in the aquatic bodies has increased very rapidly.1 The presence of heavy metals in the water or waste water causes life threatening...

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## Comparative Analysis of Ytria Stabilized Zirconia (YSZ) and Titania Doped YSZ (YZT) Sintered by two Different Routes: Conventional and Microwave Processing

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Introduction YZT ceramics, mixed conducting oxides, find multiple applications in photo catalysis, opto-electronic devices, environmental purification, photo electrochemical solar energy conversion, optical coatings, thermal barrier coatings, dental bio ceramics, Supercritical Water Cooled Reactor Insulator,...

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## Antibacterial Activity of Red Dragon Fruit Leaves Extract and White Dragon Fruit Leaves Extract Against Meningitis Bacterial

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Introduction Meningitis is inflamed in the meninges which function as a protector of the brain and spinal cord. Meningitis is caused by five main factors, namely bacterial, viruses, fungi, amoeba and several diseases. The...

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## Effects of Dopant Ions on the Properties of Polyaniline Conducting Polymer

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Previous studies have demonstrated that polyaniline (PANI) has electrical properties, 1-5 and therefore it can be classified as a conducting polymer. Recently, conducting PANI has received considerable attention and has been the subject of intense...

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## An Investigation of Textile Wastewater Treatment using Chlorella Vulgaris

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Textile industries are one of the rapid growing sectors in India. There are 21,076 textile units in India of which 5,285 units in Tamilnadu. 1 Textile processing includes sizing, de-sizing, scouring, bleaching, dyeing, rinsing...

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## Design and Fabrication of Temperature Sensor for Weather Monitoring System using MEMS Technology

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Micro Electro Mechanical Systems (MEMS) is a technology to develop micro devices and micro systems. MEMS are used for miniaturization of sensors. MEMS components are generally in size from micrometers to millimeters. The...

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## New Modified Method for Determination of Nitric Oxide Synthase Activity in Plasma of Vitiligo Patients

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Introduction Vitiligo is a skin pigmentation disorder and non-contagious disease, which is characterized by progressive skin depigmentation due to disorder in melanocytes function. With the prevalence of 1-2%, this disease represents a cause of...

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## Synthesis of a New Conjugates of Imidazole with Beta Lactam Moiety and Evaluation of its Expanded Antibacterial Activity

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Introduction Bacterial infection considered as one of the most serious problem that threaten the human life. 1 So that, antibacterial field played an important role to save many human lives and contributed to the control...

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## Efficacy of Corrosion Inhibitive Properties of Gum Exudates of Azadirachta Indica on Carbon Steel in 1N Hydrochloric Acid

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Carbon steel (CS) is extensively used in constructions as well as for industrial applications. 1,2 Under different working environments, CS is liable to undergo corrosion. Though many ways are available for corrosion inhibition of...

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## Synthesis and Evaluation of Antimicrobial Activity of New Imides and Schiff Bases Derived from Ethyl -4-Amino Benzoate

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction 1,3,4-Oxadiazole is a heterocyclic five-member ring possessing one oxygen atom and two nitrogen atoms. It is originated from a furan ring, where two methylene groups (=CH) substituted with two pyridine type nitrogen...

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## New Aromatic Azo-Schiff as Carbon Steel Corrosion Inhibitor in 1 M H<sub>2</sub>SO<sub>4</sub>

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Acidic solutions are usually used in industry for variety of purposes such cleaning and descaling of metallic parts; however, such processes are accompanied with the problem of corrosion which is considered as one...

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## Free Fatty Acids Esterification on Palm Oil Sludge using Zirconia-supported Indonesia Natural Zeolite as Heterogeneous Catalyst

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction The biodiesel development as the sources of alternative renewable energy to substitute diesel fuel from crude oil has gained more attention in the last few decades due to the decreasing of fossil fuel...

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## Identification and Antibacterial Evaluation of Selected Jordanian Medicinal Plants

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Plants are still being used as integral part of the primary healthcare, in developing countries, though synthetic medicinal drugs are available worldwide. Due to the emergence of new resistant pathogens to the most...

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## Applications of Aquaponics on Pakcoy (Brassica Rapa L) and Nila Fish (Oreochromis Niloticus) to the Concentration of Ammonia, Nitrite, and Nitrate

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Introduction The world is currently faced with increased human population resulting in a high demand for energy, food, and water. Man's quest to solve her ever-increasing needs has led to climate change, scarcity of...

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## Recombinant Triplex formed by PNA-TFO: A Molecular Dynamics Simulation Study

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Triplex-forming Oligonucleotides (TFOs) are short oligonucleotides binds in major groove of double helical DNA and form DNA triplex. The triplex formation play important role in most of the vital function as in replication,...

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## Data on the Microstructure and Passivation Behavior for Austenitic Nickel-Chromium (NO7718) and Nickel-Chromium-Aluminum-iron (NO7208) Nickel Alloys in Corrosive Media

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Austenitic nickel-chromium (NO7718) and nickel-chromium-aluminum-iron (NO7208) alloys are wrought, gamma-prime strengthened and high-performance alloys with excellent attributes including good mechanical strength, resistance to thermal creep deformation, excellent surface stability, and very high resistance...

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## Development and Validation of Rapid, Sensitive Rp-Uplc Method for Determination of Related Impurities in Dextrabeprazole Sodium

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Dextrabeprazole sodium (DEX•Na) is R (+)-isomer of Rabeprazole, (2- [[4-(3-methoxy propoxy)-3-methyl-2pyridinyl]-methyl] sulfinyl]1H-benzimidazole). 1,2,3 It belongs to a class of anti-secretory compounds that exhibit neither anti cholinergic nor histamine H2 receptor antagonist properties. However, DEX•Na suppresses...

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## Comparison of Iron Reduction Methods on the Determination of Antioxidants Content in Vegetables Sample

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Lately, consumption of health supplements undergo a sharp increase as part of human awareness to improve their health. In general, these supplements are plant products believed to reduce the risk of a number...

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## Standard Quality and Antibacterial Activity Tests of Clove Oil in Solid Soap Production Against Staphylococcus Aureus, Staphylococcus Epidermidis and Escherichia Coli

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Solid soap is a skin cleanser made of saponification or neutralization process of fat, oil, wax, rosin or acid with organic or inorganic bases without causing irritation.1 The soap can be produced using...

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## Preparation of N-TiO2/PbS Nanocomposite Using Successive Ionic Layer Adsorption and Reaction (SILAR) Method

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Solar energy, a clean, non-polluting, safe, and unlimited energy, has been proposed to alternatively replace the nonrenewable energy sources, such as coal and oil.1 The availability of solar energy in the form of...

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## HPLC Analysis of Chemical Composition of Selected Jordanian Medicinal Plants and Their Bioactive Properties

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Introduction Huge developments in the pharmaceutical industries and chemistry are taking place nowadays, due to new findings in herbal medicine. Plants were used as the important sources of most drugs for eliminating pain and...

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## Biopolymer Coated Coreshell Magnetite Nanoparticles for Rifampicin Delivery

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Introduction Nanotechnology is currently trending and is being extensively researched due to their optical, magnetic, bioimaging,<sup>1</sup> electrical properties<sup>2</sup> and many more, obtained due to its large surface area to volume ratio. In this broad...

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## A Correlation Study Between the Concentrations of Gold, Iron and Sulphate in Quartz Rock Samples Obtained from four Different Locations in Sudan

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Introduction Gold is widely distributed throughout the world, normally in very low concentration and generally in native form as metal. It is shiny yellow, soft and chemically inert metal. Gold belongs to the group...

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## Synthesis, Characterization and Herbicidal Activity of Amide Derivatives of Glyphosate

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Agrochemicals have become global necessity to increase crop productivity in agricultural fields.<sup>1-5</sup> Nowadays they play a pivotal role in controlling not only the pests and rodents but also many microbial infections.<sup>5-7</sup> There are...

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## Optimization of Lipase-Catalyzed Synthesis of Fatty Hydroxamic Acids from Terminalia Catappa L. Kernel Oil

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Hydroxamic acid (N-hydroxy carboxylic acid) is a derivative compound of nitrogen compound that binds hydrogen in its hydroxylamine molecular with -CO-NH-OH (R = alkyl or aryl).<sup>1</sup> Hydroxamic acid derivatives have received much attention...

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## Quantitative Structure Activity Relationship (QSAR) Based on Electronic Descriptors and Docking Studies of Quinazoline Derivatives for Anticancer Activity

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Cancer is a diseases which have an uncontrolled and abnormal growth. There were 1.688.780 new cancer cases diagnosed in 2017 and about 600.920 of Americans die or equally 1.650 people per day. Lung...

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## Synthesis, Characterization and Cytotoxic Activity of some new 1,2,3-Triazole, Oxadiazole and Aza- $\beta$ -lactam Derivatives

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction A wide ranging of various heterocyclic compounds has been discovered to develop pharmaceutically essential molecule. Among them which have played a significant role in medical chemistry were oxadiazoles derivatives.<sup>1,2</sup> Which has been commonly...

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## Study of Potential Phenolic Compounds from Stems of Dendrophthoe Falcata (Loranthaceae) Plant as Antioxidant and Antimicrobial Agents

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Loranthaceae is a parasitic plant widely used in traditional Chinese medicine systems. One of this species is *L. parasiticus* which is known as Sang Ji Sheng (in Chinese), parasites (in Malay) and baso-Kisei...

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## Calcareous Deposits and Effects on Steels Surfaces in Seawater – A Review and Experimental Study

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction The usefulness of seawater is multifarious especially in the areas of transportation, holding engineering infrastructures, telecommunications, and cooling reservoir in diverse manufacturing and engineering services and in military (naval) activities, water drinking through...

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## Preparation and Characterization of Indium and Gallium doped Transparent ZnO Films for Solar Cell Applications

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Introduction Solar cells consist of various materials, each performing a specific function which contributes to the overall efficiency of the solar cell. The Transparent Conducting Oxide/Film (TCO) is an important component of the solar...

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## Chemical Structure of Kerogen of Shale Formations. (By the Example of the Shale Formations of the East European Platform)

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Introduction Kerogen, which is the most important source of hydrocarbons, is one of the main objects of organic geochemistry. The term "kerogen" is understood to mean all OM of sedimentary rocks (oil shales and...

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## Electronic Structure Mechanism of Axial Ligands on Itinerant Electrons and Negative Magnetoresistance in Axially-Ligated Iron(III) Phthalocyanine Molecular Conductors

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Phthalocyanine (Pc) is a planar molecule composed of four circular N-linked isoindole rings forming a fully-conjugated 18 p-electron system – ideal structural and chemical characteristics as building blocks of functional materials. In recent...

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## pH Dependence of Size Control in Gold Nanoparticles Synthesized at Room Temperature

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Research on nanoparticles has been significantly increased during the past decade because their unique physical and chemical properties. Metal nanoparticles have a wide range of application, such as biotechnology, microelectronics, catalysis, and also...

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## Enhancing the Light Harvesting Efficiency, open Circuit Voltage and Stability of Molybdenum Doped (ZnO)<sub>6</sub> Nanocluster in Dye-Sensitized Solar Cells: A DFT Study

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Introduction Nanostructured materials are currently of prodigious attention due to their reduced dimensions and are majorly take part in a large number of new devices. Among the renewable energy sources, solar energy is the...

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## Effect of Shape and Size on Curie Temperature, Debye Frequency, Melting Entropy and Enthalpy of Nanosolids

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction The physico chemical properties of the nanosolids are a function of its shape and size. Nanoparticles with diameter varying from a few nanometers to several hundreds of nanometers are of great interest for...

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## Molecular Dynamics Simulation of Methane and Carbon Dioxide Permeation Through A Layered Inorganic Membrane

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction A lot of efforts to address problems in environment and industrial process rely on gas separation techniques. Methane and carbon dioxide gases have been a long-time subject of research interest due to their...

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## In Vitro Cytotoxicity of the Synthesized Gallic Acid Derivatives (N-Alkyl Gallamide) Against Breast MCF-7 Cancer Cells

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Breast cancer is a frequent diagnosed malignancy in females, and considerably the second most common human carcinoma in the world. In 2012, there were approximately 1.67 million of breast cancer cases which has...

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## Newly Synthesized Oxadiazole Based Mannich Base Derivatives of Fatty Acid: In Silico Study and in Vivo Anti-Hyperglycaemic Estimation

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Diabetes mellitus type 2, a chronic metabolic dysfunction describes a distinctive nature of fasting hyperglycaemia. The hyperglycaemia that leads to blooming complications is an outcome of deformation of various metabolic reaction of body....

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## In vitro Antacid Screening of the Aqueous and Ethanolic Leaf Extracts of *Ixora Coccinea* (Linn.) and *Mimosa Pudica* (Linn.)

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Due to the high prevalence of peptic ulcer, there is an increasing demand for a new anti-ulcer drug. In the Philippines alone, 4,135 peptic ulcer cases were reported in 2007.<sup>1</sup> Common antacid preparations that...

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## An Innovative Application of Nano-Technology in the Production of Hybrid Inorganic-Organic Coatings of Crude Oil Tanks

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Recently Nanotechnology application gained momentum, and environmental impact. Due to their extremely fine grain size and high grain boundary volume fraction Nano composites are known.<sup>1-4</sup> Nano technology used in agricultural systems, biomedicine, environmental...

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## Kinetics of Lycopene Degradation in Sunflower and Grape Seed Oils

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Lycopene ( $\psi,\psi$ -carotene), the carotenoid responsible for the deep red color of ripe tomatoes and tomato products, is one of the most potent natural antioxidants.<sup>1</sup> Chemically, lycopene is an acyclic tetraterpene hydrocarbon with 13 C-C...

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## Inhibitory Reactivity of Capsaicin with $\alpha$ -Amylase and $\alpha$ -Glucosidase Related to Antidiabetes using Molecular Docking and Quantum Calculation Methods

21 Oct, 2018 [Volume 34, Number 5](#)

Introduction Nowadays, diabetes is known as the most dangerous disease killing more people than cancer and AIDS combined. Actually, it is said to be a modern disease, and has traditionally been viewed as a...

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### Drug Repurposing Against Phosphomannomutase for the Treatment of Cutaneous Leishmaniasis

Sabahat Yasmeen Sheikh<sup>1</sup> , Waseem Ahmad Ansari<sup>2</sup> , Firoj Hassan<sup>1</sup> , Mohammad Faheem Khan<sup>2</sup> , Syed Shah Mohammed Faiyaz<sup>4</sup> , Yusuf Akhter<sup>3</sup> , Abdul Rahman Khan<sup>1</sup> and Malik Nasibullah<sup>1\*</sup>

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G. Sankar<sup>\*</sup>

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### Pharmacognostic Characterization and Antacid Activity of Aqueous Extract of Desmodium triflorum Linn and Pogostemon heyneanus Benth

W.J.A. Banukie Jayasuriya<sup>1\*</sup>, L. D. A. Menuka Arawwawala<sup>2</sup>, Shashani Gamage<sup>1</sup>, Himanshi Rathnasekara<sup>1</sup>, Bhavantha Dias<sup>1</sup>, Sugandhika Suresh<sup>3</sup>

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### Antimicrobial Activity of Calix[4]Pyrrole-entrenched Silver Nanoparticles and its Application as Colorimetric and Spectrophotometric Sensing of L-Histidine

Nandan C. Poma<sup>1</sup> , Keyur D. Bhatt<sup>1\*</sup> , Dinesh S. Kundariya<sup>2</sup>

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## Computational Study of the Keto-Enol Tautomerism of 3-Phenyl-2,4-Pentanedione in the Gaseous Phase and Solvents Using DFT Methods

Musa E. Mohamed Babiker<sup>1\*</sup> , Ahmed A. Alzharani<sup>1</sup>  and Ayyob M. Bakry<sup>2</sup> 

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