Himpunan Kimia Indonesia

6th ICICS 2017

South Sumatera

The 6th International Conference of the Indonesian Chemical Society 2017

PROGRAMME AND ABSTRACTS BOOK

Palembang, Indonesia October 15 – 20, 2017

http://icics.kimiawan.org

The 6th Himpunan Kimia Indonesia (HKI) annual conference on Tue-Wed, 17-18 October 2017, is organized by South Sumatera Branch of HKI in collaboration with Sriwijaya University (Unsri) and South Sumatera Province. South Sumatera was selected as the location for 2017 HKI annual conference in HKI National Meeting 2014, 3 years ago, in Ambon, Maluku. This is a bilingual conference (Indonesian and English), which means that the paper can be written in English or Indonesian language (Bahasa Indonesia), and the presentation can be delivered in English or Bahasa Indonesia.

Before, parallel to, or after the conference, there will be several satellite activities (workshop, etc.), including a meeting of the Forum of Head of Chemistry Departments in Indonesia (Temu Forum Ketua Jurusan/Prodi Kimia dan Pendidikan Kimia se-Indonesia 2017, Temu FKJKI-2017), contact: fkjki-2017@kimiawan.org) that will be started in the evening (19.00) of 17 October 2017. Any chemistry-related communities/institutions could register other satellite activities (one-day workshop, symposium, training, etc.) to icics-2017-satellite@kimiawan.org, to be offered to conference attendees. Satellite activities could be held in any date between 3 October to 31 October 2017.

One day before the conference, on Monday, 16 October 2017, HKI Congress will be held to find the next President-Elect of HKI. The elected person will be the next President-Elect of the Indonesian Chemical Society from 1 January 2018 to 31 December 2018, while Dr. Tatas Brotosudarmo will be the President of HKI.

Speach by Chairman

Assalamualaikum waromatullahi wabarakatu,

Dear Distinguished Guests and Participant,

We cordially welcome you to the 6th International Conference of Indonesian Chemical Society in Palembang South Sumatera. This conference is organized by the Indonesian Chemical Society (HKI) and Chemistry Department Faculty of Mathematics and Natural Sciences Sriwijaya University (Unsri) supported by LPPM Unsri.

I would like to inform some formal information related to this conference. The conference's theme is "Stimulating of Advanced Perspective and Current Concepts on Chemistry field". The goals of conference are to provide a vehicle the state of the art in research results and trends in chemistry field, to offer interaction, discussion and possible collaboration among chemist and the public about chemistry, to increase awareness of policy makers and public on chemistry's rule in national development. This conference consists of 4 keynotes speakers from USA, Japan, Solomon Island, 8 invited speakers, and 229 participants who deliver as oral or poster presenters. Accompanying this conference, there are some activities: Indonesia high level meeting on chemical security by Sandia USA (15-16 October), Congress of PNHKI (16-17 October), FKJKI meeting (18 October), and Palembang city tour (19 October).

We are sincerely grateful to welcome honorable keynote speakers, distinguished invited speakers and excellent of participants for sharing their knowledge in this conference.

The keynote speakers in this conference are :

1. Dr. Andrew W. Nielson (Sandia National Laboratories, USA)
2. Prof. Hisao Yoshida (Kyoto University, Japan)
3. Prof. Dr. Basil Shelton Marasinghe (Solomon Island National University, PNG)
4. Drs. Muhammad Abdulkadir Martoprawiro, Ph.D (ITB, Indonesia)

The Invited Speakers are :

1. Prof. Dr. Subandi (UM, Indonesia)
2. Prof. Dr. Suyanta (UNY, Indonesia)
3. Prof. Aldes Lesbani, PhD (Unsri, Indonesia)
4. Dr. Jarnuzi Gunlazuardi (UI, Indonesia)
5. Dr.rer.nat. Didin Mujahidin (ITB, Indonesia)
6. Dr. Muktiningsih Nurjayadi (UNJ, Indonesia)
7. Dr. Sal Prima Yudha S. (Unib, Indonesia)
8. Prof. Dr. Muhammad Bachri Amran (ITB, Indonesia)
9. Dr.rer.nat. Ria Armunanto (UGM, Indonesia)

I would like also to express thanks and appreciation to the organizing committee for their cooperative work and efforts to make our conference a success.

Finally, I would like to thank to all participants and their respective institutions that have made this conference possible and I wish you all have a pleasant meeting.

Waalaikumsalam warohmatullahi wabarakatuh

Hermansyah, M.Si., Ph.D.

Chairman of Organizing Committee

The 6th International Conference of Indonesian Chemical Society

Forward by the Dean

In the Name of Allah, the Most Beneficent, the Most Merciful.

It gives me a great pleasure to welcome you to the 6th International Conferences of Indonesian Chemical Society (ICIC) 2017 organized by the Department of Chemistry Faculty of Mathematics and Natural Sciences University of Sriwijaya in collaboration with the Indonesian Chemical Society. The theme for this conference is "*Stimulating of Advanced Perspective and Current Concepts on Chemistry Field*".

I am very happy and grateful that many distinguished Academicians, Scientist, Researchers and practitioners of Chemistry have come from both home and abroad to share their knowledge and experience. On behalf of the Faculty of Mathematics and Natural Sciences University of Sriwijaya, I would like to take this opportunity to express our deep appreciation for all of national and international keynote speakers as well as invited speakers for their willingness to come to Palembang and honoring us a keynote speeches for this conference. I also wish to give special thanks to the Sandia America that has hold a special workshop on the "*Indonesia high level meeting on chemical security*" for the last two days. Last but not least, I would like to extend our appreciation to the Indonesian Chemical Society, government, university colleagues and companies for their continued and invaluable support to make this meeting a success.

I sincerely wish you would have most productive days of interesting and stimulating discussions. I believe that this conference is a great opportunity not only for sharing knowledge and experience in chemical research, but also for starting a long and fruitful cooperation and friendship among Academicians, Researchers and practitioners of Chemistry.

Finally, I would like to thank and congratulate the organizing committee for their dedication and tremendous efforts in organizing the conference. I wish you all an enjoyable meeting and fruitful discussion.

Prof. Dr. Iskhaq Iskandar, M.Sc.

Dean, Faculty of Mathematics and Natural Sciences
University of Sriwijaya

Speach by Rector of Sriwijaya University

Bismillahirrohmaanirrohim

Assalamualaikum warohmatullahi wabarakatuh,

In the name of Alllah SWT and all praise belongs to Him who is blessing us today to come and attend this important conference.

In accordance with the university status as a research university, it is important for the university to disseminate new research findings and discoveries in the community, the nation and the world. I am pleased that Chemistry Department Faculty of Mathematics and Natural Sciences Sriwijaya University (Unsri)supported by LPPM Unsri collaborate with the Indonesian Chemical Society (HKI) have organized the sixth international conference of Indonesian chemical society (ICICS) in Palembang.

With the theme of this conference, "Stimulating of Advanced Perspective and Current Concepts on Chemistry field". I believed that this conference served as platform for the discussion and dissemination of research findings information on research trends, and latest development in the area of chemistry. It is hoped that this meeting of academicians, researchers,and professionals from universities, government institutions, research institute, and private companies can lead to much bigger things in the future.

Therefore, I sincerely expect this conference generate more cooperation in research and education. Such cooperation can lead to progress in all areas of chemistry for the welfare of mankind.

By this conference also I hope that it facilitates Indonesian chemists to publish their research results in reputable journal/proceeding.

I am sincerely grateful to welcome honorable keynote speakers, distinguished invited speakers and excellent of participants for sharing their knowledge in this conference.

This conference will be able to meet our goals and objectives and provide a rewarding experience to all participants, from local and international. My appreciation also goes to the organizing committee for making this conference a success.

I take this opportunity to thank and to appreciate the Sandia and CRDF United State of America which have hold the workshop on 'Indonesia high level meeting on chemical security' on October 15-16, 2017.

Congratulation also address to Indonesian chemical society and head of chemistry department from Universities in Indonesia for their annual national meeting and congress during this conference.

Finally, in anticipation of successful conference, in the name of Allah, the beneficient, the merciful.

"Bismillahirrohmaanirrohim"

I hereby officially open the 6th International Conference of Indonesian Chemical Society 2017"

Good luck, I wish you all an enjoyable meeting and fruitful discussion.

Wassalamualaikum Warohmatullohi wabarakatuh.

Prof. Dr. Ir. AnisSaggaf, MSCE.
Rector of Sriwijaya University

Conference Activities

TIMELINE		ACTIVITIES
Sunday, Oct 15, 2017	09.00–16.00	High Level University Meeting on Chemical Security **(Sandia Laboratory, USA)**
Monday, Oct 16, 2017	09.00–16.00	High Level University Meeting on Chemical Security **(Sandia Laboratory, USA)**
	13.00 – 17.00	**Indonesian Chemical Society Forum Meeting**
Tuesday, Oct 17, 2017	08.00–16.00	ICICS Seminar
	19.00-21.00	Indonesian Chemical Society Congress
Wednesday, Oct 18, 2017	08.00–16.00	ICICS Seminar
	08.00–16.00	Department Chief of Chemistry Meeting
Thurday, Oct 19, 2017	08.00–16.00	**City/Musi Tour**
	13.00–17.00	**Computational Chemistry Workshop**
Friday, Oct 20, 2017	08.00–16.00	**Computational Chemistry Workshop**

keynote SPEAKERS

Prof. Hisao Yoshida,
Kyoto University, Japan

Andrew W. Nelson, Ph.D, MPH
Sandia Lab, USA

Prof. Dr. Basil Shelton Marasinghe,
Solomon Islands National University, PNG

Drs. Muhamad Abdul Kadir Martoprawiro, PhD
Chemical Society, Indonesia

invited SPEAKERS

Prof. Jarnuzi Gunlazuardi, Ph.D.
Universitas Indonesia

Prof. Aldes Lesbani, Ph.D.
Universitas Sriwijaya

Dr. rer. nat. Didin Mujahidin
Institut Teknologi Bandung

Dr. Muktiningsih Nurjayadi
Universitas Negeri Jakarta

Dr. Salprima Yudha S.
Universitas Bengkulu

Dr. Suyanta
Univ. Negeri Yogyakarta

Prof. Dr. Subandi
Univ. Negeri Malang

Prof. Dr. Muhammad Bachri Amran
Institut Teknologi Bandung

Dr.rer.nat. Ria Armunanto.
Universitas Gadjah Mada

keynote SPEAKS

Photocatalysis in various chemical reactions

Hisao Yoshida*

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Photocatalyst can catalyze various chemical reactions by using photoenergy. When the semiconductor photocatalyst absorbs a photon, an excited electron and a hole are generated at the conduction band and the valence band, which can promote reduction reaction and oxidation reaction, respectively, at the surface. This mechanism is quite different from that of the conventional catalysis, that is, the adsorption of the molecule makes the molecule be active. The application of photocatalysis can be classified into three: utilization for environmental application, energy conversion, and unique chemical reactions. The first is nowadays quite popular in literature: the photocatalysts can promote degradation of many kinds of organic compounds even in aqueous solutions, in air, or on the surface of materials to keep them pure and clean. This will contribute to the comfortable environment of our life. The second is the solar energy conversion to chemical potential, e.g., hydrogen production via water splitting, carbon dioxide conversion to useful chemicals and so on. This class is quite important for utilization of the sustainable solar energy and contribute to solving the energy and environmental issues. The last is also attractive: photocatalyst can realize new types of catalytic reactions that cannot proceed in the conventional methods. These kinds of photocatalyses will open a new field of chemistry. In the lecture, I will introduce several unique photocatalytic reactions by using some kinds of photocatalysts that we have developed so far, such as methane conversion, reduction of carbon dioxide, and organic synthesis.

Keywords: hydrogen, splitting, semiconductor, energy, conversion

Advancing Chemical Sciences in Indonesia by Attracting More Students to Chemistry

Basil Marasinghe*

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In order to advance chemical sciences in any country, it is important to get best students to study chemistry. To achieve this object, chemistry has to be made very attractive to students. 10-15 years ago, chemistry was not an attractive subject among undergraduates in Papua New Guinea. 12 years ago the author set about introducing several measures to make chemistry more popular among undergraduates. They included the use of information technology, introduction of weekly industrial visits and work experience programs in chemical industries, moving away from tests and examination being memory based to those based on understanding concepts and processing of knowledge, making learning more students centred than teacher centred, discussions on ethnochemistry and last but not least, addition of some humour to chemistry. This paper details some of these measures which most probably have led to a significant turnaround in students' attitude to the subject and its increased popularity among them.

Keywords: ethnochemistry, ethnomedicine

The Evolution of Chemical Risk Management

Andrew W. Nelson

International Biological and Chemical Treat Reduction Sandia National Laboratories, Albuquerque, USA

Abstract / presentation could be downloaded from:

docs.kimiawan.org/icics/andrew.pdf

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Computational Chemistry in Indonesia

Muhamad Abdul Kadir Martoprawiro*

Department of Chemistry, Institut Teknologi Bandung

Abstract / presentation could be downloaded from:

docs.kimiawan.org/icics/muhamad.pdf

If requested, fill in user: **icics** password: **2017** *invited SPEAKS*

Artificial Photosynthesis for Water Splitting: New Device Type Based on Modified Dyes Sensitized Solar Cell Having Catalysis Zone Extension.

Jarnuzi Gunlazuardi

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Water splitting induced by visible light is one of the interesting tasks to produce hydrogen (fuel). However to split water in to hydrogen and molecular oxygen by visible light induction is a difficult task. Titania (TiO_2 crystal) was reported being able to split water[)], but need light with wave length less than 410 nm. Fortunately, titania can be composited with other small band gap semiconductor but has a conduction band level slightly higher (e.g. CdS). The visible light excites electron of CdS to its conduction band, that will flow down to the titania's conduction band. Hence the CdS/Titania system is considered as visible light active semiconductor composite. Having this system along with ability to morphologically control of highly ordered titania nanotubes array film[)], we developed a system that have a potential to produce hydrogen from water under induction of visible light. A Highly Ordered Titania Nanotubes (HOTN) arrays have been successfully prepared by electrochemical oxidation of titanium metal sheet in a viscous electrolyte. The electrolyte comprises of ethylene glycol and water containing fluoride ion. By varying anodization voltage and time, at certain electrolyte composition, a typical tube length (2 - 7 µm) , inner tube diameter (40 – 80 nm), and thickness of the tube's wall (10 – 27 nm) can be controlled. The prepared HOTN then was sensitized by CdS nano particle by a SILAR (successive ionic layer adsorption and reaction) method[6)]. The resulting CdS/HOTN showed excellent response toward visible light. The obtained CdS/HOTN then was employed to construct a modified dyes sensitized solar cell (DSSC) having catalysis zone extension. To assembly the modified DSSC, the HOTN sheet was prepared carefully, in which half part of HOTN was sensitized by CdS (hence CdS/HOTN), dedicated as DSSC zone and another half part was leave it uncovered, managed as catalysis zone. The DSSC zone is a sandwich of CdS/HOTN, electrolyte (Na_2S/S; KCL in methanol water), and Pt/SnO_2-F Glass. Upon absorbing light, the CdS in the DSSC produce exited electron that flow to titania and subsequently migrate to the catalysis zone. The "hot" electron in the catalysis zone eventually reduce proton (water) in its adjacent to generate hydrogen. The deficit electron in CdS semiconductor (valence band) will be compensate by electrolyte in the DSSC zone, which will have uptake electron from the counter electrode in catalysis zone. So in the catalysis zone there will be reduction reaction of water (proton) to produce hydrogen (acceptor electron from the DSSC zone) and oxidation reaction of water to produce molecular oxygen or hydroxyl radical (donor electron to the DSSC zone). As long as light strike the DSSC zone the catalysis zone will eventually produce hydrogen.
The above modified DSSC which employing CdS/HOTN absorb visible light and convert it to energy which induce a chemical reaction in the catalysis zone to produce hydrogen from water. In our typical modified DSSC, when the active counter electrode (semiconductor) was being employed, the system can split water to hydrogen and molecular oxygen, by solely visible light, thus a kind of artificial photosynthesis. The proof of concept and features for further development will be discussed.

Keywords: Water Splitting; Hydrogen; Titania nanotubes; Cadmium Sulfide; Artificial photosynthesis

Supramolecular Ionic Crystals Based on Polyoxometalates-Organometallic Complexes

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Polyoxometalates are early transition metal oxygen anions clusters, which have various properties such as acid bases, redox potentials, shapes and structures, and solubility depending on counter ions. The researches of polyoxometalates are rapidly growing in this decade due to application not only in laboratory but also in industrial scales such as supramolecular building blocks, catalysis, membranes, adsorbents, and also sensors. In this report, polyoxometalates are used as anions in reaction with organometallic complexes as cations to form supramolecular ionic crystals. Several kinds of polyoxometalates and organometallic complexes are used in order to know the structural effect for formation of supramolecular ionic crystals. The applications of these supramolecular ionic crystals are also addressed especially for separation and catalysis.

Keywords: ionic crystal, polyoxometalate, organometallic complexes

The Utilization of Palm Oil as Renewable Block Building Source in Chemical Industry

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Palm oil is one of the important national commodity and contributes significantly to the national income in Indonesia. Modern chemical reaction can modify the palm oil components into fatty acid derived high economic value materials, in addition to the palm oil utilization in food industry, traditional oleochemicals and fuels. Oleic acid is the major components in palm oil with a content of ca. 40%. Ethenolysis of methyl oleate successfully furnished methyl 9-decenoate and 1-decene via cross olefin metathesis reaction in the presents of Grubbs II catalyst. Valorization of methyl 9-decenoat as a new building block have an important role as renewable building block on further transformation to produce many high-value chemicals. In this presentation, we will show the transformation of methyl 9-decenoate in the synthesis of several potential monomers and the synthesis of civeton. The well-defined strategy on a target-oriented transformation could be a great contribution of organic chemical synthesis in improving the economic value of palm oil.

Keywords: palm oil, oleic acid, olefin metathesis, renewable building block.

Immunogenicity Evaluation of Recombinant Fim-C *S. Typhi* Protein as Typhoid Vaccine Candidate on Wistar Rat to Increase the Quality of Urban Health in Indonesia

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Typhoid fever is a world health problem and often occurs in developing countries, including Indonesia. The cause of typhoid fever in humans is *Salmonella typhi* bacteria. Transmission of the disease is generally through a pattern of life that is less healthy and hygienic. In a previous study, the UNJ Salmonella team had successfully isolated, cloned, expressed, and purified recombinant protein Fim-C *S. typhi* inclusion bodies sized 31 Kilo Dalton (KDa). Furthermore, these proteins have been used as antigen in immunogenicity test with ddY mice as test animals and give excellent results. This study aims to determine the immune response of rodent test animals with higher levels against recombinant protein Fim-C *S. typhi* inclusion bodies as antigen. Immunogenicity test was performed using male Wistar rats. That were divided into five test groups: Normal group (control, without injection), Control Group 1 (injected with PBS), Control Group 2 (injected with Adjuvant FCA/FIA), Samples Group 1 (injected with Fim-C Inclusion Bodies S. typhi protein), Samples Group 2 (Injected with Fim-C Inclusion Bodies S. typhi plus Adjuvant FCA/FIA protein). The results of the ELISA (Enzyme-Linked Immunosorbent Assay) analysis showed an increase in antibody titers produced by Wistar rats after subcutaneous injection with Fim-C protein emulsified adjuvant or without adjuvant. The result of analysis by Western Blot method showed the specific interaction between Fim-C *S. typhi* antigen with anti-Fim-C *S. typhi* antibodies. Data obtained from both methods confirm that the antigen has a high immunogenicity. It can be concluded that recombinant protein Fim-C *S. typhi* inclusion bodies can be used as a potential vaccine candidate for typhoid disease. These results are expected to be an alternative in the discovery of new vaccines that can improve the quality of life of Indonesian society.

Keywords : Typhoid Fever, Fim-C S. Typhi, Recombinant Protein, immunogenicity test, Wistar Rat

Biomolecules-Mediated Synthesis of Gold and Silver Nanoparticles: Recent Developments

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An environmentally-friendly approach was developed to synthesize gold and silver nanoparticles using biomolecules. The biomolecules were extracted using demineralized water and the extracts were used to reduce silver or gold cations to form silver and/or nanoparticles. In general, the reactions were carried out under open air condition at room tempeature (without any elevated temperature). Their characterizations along with some applicationshave also been discussed.

Electrocoagulation Technic for Improvement Quality of Swimming Pool Water

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This study aims to improvement quality swimming pool water by electrocoagulation process. The condition electrocoagulation are find to make good process and determine the quality of the water pool based on the parameters of Ca^{2+} concentration, pH, and TDS, after electrocoagulation process is carried out according to Indonesian Ministry of Health Regulation No. 416 / Menkes / Per / IX / 1990. The object of this research was the optimum condition electrocoagulation efficiency to remove of Ca^{2+} metal ions, pH and TDS in the FIK's swimming pool water, Yogyakarta State University. Optimization of the electrical voltage was done on variation 2, 4, 6, 8, 10 and 12 volts and optimization of the time electrocoagulation process was done on variations of 2, 4, 8, 16 and 24 hours. Parameters used are concentration of Ca^{2+} in the water, TDS and pH. Effectiveness of the electrocoagulation based on the graph, the separation efficiency of Ca^{2+} metal ion, TDS and

pH values. The samples were analyzed using Atomic
Absorption Spectroscopy (AAS), TDS meter and pH meters. The results showed the optimum potential is 10 volt and the optimum time of electrocoagulation process is 24 hours. The quality of the water pool based on the pH parameter after electrocoagulation process according to Indonesian Ministry of Health Regulation No. 416 / Menkes / Per / IX / 1990 is well as water quality standard swimming pool is pH 6.7 and TDS 231,3.

Keywords: electrocoagulation, swimming pool water.

Exploration of Herbal Anti Gout Drug: A Case Study on Xanthin Oxydase Inhibitor

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The gout prevalence was increase sharply in recent decade. On other hand, as a mega-biodiversity country, Indonesia is a home to 11 percent of the world's flowering plant species and potencial as resource of many bioactive metabolites, including herbal antigout drug. Therefore, the herbal antigout exploration by biochemical studies is important to do. In this paper we presented some results of our preliminary exploration on herbal juice and extract that have activity as xanthin oxydase inhibitor, so they have potency as anti gout drug. Among them are seed peel extract of: melinjo (Gnetum gnemon), mangoosten (Garcinia mangostana), peanut (Arachis hypogaea L.), extract of soursop (Annona muricata) and sugar apple (Annona reticulata) fruit.

Keywords: :xanthine oxidase inhibitor, herbal anti gout, soursop, sugar apple

Structural and Dynamical Properties of Solvated Be(II) Ion in liquid ammonia: A Quantum Mechanical Charge Field Molecular Dynamics Simulation Study

Priyagung Dhemi Widiakongko, Bambang Setiaji and Ria Armunanto

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A quantum mechanical charge field molecular dynamics simulation study of structural and dynamical properties of solvated Be(II) ion in liquid ammonia using was carried out. The first and second solvation shell were treated by quantum mechanics at Hartree-Fock level of theory, and the outer region of the system was described using coulombic potential. The structure was evaluated in terms of radial and angular distribution functions and coordination number distributions. Ligand exchange processes between coordination shells have been investigated and evaluated. A rigid structure was observed for the first solvation shell showing a tetrahedral coordinated $Be(NH_3)_4^{2+}$ complex with a Be-N averaged distance of 1.745 Å. The second solvation shell shows a labile structure with large number of successful ligand exchange. The simulation result has a good agreement with the experiments.

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Fatty Acids From Microalgae *Botryococcus braunii* For Raw Material of Biodiesel

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Abstract. One of the alternative sources of renewable energy that can overcome the environmental crises and the current fossil energy crisis is microalgae. Microalgae contain fatty acids that can be converted into biofuel products, such as biodiesel. This study was a preliminary research which was conducted to determine the amount of fatty acids contained in microalgae and its potentiality to be converted into biodiesel. The microalgae used in this study were *Botryococcus braunii*. Data collection of fatty acids of *Botryococcus braunii* were obtained by the direct analysis in the laboratory using an instrument in the form of gas chromatography mass spectrometry (GC-MS) and also obtained from literature study in several research of previous researcher. Based on that, it was found out that *Botryococcus braunii* contained with oleic acid ranged from 15.65 – 35.85%, linoleic acid 3.05 – 23.15%, palmitic acid 4.03 – 22.13 % and stearic acid 0.48 – 15.41%. The profile and fatty acid content of this preliminary study could be one of the decisive parameters in the selection of microalgae species. Based on results concluded that *Botryococcus braunii* had good potentiality to be converted into biodiesel because the ratio of saturated and unsaturated fatty acids in this species is not much different.

1. Introduction

Over the last decade, the issue of environmental crises and the fossil energy crisis has become one of the global issues that motivates researchers in the world to conduct research concerning alternative and renewable energy. Oil-based biofuel derived from plants is one of the many solutions developed due to the availability of abundant raw materials and fairly simple production technology [1]. One research on biofuels that is being developed to be an alternative is to use photosynthetic microorganisms in the form of microalgae that are converted into biodiesel [2].

Microalgae, according to Mata et al. (2010), is a prokaryotic or eukaryotic photosynthetic microorganism whose growth is very productive and can outperform other land plants and is considered efficient enough to be used as biofuel due to the high fat or oil content and product of the photosynthesis from microalgae is also very high around 3 – 8%, while for land plants it only reaches 0.5% [3-4]. The potential comparison of some types of biodiesel raw materials can be seen in Table 1.

Table 1. Comparison of the Potential of Some Biodiesel Raw Materials [5]

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Raw Material	Produced Lipid Yield (L/Ha)	Required Area Width (M ha)
Corn	172	1,540
Soybean	446	594
Canola flowers	1,190	223
Jatropha curcas	1,892	140
Coconut	2,689	99
Oil palm	5,950	45
Microalgae[a]	136,900	2
Microalgae[b]	58,700	4.5

[a]70% lipid assumption in biomass (% dry weight)

[b]30% lipid assumption in biomass (% dry weight)

One type of microalgae that can be utilized to biodiesel is Botryococcus braunii. Botryococcus braunii is a single green cell microalgae and is commonly found in the lakes, ponds, or brackish waters and the sea with a chlorophyll content of ± 1.5 – 2.8%. Botryococcus braunii has a cell nucleus with a size of ± 15 – 20 μm and lives in colonies. It is non-motile and each movement is strongly influenced by the flow of water. Botryococcus braunii is a potential source of renewable energy raw materials because this type of microalgae contains many hydrocarbon compounds. According to Samori et al. (2010), in the hydro cracking process of this type of microalgae, distillate can produce 67% gasoline, 15% aviation fuel, 15% diesel fuel and 3% residual oil. Fat content (fatty acids) of this type of microalgae is also quite high, ranging from 40 – 85%. In the process of photosynthesis, Botryococcus braunii also contributes significantly in reducing CO2 emissions, namely 1.5×10^5 tons y^{-1} per 8.4×10^3 in the microlaga cultivation area [6-8]. The compounds composition contained in Botryococcus braunii is shown in Table 2.

Figure 1. Microscopic of Botryococcus braunii [9]

Table 2. Compounds Composition in *Botryococcus braunii* [10]

Compound Type	Composition (%)
Chlorophyll a	0.4
Carotenoids	1.2
Protein	17.8
Carbohydrates	18.9
Lipid	61.4

Lipid are insoluble compounds in water of organic solvents such as chloroform hexane, toluene, and acetone, and lipids can also form combinations with other simple compounds such as triglycerides, and phospholipids [11]. Microalgae have a number of lipids with the same composition and even tend to be more than the other plants. The largest form of fat in microalgae cells is the triglycerides that can account for 80% of the total fat. This fat is the most important of the microalgae because it is the kind of oil that is good for producing biodiesel. Microalgae fats are usually esters composed of glycerol and fatty acids with a long chain of C14 to C22. The fatty acid composition of microalgae is monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs), such as palmitic acid (C16:0), palmitoelic acid (C16:1), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2), as well as several other types of acids [12].

The purpose of this study is as a preliminary research to determine the profile and composition of fatty acids contained in microalgae *Botryococcus braunii* and the relationship between the identification of fatty acids and the potential of this type of microalgae as a source of renewable energy, i.e. biodiesel. Beside the direct research in laboratorium, researcher also adding another data as reference materials, some data obtained from some literature that discusses fatty acids *Botryococcus braunii* were implemented.

2. Material and Methods

The study was started with cultivation, extraction and transesterification process until biodiesel were obtained. The data for the cultivation and harvesting process of microalgae were obtained from direct observation conducted for ± 2 months in the laboratory of Process Unit of Chemical Engineering Department of Sriwijaya State Polytechnic, and the data of fatty acids were obtained by doing GC-MS analysis done in chemistry laboratory of materials processing of Bandung Institute of Technology. As supporting data of the main data obtained from the results of the study, the researcher used some literature study from some previous researchers. For the literature used as supporting data in this paper can be seen in Table 3.

Table 3. Literature studies on Fatty Acids Profile of *Botryococcus braunii*

Ref.	Lead Author	Description
[8]	Rao	Focused on the cultivation of *B. braunii* in two different media: raceway ponds and circular ponds from which both cultivation mediums obtained different composition of *B. raunii* fatty acids.
[13]	Ramaraj	Evaluated the feasibility of biodiesel production directly from *B. Braunii* biomass at laboratory scale achieved through direct transesterification process.
[14]	Diraman	Analyzed the fatty acid profiles of two types of microalgae namely *B.braunii* and *P.cruentum* from which it was known that *B. braunii* had potentiality as a source of biodiesel feedstock and *P.cruentum* was essential for fish feed.
[15]	Custódio	Analyzed the profile and fatty acid composition of *B.braunii* and *N.oculata* from which it was found out that the fatty acid composition which was a biodiesel fatty acid in *B.braunii* was higher than *N.oculata*

The study phase was begun with the cultivation of *Botryococcus braunii* microalgae seedlings obtained from the Balai Budidaya Perikanan dan Air Payau (BBPAP) in the area of Situbondo, East Java as much as 100 ml.

This microalgae cultivation was carried out in a culture bottle attached to the aerator with a duration of 10 days cultivation, and the cultivation medium used in the form of seawater with 25 – 35 ppt salinity of 500 ml. The medium of nutrition used in this cultivation is the walne's medium as much as 1 ml on each cultivation. Lighting was done using a 20 watt TL lamp with a bright dark method with a 12 hour timeframe (12 light hours:12 hours of dark). Further harvesting and cell density calculations were performed using a hemocytometer on which the amount of the cell was calculated using equation (1) [16].

$$\text{Number of cells per box} = \left(\frac{\text{number of calculated cells}}{\text{number of boxes}}\right) \times 25 \times 10^4 \quad (1)$$

The second stage after cultivation was the process of taking lipids from microalgae that have been cultivated or known as the extraction process. Extraction method used was soxhlet method, that is extraction method which is done by heating and using solvent. The solvent used was 175 ml of n-hexane to extract 10 grams of *Botryococcus braunii*. This extraction process lasted for 4 hours in order to produce optimal lipids [16]. Furthermore, the obtained lipid was weighed and calculated in quantity by using equation (2).

$$\%\text{yield} = \frac{\text{mass of extracted lipid}}{\text{initial sample mass}} \times 100\% \quad (2)$$

The last step conducted in this study was the making of biodiesel or FAME *(Fatty Acid Methyl Ester)* by using transeterification process with solvent in the form of methanol. The process was carried out for 2 hours until the two layers of triglycerides were formed on the bottom layer and FAME on the top layer. After that, several analyses of FAME were produced, one of which was fatty acid component analysis in FAME made from *Botryococcus braunii* by using GC-MS (Gas Chromatography-Mass Spectrometer) tool which was done in chemistry laboratory of material processing of Bandung Institute of Technology.

3. Results and Discussion

One of the parameters that could be considered as the reason in selecting the species of microalgae as the raw material of renewable energy, particularly biodiesel, is the lipid quantity resulted from the extraction process and the fatty acids composition owned by those microalgae. For this reason, this preliminary study was conducted in order to know the potential of *Botryococcus braunii* species of microalgae to be converted into biodiesel.

Results

This study was conducted through 3 stages, namely cultivation stage, extraction stage and FAME production stage. Then, several analyses and calculations were also done, the calculation of cell density amount, the calculation of resulted-lipid quantity, and the analysis of fatty acids. For the calculation of the amount of cell density and lipid quantity, the data were directly obtained from the conducted study. Meanwhile, for the analysis of fatty acids contained in *Botryococcus braunii*, the data were obtained from two sources which were the data of the study and the companion data from the existing literature (Table 3).

In the cultivation process done by the researchers, the value of cell density was observed by using microscope and hemocytometer chamber. The calculation of the amount of cell density was done in order to know the amount of microalgae cell developing during the growth period. By the duration of cultivation for 10 days, the highest amount of cell density was obtained on the 7th day of cultivation which was 5.208×10^4 cells/ml. The calculated data of the amount of the cultivated *Botryococcus braunii* cell density could be seen in Figure 2.

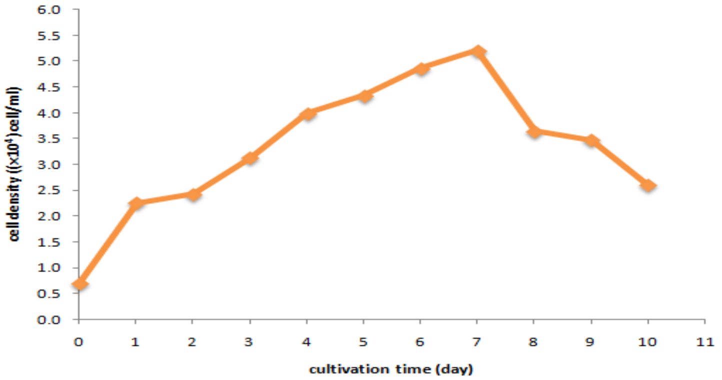

Figure 2. The Graph of *Botryococcus braunii* Cell Density

In the stage of extraction, the quantity of lipid rendemen, the extraction result, was calculated or % yield. % yield is a comparison between product mass and initial raw material mass [16]. The lipid rendemen resulted from extraction is colored as bright yellow and not too smelly and slightly thick. The lipid % yield resulted from soxhlet extraction was 24% with 175 ml of n-hexane solvent.

After the extraction process was complete, the third stage, producting FAME, was done using transesterification method. The resulted FAME was bright yellow with a volume of ± 10 ml. From the resulted FAME, the composition of fatty acids from microalgae used as raw material that was *Botryococcus braunii* could be analyzed by using GC-MS instrument. Based on the results of the analysis, 3 types of fatty acid compounds in FAME produced, which was a compound contained in biodiesel, palmitic acid, stearic acid, oleic acid and linoleic acid, could be detected [12]. The graph of GC-MS analysis result from FAME and the composition of each fatty acid detected in the GC-MS analysis could be seen in Figure 3 and Table 4.

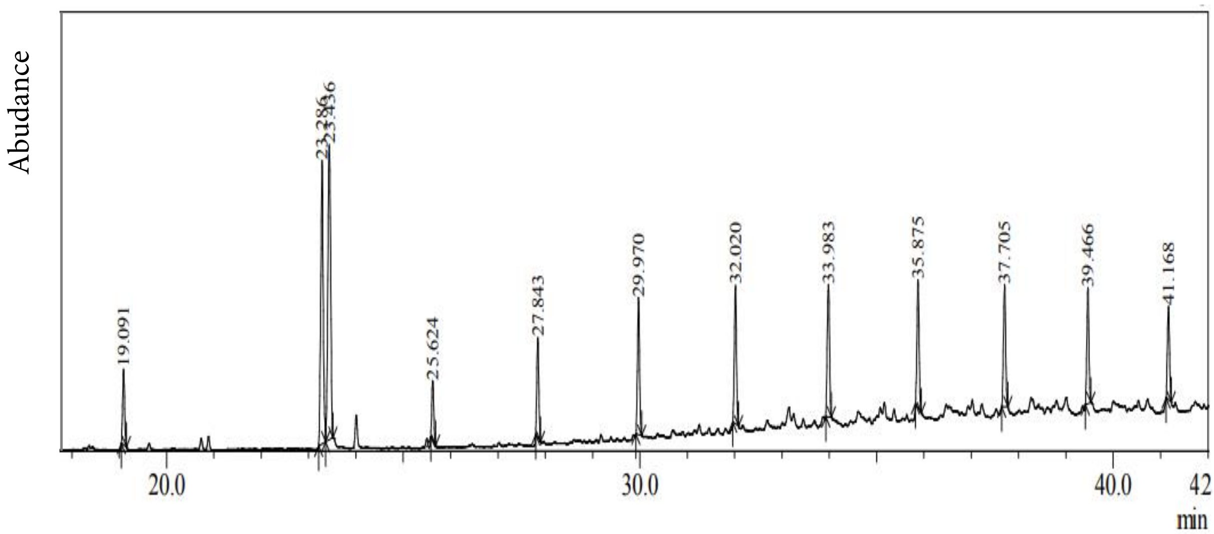

Figure 3. The Graph of GC-MS analysis from FAME in Direct Study

Table 4. Profile of *Botryococcus braunii* Fatty Acids in Direct Study

Fatty Acid	Retention Time	Area (%)	Height (%)
Palmitic acid (C16:0)	19.091	3.59	4.03
Oleic acid (C18:1)	23.286	16.91	15.65
Linoleic acid (C18:2)	23.436	20.66	15.01

As a companion data, the researchers also conducted a literature study on *Botryococcus braunii* fatty acids from the previous studies. There were 4 literatures used as the companion data (Table 3). The research data explained that there were 4 types of fatty acids contained in *Botryococcus braunii* that were biodiesel content. The composition of those four types of fatty acids in the studies could be seen in Table 5 and the comparison of fatty acid data from the results of direct study and previous study could be seen in Figure 4.

Table 5. Fatty Acids of *Botryococcus braunii* in Several Previous Studies

Fatty Acid	Composition (%)				
	Ramaraj	Diraman	Rao[a]	Rao[b]	Custódio
C16:0	11.66	12.55	16.52	22.13	18.05
C18:0	5.85	15.41	8.21	5.19	0.84
C18:1	45.4	35.47	34.23	28.35	35.85
C18:2	3.05	4.32	12.26	16.24	23.15

[a]cultivation in raceway ponds
[b]cultivation in circular ponds

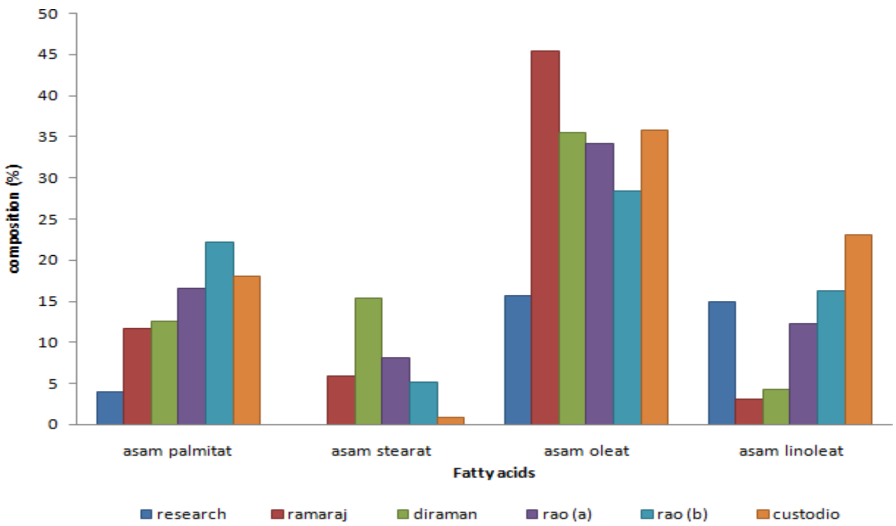

Figure 4. The Graph of *Botryococcus braunii* Fatty Acids Composition from Direct Study and Literature Study

Based on the existing fatty acids data, it was known that the range of fatty acid composition of *Botryococcus braunii*, especially for 4 types of fatty acid which was the biodiesel content was 4.03 – 22.13% for palmitic acid, 0.84 – 15.41% was stearic acid, then for oleic acid ranged between 15.65 – 45.4% and linoleic acid ranged from 3.05 – 23.15%.

Discussion

The growth phase of microalgae is generally divided into five phases of growth, namely lag phase, exponential phase, phase of growth rate lowering, stationary phase and phase of death [17]. From the research results, it was known that in the lag phase, the number of *Botryococcus braunii* cells were 2.257×10^4 cells/ml. Lag phase is an early phase of growth or adaptation of microalgae to the culture medium and nutrient medium used.

The highest growth phase of *Botryococcus braunii* occurred on the 7th day of cultivation with a cell number 5.028×10^4 cells/ml. This highest growth phase is called the exponential phase in which the cells divide rapidly and there is an increase in the number of cells. Based on the growth graph of *Botryococcus braunii* (Figure 2), it could be seen that the increase of *Botryococcus braunii* cells number occured from the 2nd day until the 6th day of cultivation, yet the number of cells peaked on the 7th day. This happened because the microalgae cells cultivated have been in stable culture conditions.

After the peak increase or exponential phase, the microalgae cells would have the lowering of growth rate until there would be a stop of growth and the microalgae would undergo the phase with the lowest number of cells on the 10th day of cultivation. This phase is called as the death phase. The phase of death occurs as the stock of nutrients in the culture medium has decreased or discharged that causes microalgae cells in culture medium can no longer develop and slowly die until the number of cells in the culture medium becomes constant. The number of cells on the 10th day of cultivation was 2.604×10^4 cells/ml.

After the cultivation, microalgae were harvested and dried for later being extracted using the soxhlet method. Soxhlet extraction is usually used to extract the compound with limited solubility in a solvent and the impurities are insoluble in that solvent [18]. In this study, the compound of n-hexane was used as the solvent. The selection of this solvent was due to the nature of fat which is water-insoluble or polar solvent but soluble only in non-polar solvents and was also because the type of microalgae used in this study would be easily extracted by using n-hexane.

The resulted lipid rendemen from soxhlet extraction using n-hexane of 175 ml had a yield % of 24%. The resulted rendemen was quite high considering that the sample of *Botryococcus braunii* extracted was only 10 grams. The volume of solvent used also affected the lipid produced with 175 ml of solvent that 45 solvent cycles were occured. Once the solvent is added then there will be more cycle happened and the resulted lipid rendemen will also increase.

Furthermore, the obtained lipid was converted to FAME, then the obtained FAME was analyzed to find out the profile and composition of the fatty acids contained there that whether the fatty acids of *Botryococcus braunii* was a component of biodiesel fatty acid or not could be identified. The analysis was performed using GC-MS instrument. From the analysis conducted directly, 3 types of fatty acids which were the components of biodiesel fatty acids, namely palmitic acid, oleic acid and linoleic acid were obtained, while the stearic acid was not detected by the instrument. This may be due to excessive sample storage time and poor storage mode allowing for the occurrence of oxidation in the sample before the sample arrived at the analysis site.

In the study conducted by Rao et al., (2012), two cultivations with different culture media, raceway ponds and circular ponds, in outdoor conditions were done. The total lipid produced by *Botryococcus braunii* was about 24% (w/w) with the dominant component of palmitic acid and oleic acid, both in cultivation using raceway and circular ponds [8].

The fatty acid profile contained in the microalgae oil was related to the biodiesel produced. Unsaturated fatty acids had a lower liquid point compared to saturated fatty acids that had good flowing ability at low temperatures. The opposite occured with saturated fatty acids that had a high melting point so that at low temperatures, it tends to not form a liquid or become a gel. According to Hu et al. (2008) and Chinnasamy et al. (2010), saturated fatty acids will tend to be at low temperatures but produce biodiesel with high oxidative stability [18-19].

According to Ramaraj et al. (2016), *Botryococcus braunii* is included to the microalgae which have good potential once being converted into biodiesel. It can be known from the high amount of lipid produced by *Botryococcus* and fatty acid profile owned by *Botryococcus braunii* was a component of biodiesel fatty acids as well. In the study conducted, it could be seen that the components of fatty acids dominantly owned by *Botryococcus braunii* were oleic acid, followed by palmitic acid, linoleic acid and stearic acid [13].

Lipids with high oleic acid content are known to have a good balance to the characteristic of fuel. The higher oleic acid in the fuel can increase oxidative stability for longer storage. Besides, *Botryococcus* has saturated and saturated fatty acids that are well balanced so that the biodiesel produced can still flow at low temperatures but have high oxidation values as well [13-14].

In a study conducted by Custódio et al. (2014) on fatty acids in *Botryococcus braunii* and *Nannochloropsis oculata,* it was also known that the fatty acid composition which was the content of biodiesel fatty acids in *Botryococcus braunii* was higher than the one in *Nannochloropsis oculata* and *Botryococcus braunii* was more potential to be converted to biodiesel compared to *Nannochloropsis oculata* for fatty acids in *Nannochloropsis oculata* were more dominated by saturated fatty acids [15].

4. Conclusion

Based on the study and literature study conducted, it could be known that *Botryococcus braunii* had a growth with a pretty high amount of cell density and could result plentiful lipid rendemen that had a good potential once being converted to biodiesel. Besides, some fatty acids components contained in *Botryococcus braunii* were the fatty acids components of biodiesel and the content of saturated and unsaturated fatty acids of *Botryococcus braunii* which were balanced that could be considered to be the raw material of biodiesel. The high composition of oleic acid in *Botryococcus braunii* could also be the basis in getting *Botryococcus braunii* as the raw material of biodiesel.

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