The effects of material to solvent ratio on the performances of natural dyes extraction

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The Effects of Material to Solvent Ratio on the Performances of Natural Dyes Extraction

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Abstract. The utilization of natural dyes from natural resources in fashion industry is preferred than synthetic dyes as the natural dyes is considered as more environmentally friendly than synthetic dyes. In addition, dyes from natural resources, such as plant, are renewable resources that can be sustainably used. In recent years dye from Mangifera has been used widely as sources for yellow color in fashion industry. However, there are still more studies need to investigate the effects of solvent to material ratio during extraction process to attain a standard color that can be applied in industry. Thus, this study focused on the extraction process of dye from mangifera leaf to optimize and provide recommendation about the best solvent and the ratio of solvent to material used in the dyeing process. Experimental results showed that the best solvent for Mangifera indica extraction process is methanol. In addition, the best material to solvent ratio to obtain maximum yield was 1 : 7.

Keywords: Natural dyes, extraction, solvent, ratio

INTRODUCTION

Dyes are useful in various fields, including food and beverages, textiles, cosmetics, and household materials. The usage of color could add aesthetic value to any product [1]. Based on the sources, textile dyes could be classified into two categories: natural dyes, which are generated from plants or animals, and synthetic dyes, which are produced from chemical reaction with aromatic hydrocarbon derivatives (benzene, naphthalene, and anthracene) as the raw materials [1-2]. Excess usage of synthetic dyes could damage the environment due to its toxic waste that degraded into carcinogenic compounds [3-4]. Thus, it would also harm the other living creatures nearby. Therefore, natural dye is considered as an alternative because it is less toxic, renewable, biodegradable, and environmentally friendly [5]. Furthermore, mordant substitution by the natural dye eliminates the heavy metal content in the waste. Common technique used for obtaining specific substances from natural plants is extraction [6]. Extraction for dyes can be conducted by using either maceration, reflux or soxhlet extractions.

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The benign utilization of natural dyes instead of synthesized ones, as mentioned earlier increased the demand for natural coloring agents. In Indonesia, batik artisans and the yarn industries commonly use natural dyes conventionally. However, they pay less attention to the method, process condition, and materials-solvents usage. From the previous study by Sutrisna et al. (2020) [7], the optimum method and condition for sappan bark extraction was a Soxhlet with ethanol as the solvent which produced 4.96% of yield and 0.69 of absorbance. As for the mango leaves extraction, the reflux method with water as the solvent was found to be the best way to extract yellow color with 2.52% yield and 0.48 absorbance, and the Soxhlet method with methanol as the solvent produced green color with 6.00% and 0.69 of yield and absorbance, respectively.

In this study, the material to solvent ratio of *Mangifera indica* (mango leaves) was observed with specific methods and conditions. A yellowish-green color from *mangiferin*, which is contained in *Mangifera indica* (mango leaves), was expected and finally shown. In addition to discovering the optimum ratio of material to solvent by yield and absorbance, the dye application for yellow color on fabrics was also investigated in this paper. Hence, further research about natural dye extraction from natural ingredients was needed to obtain a fit material to solvent ratio.

MATERIALS AND METHODS

Materials

Mangifera indica leaves (Gadung species) were gathered directly from the trees planted in Surabaya, Indonesia. The leaves were washed, sun-dried for about 4-5 days, and ground using a kitchen blender until the powder was attained. The powder was then screened to get 40/70 mesh particle size and extracted using distilled water and methanol 95% (technical grade, purchased from Brataco Chemika, Jakarta, Indonesia) as solvents.

Methods

The ratios of material to solvent 1:7 and 1:15 were used in case of each variable for *Mangifera indica* leaves extraction. The extraction using reflux and Soxhlet set equipment was maintained by TP-101 digital temperature indicator at 100^{o}C on the three-neck rounded flask for distilled water, 64^{o}C for methanol, and 79^{o}C for ethanol following each boiling point. Samples were collected at 30 minutes intervals, filtered using filter paper Whatman Grade 40 (for reflux method), and the absorbance were measured using HP-8453 Double Beam UV-Vis Spectrophotometer at a wavelength of 463 nm for *Mangifera indica* leaves. Time variation was employed in three ways i.e. 2, 4, and 5 hours. The yields at the end of time variation were calculated by taking 5 ml of samples that were dried in an oven for 2 hours at 110^{o}C. Moreover, LC-HRMS analysis was done using Thermo Scientific^{TM}-Q Exactive^{TM} as the high-resolution mass spectrometer. Two solvents of 0.1% formic acid in water and 0.1% formic acid in acetonitrile were used along with Hypersil GOLD aQ 50 x 1 mm x 1.9 u particle size analytical column. Throughout the analysis process, the column oven is maintained at 30^{o}C. The dye application for both ratios was applied in linen cloth which had a high absorption.

RESULTS AND DISCUSSION

Mangifera indica Spectral Analysis

The absorbance data of *Mangifera indica* leaves extraction for each method are presented in Fig. 1 and Fig. 2, respectively.

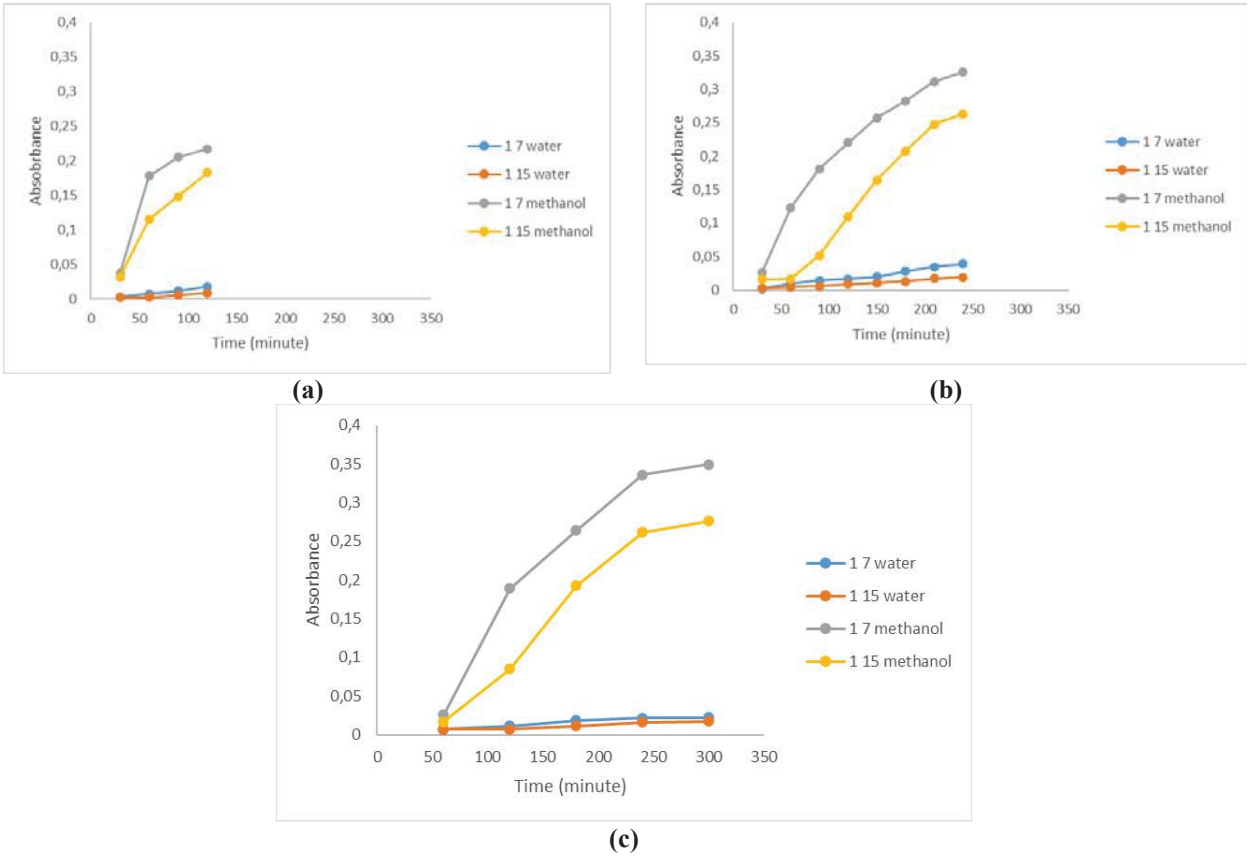
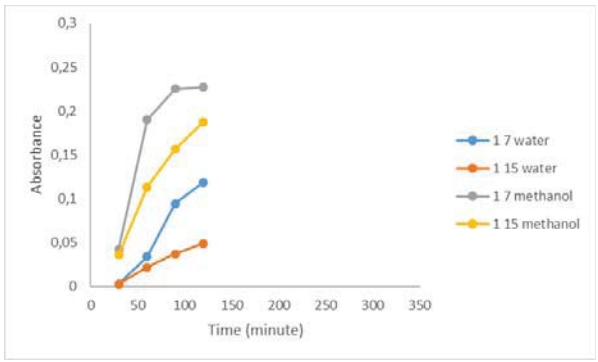


FIGURE 1. Methanol and Water Solvents Absorbance vs Time (min) Relation for **(a)** 2 hours; **(b)** 4 hours; **(c)** 5 hours by Soxhlet Method

The absorbance trend vs time for methanol solvent in Fig. 1 showed an increase then reached a steady state as shown in Fig. 1c for 5 hours extraction. In the case of solvent, the usage of water was not shown any significant absorbance rise compared to methanol. Thus, it is indicated that the Soxhlet method for leaves extraction was more suitable with methanol solvent. Due to methanol's volatile characteristic and lower surface tension than water (20.21 mN/m for methanol and 58.98 mN/m for water), the extraction process in the materials' pore was easier [7]. Furthermore, the functional groups in methanol (-OH and -CH_3) could dissolve either polar or non-polar compounds which could extract the *mangiferin* better than water as a universal solvent [8].

Both of the solvents for *mangiferin* extraction by reflux method generated a high increase of absorbance along the time as shown in Fig. 2. However, methanol solvent still gave a higher absorbance than water solvent. Therefore, it can be concluded from Fig. 1 and 2 that methanol solvent produced a better performance for both extraction methods. This phenomenon happened because of the flavonoid compound that had the -OH functional group in *mangiferin,* which had similar polarity with the solvent. Therefore, the materials to methanol solvent ratio was further discussed.



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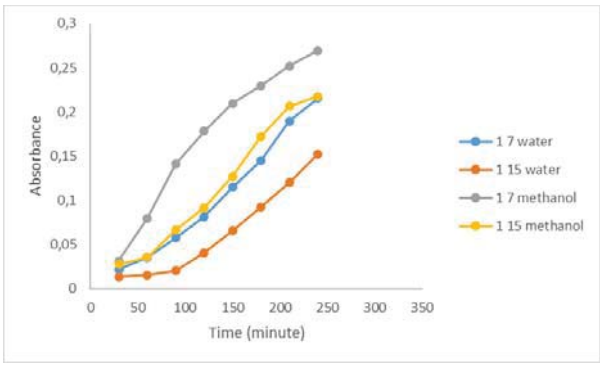

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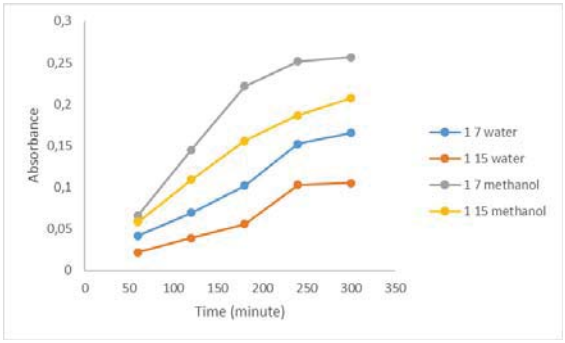
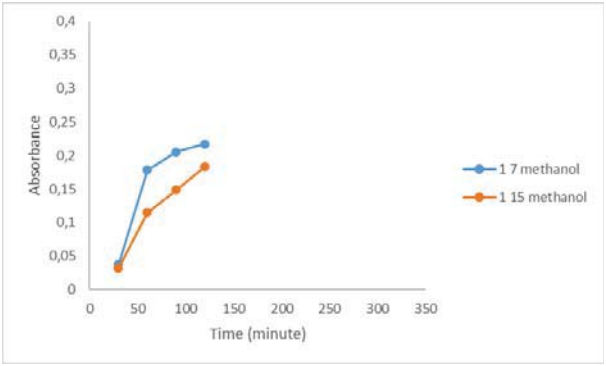


(c)

FIGURE 2. Methanol and Water Solvents Absorbance vs Time (min) Relation for **(a)** 2 hours; **(b)** 4 hours; **(c)** 5 hours by Reflux Method

Materials to Solvent Ratio in *Mangifera indica*

The plots of the absorbance with time are shown in Figure 3 and Figure 4 for each extraction method sequentially. The materials to solvent ratio of 1:7 produced a greater absorbance value for all extraction duration as shown in Fig. 3. Moreover, a 1:7 ratio by the Soxhlet method gave an economic advantage where it only needed a small amount of solvent to dissolve the same quantity of materials.



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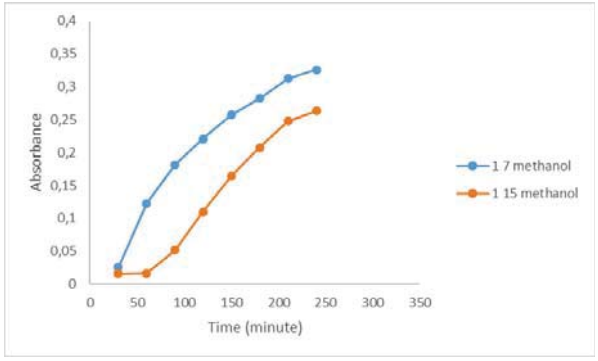

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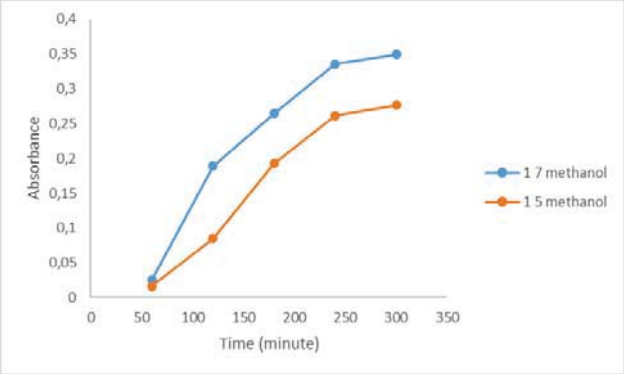
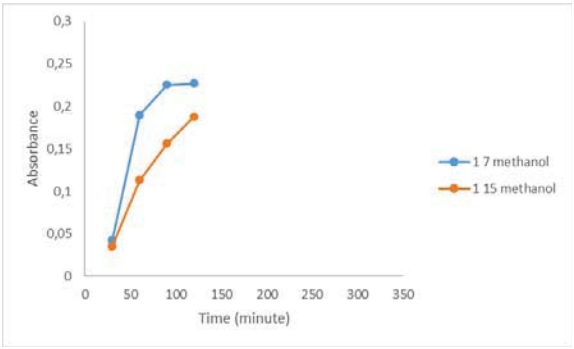


(c)

FIGURE 3. Methanol Solvent Absorbance vs Time (min) Relation for **(a)** 2 hours; **(b)** 4 hours; **(c)** 5 hours by Soxhlet Method

An extraction process of *Mangifera indica* by reflux method with methanol in Fig. 4 performed the same tendency with the Soxhlet method in Fig. 3 where 1:7 materials to solvent ratio gave higher absorbance results than the 1:15 ratio. A greater amount of solvent produced a lower absorbance because a large amount of solvent diluted the sample containing color substances.



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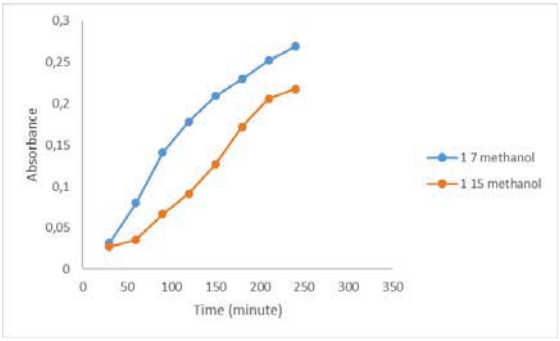

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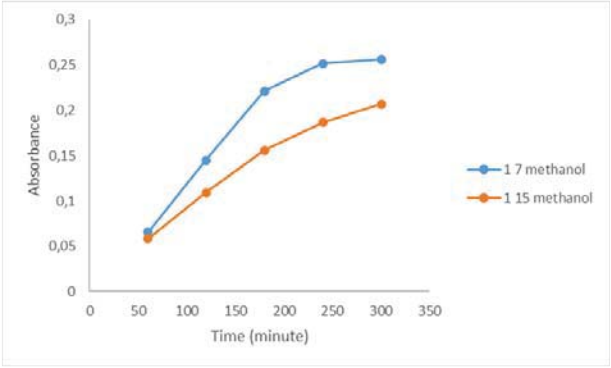


(c)

FIGURE 4. Methanol Solvent Absorbance vs Time (min) Relation for **(a)** 2 hours; **(b)** 4 hours; **(c)** 5 hours by Reflux Method

Comparing the extraction method by methanol solvent, the Soxhlet extraction gave a better extraction result than the reflux one based on the absorbance number. It was due to continuous reflux and siphoning method resulting renewable solvent that Soxhlet method had. In addition, a Soxhlet method was more suitable with a low boiling point solvent which could easily evaporate. Thus, the extraction process by methanol generated a better performance in the Soxhlet method than the reflux method.

Mangifera indica Yield Analysis

The yield of *Mangifera indica* extraction for each ratio was presented in Table 1 and Table 2.

TABLE 1. Yield Percentage of *Mangifera indica* Extraction by 1:7 Ratio

Method	Water Solvent (%)	Methanol Solvent (%)
Soxhlet ; 2 hours	0.89	2.16
Soxhlet ; 4 hours	1.22	4.1
Soxhlet ; 5 hours	1.14	3
Reflux ; 2 hours	1.41	2.51
Reflux ; 4 hours	2.08	2.72
Reflux ; 5 hours	1.71	2.54

TABLE 2. Yield Percentage of *Mangifera indica* Extraction by 1:15 Ratio

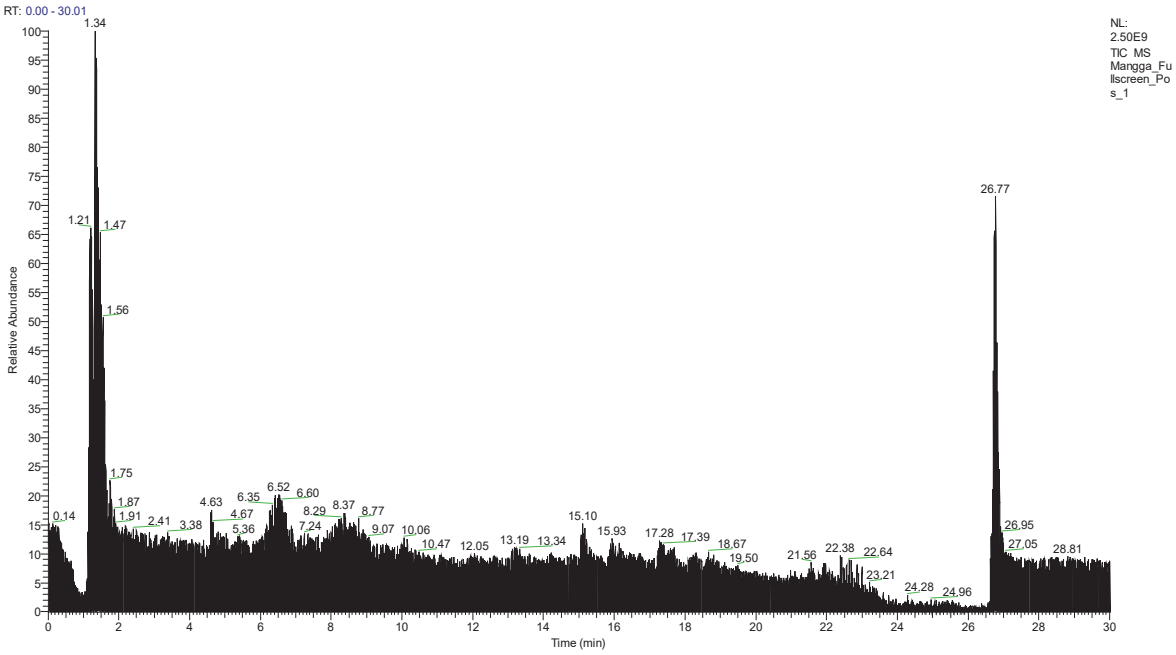
Method	Water Solvent (%)	Methanol Solvent (%)
Soxhlet ; 2 hours	0.15	1.74
Soxhlet ; 4 hours	1.14	3.7
Soxhlet ; 5 hours	0.66	2.61
Reflux ; 2 hours	1.3	1.22
Reflux ; 4 hours	1.46	2.1
Reflux ; 5 hours	1.38	2

As shown in Table 1 and Table 2, yield percentages for both extraction methods by water and methanol solvents were not proportional to the increase of extraction duration where a maximum yield was achieved at 4 hours of extraction. These results were also in line with the spectral analysis. Overall, the 1:7 materials to solvent ratio generated a greater yield value than the 1:15 ratio in every method and time of extraction.

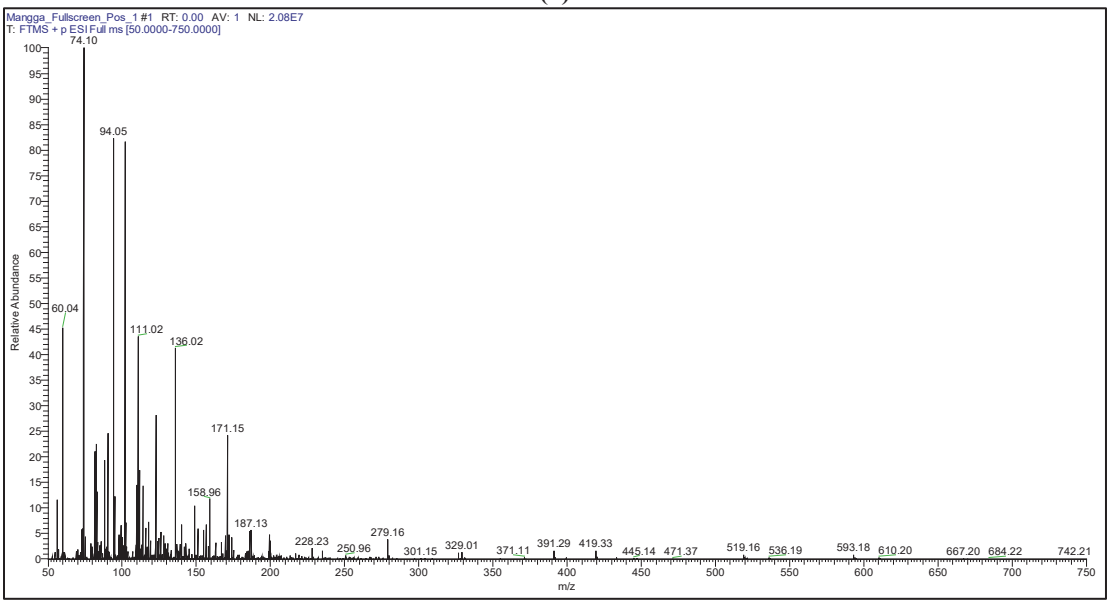
According to Zhang et al., (2018) [9], a similar polarity between materials and solvent played a big role in the extraction success. This statement was proven by the yield percentages in Table 1 and Table 2 which a higher yield was resulted from using methanol solvent.

Mangifera indica LC-HRMS Analysis

The best extraction performance of *Mangifera indica* (both ratios), Soxhlet extraction by methanol solvent for 4 hours, were shown in Fig. 5 and Fig. 6 respectively. LC-HRMS analysis by scan mode was chosen to identify and quantify the compounds containing in the leaves extract.



(a)



(b)

FIGURE 5. LC-HRMS Analysis of 1:7 Ratio. **(a)** Chromatogram; **(b)** Mass Spectrum

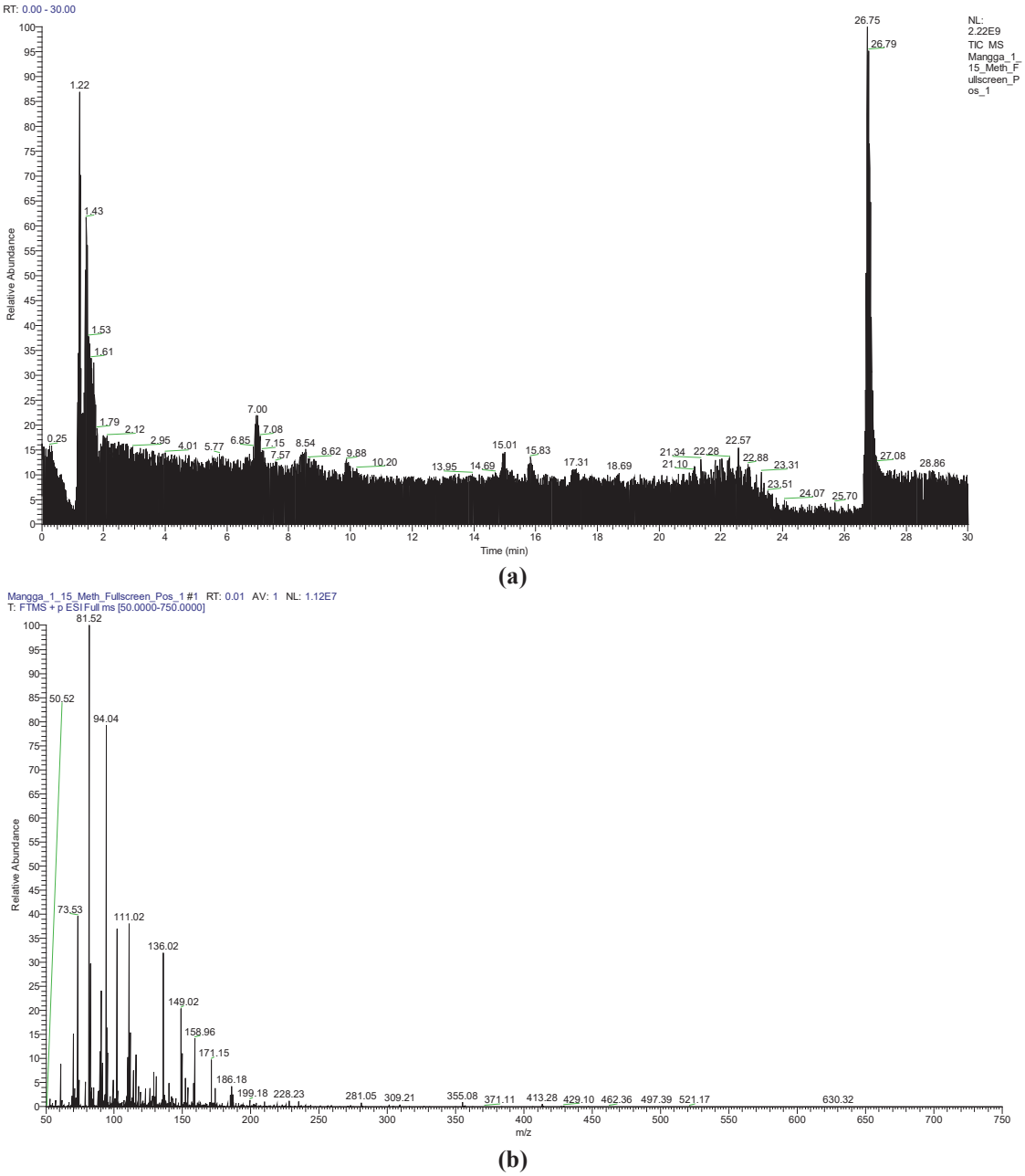


FIGURE 6. LC-HRMS Analysis of 1:15 Ratio. **(a)** Chromatogram; **(b)** Mass Spectrum

The highest 5 peaks in Fig. 5 and Fig. 6 were summarized in Table 3 and Table 4 consecutively.

TABLE 3. *Mangifera indica* LC-HRMS Analysis Summary for 1:7 Ratio

Compound Name	Retention Time	Area	m/z
N-(2,6-difluorophenyl)-2-(4-nitrophenyl) acetamide	1.34	38,054,009.88	73.3
Choline	1.47	3,459,385,491.39	104.02
Trigonelline	1.56	149,947,034.42	136.02
L-Norleucine	1.75	122,181,566.79	158.96
L-Phenylalanine	1.87	123,635,161.53	171.15

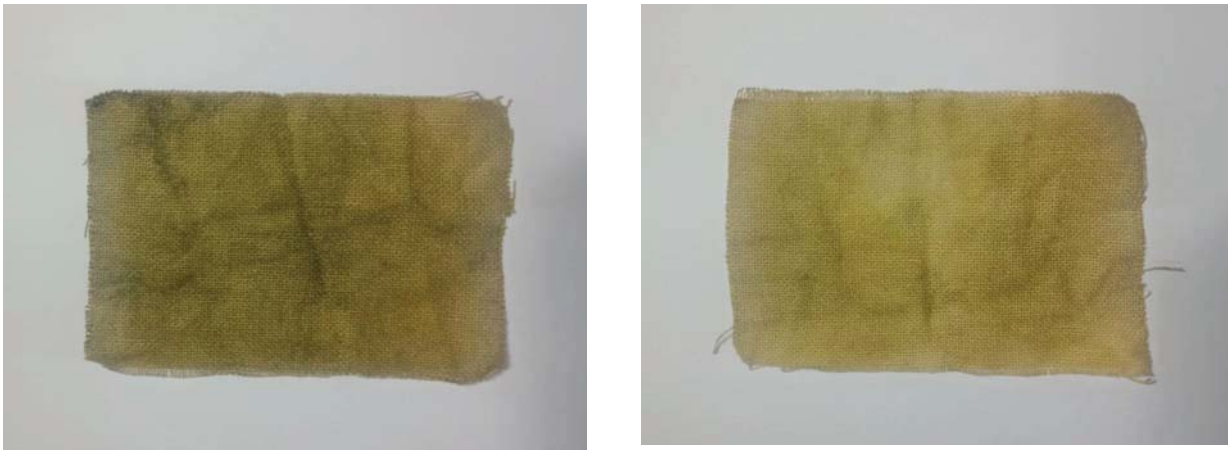
TABLE 4. *Mangifera indica* LC-HRMS Analysis Summary for 1:15 Ratio

Compound Name	Retention Time	Area	m/z
Choline	1.43	274,517,020.11	104.11
3-Hydroxy-2-methylpyridine	1.53	17,978,973.68	136.02
(7E,13E)-9,15-dihydroxy-4,10,16-trimethyl-1,5,11-trioxacyclohexadeca-7,13-diene-2,6,12-trione	1.61	1,237,464,377.44	149.02
L-Norluecine	1.79	29,187,369.42	158.96
Adenosine	2.12	245,360,485.90	171.15

LC-HRMS analysis for 1:7 and 1:15 ratios indicated the same choline compound with a different retention time as shown in Table 3 and Table 4. The late detection time for choline in the 1:15 ratio was due to a minimal compound contained in the sample. The m/z values for both ratios also showed a similarity number with data from Pubchem NCBI respectively by 104.02, 104.11, and 104.10. Thus, it can be concluded that the ratio difference did not affect the content in the sample.

Mangifera indica Linen Cloth Coloring

The coloring results were shown in Figure 7 for 4 hours of Soxhlet extraction by methanol solvent.



(a) **(b)**

FIGURE 7. *Mangifera indica* Coloring Results in Linen Cloth for **(a)** 1:7 Ratio; **(b)** 1:15 Ratio

The coloring result of *Mangifera indica* extraction produced a darker color in thew 1:7 materials to solvent ratio (Fig. 7a) than the 1:15 ratio. The pale color in Fig. 7b might be due to the coloring agent dilution in the 1:15 materials to solvent ratio.

CONCLUSION

This research has conducted the extraction processes of yellow colour from mango leaf. The extraction process required different process conditions to optimize the yield of dyes produced. Methanol was found to be the best solvent for *Mangifera indica* extraction from spectrophotometer and LC-HRMS analysis. Regarding the material to solvent ratio, the 1:7 ratio showed to be the best extraction performance for both materials. The application of color into the fabric showed a promising result and further research are still required to enhance the colouring process of fashion in industrial scale.

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The utilization of natural dyes from natural resources in fashion industry is preferred than synthetic dyes as the natural dyes is considered as more environmentally friendly than synthetic dyes. In addition, dyes from natural resources, such as plant, are renewable resources that can be sustainably used. In recent years dye from Mangifera has been used widely as sources for yellow color in fashion industry. However, there are still more studies need to investigate the effects of solvent to material ratio during extraction process to attain a standard color that can be applied in industry. Thus, this study focused on the extraction process of dye from mangifera leaf to optimize and provide recommendation

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Keywords: Natural dyes, extraction, solvent, ratio

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PREFACE

WELCOME FROM InCITE 2021 ORGANIZING COMMITTEE

Welcome to InCITE 2021! The third bi-annual international conference on engineering domain conducted by the Faculty of Engineering, The University of Surabaya (UBAYA). Due to the COVID-19 pandemic, InCITE 2021 is held as an online conference. Online conference opens the opportunity for many researchers around the globe to share their findings and learn from other global researchers with less restrictions.

InCITE 2021 invites three keynote speakers, well reputable global researchers in their research domain from Australia and Taiwan. Following each keynote session are two presentation sessions run in parallel.
This year, we received 66 papers submitted by researchers from four distinct countries (i.e., first author's country of origin): Indonesia, Australia, Taiwan, and Kazakhstan.

We employed a double-blind review to ensure a high standard and a minimum level of bias in the reviewing processes. This resulted in 56% of the submissions were accepted and will be published to the AIP Conference Proceedings.

Authors of all accepted papers are to disseminate their findings during InCITE 2021 conference between 25 to 26 of August 2021. This presents a great opportunity for everyone, including the researchers, to discuss and further improve current achievements.

We thank all keynote speakers, presenters, and reviewers/scientific committees for the generous supports. We thank the University of Surabaya, the Faculty of Engineering UBAYA, and all InCITE 2021 committees that enable InCITE 2021.

We wish you a very pleasant and rich conference experience in InCITE 2021 and looking forward to seeing you again on InCITE 2023! Thank you.

Yours sincerely,
Asst. Prof. Dr. Jimmy
InCITE 2021 Organizing Committee

INVITED SPEAKERS

Dr. Ahmed Mourad
Postdoctoral Research Fellow
Information Engineering Lab (IELAB)
University of Queensland
AUSTRALIA

Prof. Chuan-Kai Yang, Ph.D
Professor
Information Management
National Taiwan University of Science and Technology
TAIWAN

Dr. Anton van der Vegt
Postdoctoral Research Fellow
EMPOWER, a Joint Venture between Queensland Health & the University of Queensland
University of Queensland
AUSTRALIA

ACKNOWLEDGMENT

International Conference on Informatics, Technology and Engineering 2021 (InCITE 2021) Organizing Committee wishes to express its gratitude and appreciation to:

Dr. Ir. Benny Lianto, MMBAT., Rector of Universitas Surabaya for consenting to be the guest of honour

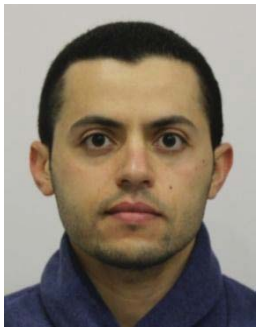
All invited speakers session, moderators and conference speakers, for their participation

All conference sponsors, supporters, exhibitors and advertiser for their generous support

All participants and other who have in one way or another contributed towards the success of this conference

KEYNOTE SPEAKERS

Dr. Ahmed Mourad



Dr. Ahmed Mourad is a Postdoctoral Research Fellow at the Information Engineering Lab (ielab), University of Queensland. His current research focuses on Conversational Systems in the context of Agricultural domain. AgAsk is a conversational agent that will provide access to agricultural R&D output (which is currently locked away into project reports, communications and scientific publications) leading directly to better, data-driven growing decisions. Through machine learning driven question-answering systems, AgAsk will elicit and understand growers information needs and preferences, providing contextualised access to insights in agricultural R&D.

He completed his PhD in Computer Science at RMIT University in 2019 under the supervision of Professor Mark Sanderson, Professor Falk Scholer and Associate Professor Walid Magdy. His research focused on the Influence of geographic biases on geolocation prediction in Twitter. Before the PhD, He worked as a Research Assistant at Qatar Computing Research Institute (QCRI) focusing on Information Retrieval and Sentiment Analysis on Arabic datasets. He also worked as a Software Engineer at large corporates including Microsoft and Mentor Siemens.

Prof. Chuan-Kai Yang, Ph.D

Prof. Chuan-Kai Yang, Ph.D received his Ph.D. degree in computer science from Stony Brook University, USA, in 2002, and his M.S. and B.S. degree in computer science and in mathematics from National Taiwan University in 1993 and 1991, respectively. He served as the chairman for the department of information management, National Taiwan University of Science and Technology, Taiwan, from 2017 to 2019, and is currently a Professor in the department. His research interests include computer graphics, scientific visualization, multimedia systems, and computational geometry. He has published over hundreds of research papers, including more than 30 SCI journal papers and more than 40 international conference papers.

Dr. Anton van der Vegt

Anton completed his PhD in Information Retrieval from The University of Queensland, co-sponsored by CSIRO. His reserach investigated the impact of time and knowledge constraints on the ability of clinicians to make high quality clinical decisions in the context of using a search engine to support this task. Anton proposed a minimal interaction framework, as an alternative to the traditional SERP (Search Engine Results Page) approach to clinical search. As a result of his research, numerous papers have been published in high ranking journals such as JASIST, JMLA and JDOC.

Prior to his PhD studies, Anton spent four years working in the UK, supporting the implementation of the National Programme for IT into the NHS; this included development and installation of clinical and administrative software systems to connect patient care across the UK. Through this work he developed a much better understanding of the unique challenges faced by clinicians and public healthcare organisations when implementing such systems. This experience, together with his thesis research informs his current role as PostDoctoral Research Fellow with EMPOWER, a Joint Venture between Queensland Health and the University of Queensland. The purpose of this JV is to create a scalable platform for clinicians to access intelligent information to improve clinical outcomes across Queensland.

ACTIVITY DETAILS

Place and date of event
August 25th – 26th, 2021
Location: Virtual Meeting

Day 1: Wednesday, August 25th 2021 (Time Zone: (GMT+7:00) Jakarta)

From	To	Activities	Venue
08.00	08.30	Registration	Main Virtual Room
08.30	08.45	Opening Ceremony: Welcome Speech By Rector of Universitas Surabaya: **Dr. Ir. Benny Lianto, MMBAT**	Main Virtual Room
08.45	09.15	**Keynote Session 1** Dr. Ahmed Mourad (University of Queensland, AUSTRALIA)	Main Virtual Room
09.15	09.45	Keynote Session 1 Closing + Photo Session	Main Virtual Room
09.45	10.00	Break	-
10.00	12.05	Parallel Session 1	Virtual Breakout Room
12.05	13.00	Break	-
13.00	13.30	**Keynote Session 2** Prof. Chuan-Kai Yang, Ph.D (National Taiwan University of Science and Technology, TAIWAN)	Main Virtual Room
13.30	14.00	Keynote Session 2 Closing + Photo Session	Main Virtual Room
14.00	14.15	Break	-
14.15	16.20	Parallel Session 2	Virtual Breakout Room
16.20	16.30	Closing Day I	Main Virtual Room

Day 2: Thursday, August 26th 2021 (Time Zone: (GMT+7:00) Jakarta)

From	To	Activities	Venue
08.00	08.30	Registration	Main Virtual Room
08.30	09.00	**Keynote Session 3** Dr. Anton van der Vegt (University of Queensland, AUSTRALIA)	Main Virtual Room
09.00	09.30	Keynote Session 3 Closing + Photo Session	Main Virtual Room
09.30	10.00	Break	-
10.00	12.05	Parallel Session 3	Virtual Breakout Room
12.05	13.00	Break	-
13.00	14.40	Parallel Session 4	Virtual Breakout Room
14.40	15.05	Awarding Session and Closing Ceremony	Main Virtual Room

Schedule on Parallel Session

PARALLEL SESSION 1

Venue: Virtual Meeting – Breakout Room Suro

Session Chair: Alexander Yohan

No.	From	To	Paper ID	Author	Paper Title
1.	10.00	10.25	43	Joko Siswantoro, Ida Bagus Made Artadana and M. Z. F. N. Siswantoro	Automatic Leaf Geometric Properties Measurement Based on Camera Parameters
2.	10.25	10.50	20	Vincentius Riandaru Prasetyo and Anton Hendrik Samudra	Hate Speech Content Detection System on Twitter using K-Nearest Neighbor Method
3.	10.50	11.15	30	Mohammad Farid Naufal and Selvia Ferdiana Kusuma	Weather Image Classification using Convolutional Neural Network with Transfer Learning
4.	11.15	11.40	33	Daniel Prasetyo	Implementing Directed Pairwise Judgement Approach in Web-based AHP Survey Application to Reduce Inconsistency Ratio
5.	11.40	12.05	29	Yenny Sari, Vincentius Riandaru Prasetyo and Kevin Liyansah	Designing a Recommender System based on the Application of Decision Tree Algorithm in Data Mining with KNIME

Venue: Virtual Meeting – Breakout Room Boyo

Session Chair: Esti Dwi Rinawiyanti

No.	From	To	Paper ID	Author	Paper Title
1.	10.00	10.25	63	Eric Wibisono, Iris Martin and Dina Natalia Prayogo	Genetic Algorithm with Adaptive Diversification and Intensification for the Vehicle Routing Problem
2.	10.25	10.50	23	Senapati C. Adisasmito, Pradipta Deffinika Pamungkas and Anas Ma'Ruf	Real-time Monitoring Design for Make-To-Order Industry
3.	10.50	11.15	44	Gunawan	Community Mobility during Covid-19 Pandemic and Tourism Performance: Data Mining Approach
4.	11.15	11.40	35	Hans Tanto, Hanijanto Soewandi and Indriati Bisono	Simple Heuristics for Scheduling Apache Airflow: A Case Study at PT. X

PARALLEL SESSION 2

Venue: Virtual Meeting – Breakout Room Suro

Session Chair: Eric Wibisono

No.	From	To	Paper ID	Author	Paper Title
1.	14.15	14.40	15	Markus Hartono	Kansei Engineering and Product-Service Systems (KEPSS) for Customer-centered Experience
2.	14.40	15.05	28	Indra Setiawan and Hernadewita	Reducing Lead Time of Production Process Using Integration Value Stream Mapping and Kaizen: A Case Study in the Side Board Division
3.	15.05	15.30	39	Esti Dwi Rinawiyanti, Xueli Huang and Sharif As-Saber	Integration of Corporate Social Responsibility for Improved Business Performance: Evidence from the Indonesian Manufacturing Industry
4.	15.30	15.55	55	Noverta Putra, Indri Hapsari and Dina Prayogo	Inventory System Improvement for Short-lived Item
5.	15.55	16.20	38	Hibarkah Kurnia, Choesnul Jaqin and Humiras Hardi Purba	Quality Improvement with PDCA Approach and Design of Experiment Method in Single Socks Industry in Indonesia

Venue: Virtual Meeting – Breakout Room Boyo

Session Chair: Emma Savitri

No.	From	To	Paper ID	Author	Paper Title
1.	14.15	14.40	42	Putu Doddy Sutrisna, Meyta Sanoe, Rifando Gogo Adiyaksa, Kristina Wahyu Agustine, Hadiatni Rita Priyantini, Prayogo Widyastoto Waluyo and I Made Ronyastra	The Effects of Material to Solvent Ratio on The Performances of Natural Dyes Extraction
2.	14.40	15.05	56	Rezha Rachmady, Ari Rahman and Wahyu Kunto Wibowo	Textile Wastewater Purification Using Corona Discharge Method
3.	15.05	15.30	10	Lieke Riadi, Ruth Chrisnasari, Joshua Kristanto, Cahaya Caesar Brigavida and Meyta Sanoe	Immobilization of Xylanase on Acid Pretreatment Bentonite as Green Biocatalyst
4.	15.30	15.55	41	Lanny Sapei, Rudy Agustriyanto, Endang Wahyu Fitriani, Zerravym Levy and Cindy Sumampouw	Rice Husk Ash for the Stabilization of the Outer Interfacial Layer of W/O/W Double Emulsion
5.	15.55	16.20	54	Delyana Ratnasari, Widiyastuti Widiyastuti and Heru Setyawan	One-Step Electrochemical Synthesis of Silica-coated Magnetite Nanofluids

PARALLEL SESSION 3

Venue: Virtual Meeting – Breakout Room Suro

Session Chair: Joko Siswantoro

No.	From	To	Paper ID	Author	Paper Title
1.	10.00	10.25	46	Alexander Yohan, Nai-Wei Lo and Kevin Valentino	A Design of Secure Supply Chain Management System with Blockchain Technology
2.	10.25	10.50	27	Susana Limanto, Endah Asmawati and Yusuf Wira Kencana Putra	School Finder, Intelligent Recommendation System for Elementary School Selection
3.	10.50	11.15	58	Andre Andre and Marcellinus Ferdinand Suciadi	The Online Attendance System Models for Educational Institutions
4.	11.15	11.40	36	Elieser Tarigan	Simulation of Impact Azimuth Angle on Specific Energy Output of a Fixed Mounting Rooftop PV System in Jakarta, Indonesia
5.	11.40	12.05	65	Christabel Parung and Prayogo Waluyo	Users' Perception of Digital Prototypes in Indonesian Fashion Industry: A Qualitative Study

Venue: Virtual Meeting – Breakout Room Boyo

Session Chair: Putu Doddy Sutrisna

No.	From	To	Paper ID	Author	Paper Title
1.	10.00	10.25	34	Puguh Setyopratomo and Lanny Sapei	Rheological Behavior and Antioxidant Activity of Carrageenan Extracted from Green Seaweed (Eucheuma cottonii) Using Alkaline Solution at Low Temperature
2.	10.25	10.50	49	Marta Devega Yuharma, Widiyastuti Widiyastuti, Ni Made Intan Putri Suari and Heru Setyawan	A Performance Study of Magnetite-Lignin Composites as Photothermal Materials in Solar Steam Generation System
3.	10.50	11.15	50	Diana Novita Sari, Mahardika F. Rois, Widiyastuti Widiyastuti and Heru Setyawan	Organosolv Lignin from Coir Fibers as Potential Biomaterials for Sunscreen
4.	11.15	11.40	53	Ratri Sekaringgalih, Widiyastuti Widiyastuti and Heru Setyawan	The Effect of Sodium Lauryl Sulfate on Silica Nanofluid Stabilization Using Microbubble Method
5.	11.40	12.05	60	Emma Savitri	Synthesis and Characterization of Chitosan-Allium Sativum Film

PARALLEL SESSION 4

Venue: Virtual Meeting – Breakout Room Suro

Session Chair: Christabel Parung

No.	From	To	Paper ID	Author	Paper Title
1.	13.00	13.25	32	Jimmy Jimmy and Vincent Riandaru Prasetyo	Sentiment Analysis on Feedback of Higher Education Teaching Conduct: An Empirical Evaluation of Methods
2.	13.25	13.50	26	Md. Hazrat Ali	Recent advances and application of Selective Laser Melting (SLM) in the aerospace industry
3.	13.50	14.15	25	Rudy Agustriyanto, Puguh Setyopratomo and Endang Srihari Mochni	Dynamic Study of Batch Milk Cooling Process at KUD SAE Pujon
4.	14.15	14.40	31	Ellysa Tjandra, Sri Suning Kusumawardani and Ridi Ferdiana	Student Performance Prediction in Higher Education: A Comprehensive Review

Venue: Virtual Meeting – Breakout Room Boyo

Session Chair: Elieser Tarigan

No.	From	To	Paper ID	Author	Paper Title
1.	13.00	13.25	52	Delta Ardy Prima	Implementation of Behavior Tree for Creating an In-Game Cut-Scene
2.	13.25	13.50	45	Putu Padmareka Deandra, Herry Santoso and Judy Retti B. Witono	Carbon Based Sulfonated Catalyst as an Environment Friendly Material: A Review
3.	13.50	14.15	9	Yu-Chung Tsao, Felix Arril Simbara Barus and Chien-Wei Ho	How energy efficiency, smart factory, and mass personalization affect companies in Industry 4.0
4.	14.15	14.40	18	Yoni Kristiawan, Edi Purwanto, and Rustono Farady Marta	The Role of Supply Chain Performance to Determine the Firm Performance

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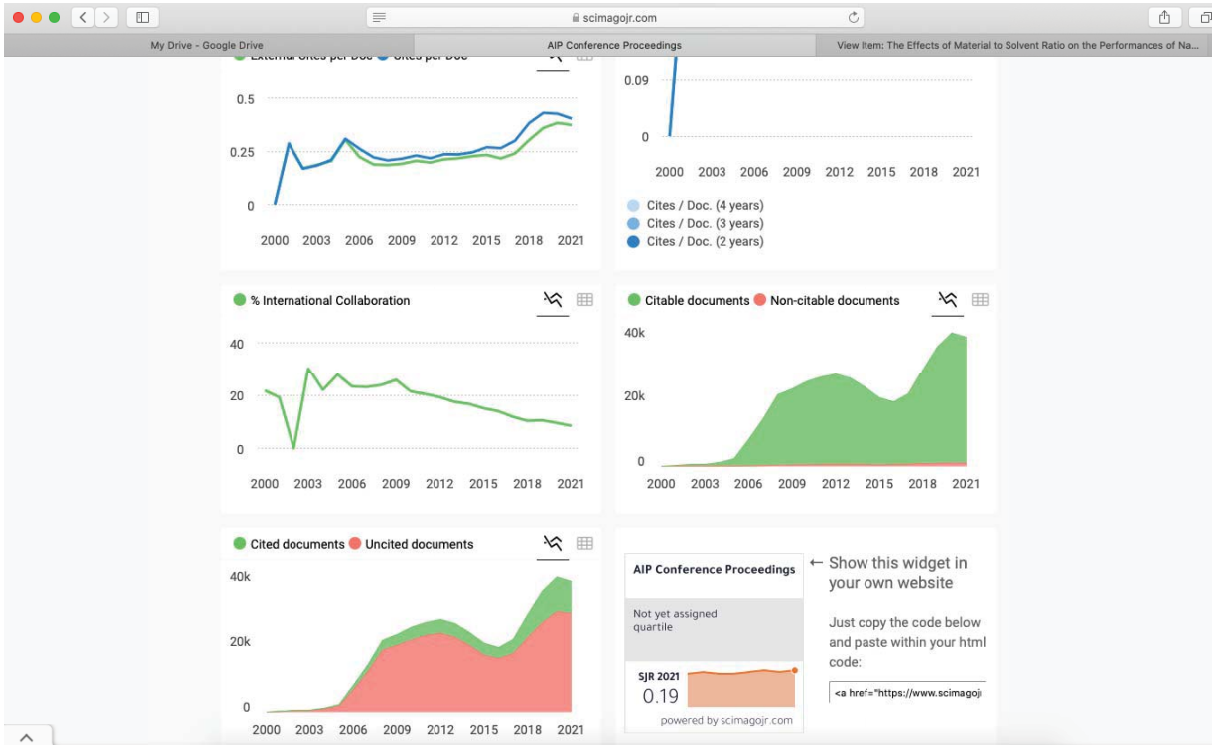

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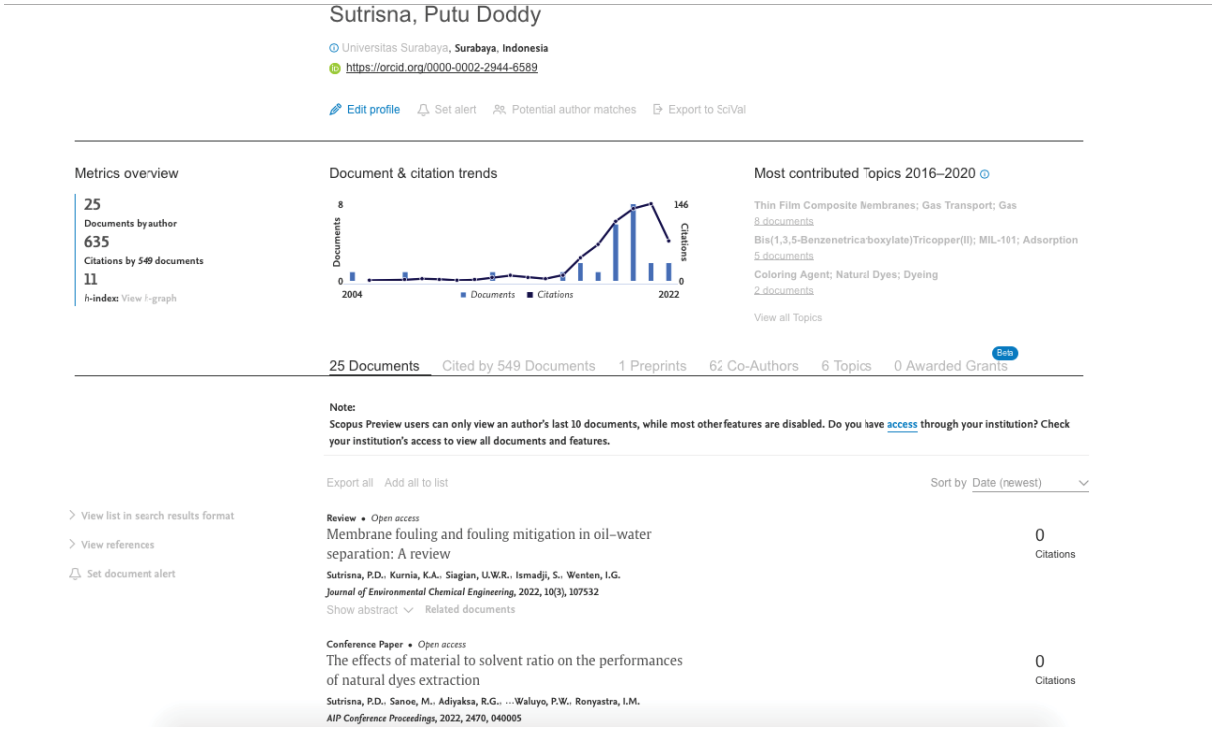

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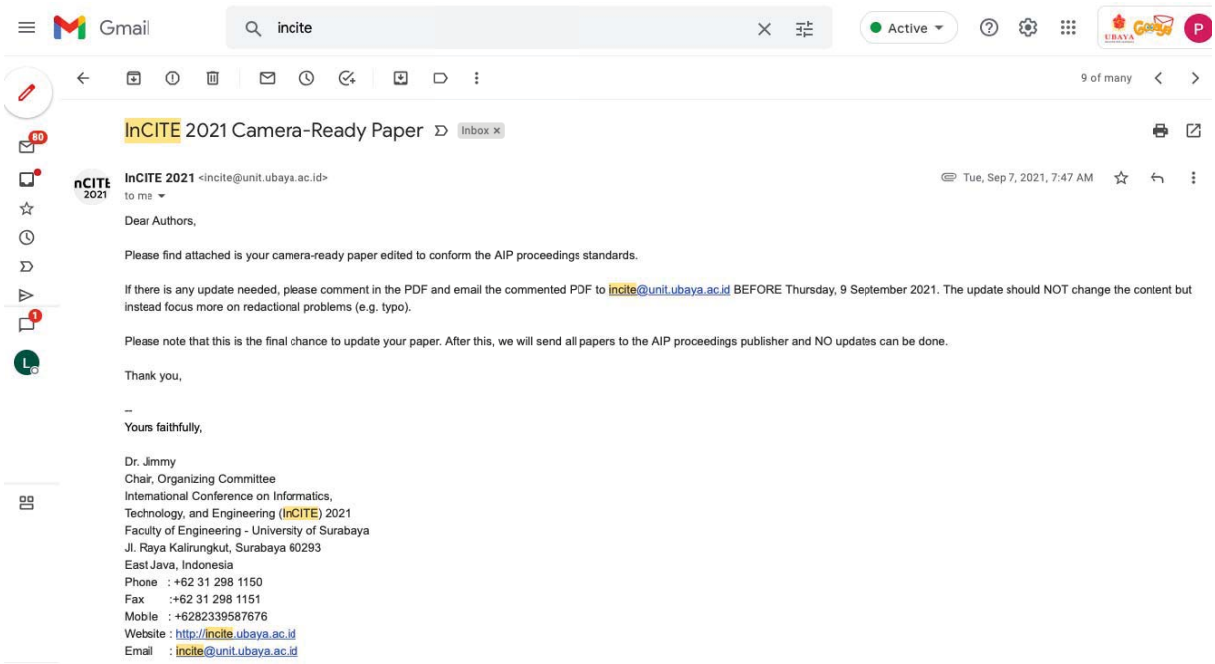

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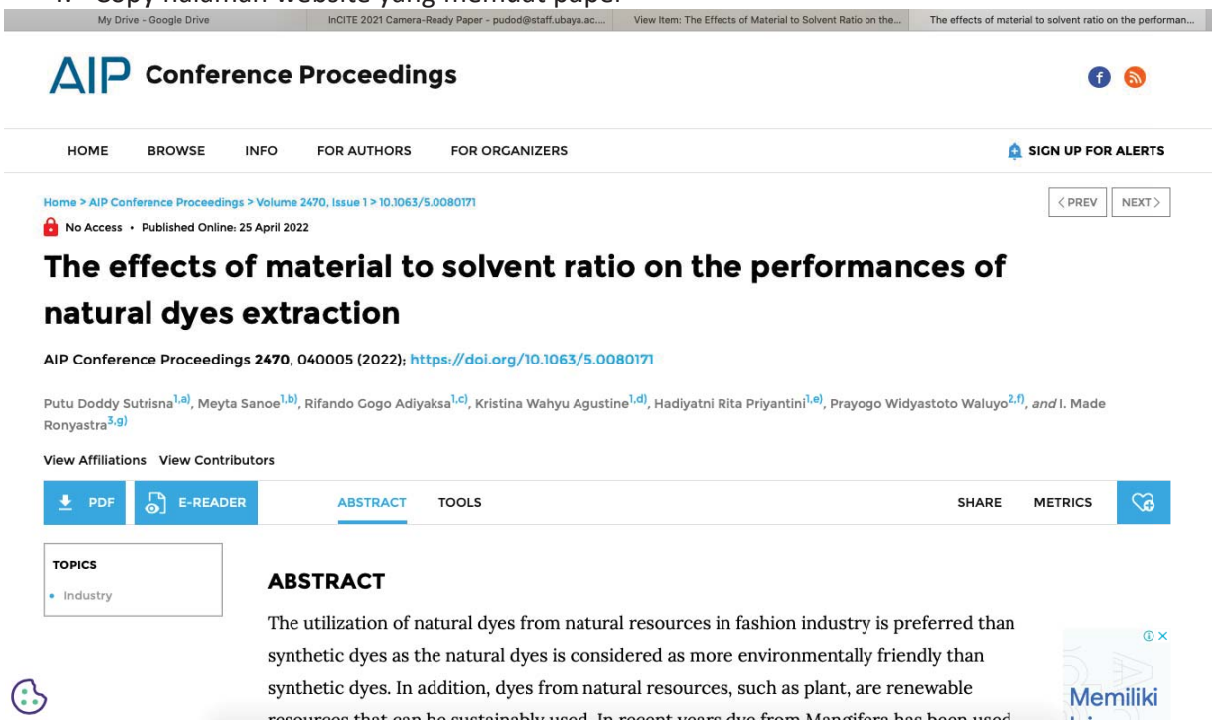

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The effects of material to solvent ratio on the performances of natural dyes extraction

AIP Conference Proceedings 2470, 040005 (2022); https://doi.org/10.1063/5.0080171

Putu Doddy Sutrisna[1,a], Meyta Sanoe[1,b], Rifando Gogo Adiyaksa[1,c], Kristina Wahyu Agustine[1,d], Hadiyatni Rita Priyantini[1,e], Prayogo Widyastoto Waluyo[2,f], *and* I. Made Ronyastra[3,g]

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ABSTRACT

The utilization of natural dyes from natural resources in fashion industry is preferred than synthetic dyes as the natural dyes is considered as more environmentally friendly than synthetic dyes. In addition, dyes from natural resources, such as plant, are renewable resources that can be sustainably used. In recent years dye from Mangifera has been used

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