BOOK OF ABSTRACT & PROGRAM

2020 4th International Conference on Engineering and Applied Technology (ICEAT)

October, **27-28**, 2020

Magelang, Jawa Tengah
Indonesia

Organized by :

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ICEAT
2020 4th INTERNATIONAL CONFERENCE ON ENGINEERING AND APPLIED TECHNOLOGY
Resource - Based Sustainable Engineering Science and Technology: A New Direction of 4.0 Research and Development
October 27th, 2020 / MAGELANG, INDONESIA

Book of Abstract and Program

2020 4th International Conference on Engineering and Applied Technology (ICEAT)

Resource - Based Sustainable Engineering Science and Technology:

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Welcome Message from
Rector of Universitas Muhammadiyah Magelang

Assalamualaikum wr. wb.

Greetings to all of us,
Welcome to Universitas Muhammadiyah Magelang (UNIMMA).

First of all, let us praise and thank Allah SWT, Almighty God, for His grace, we are all in good health so that we can attend "the 4th International Conference on Engineering and Applied Technology (ICEAT) 2020 ". This activity is held in the form of a Blended Learning Conference, in which some participants attend offline and some online.

The activity of the 4th International Conference on Engineering and Applied Technology (ICEAT) 2020 which was originally held on June 29 - June 30 2020 in Magelang, coincided with the 48th Muhammadiyah Congress in Solo. However, due to the Covid'19 outbreak that hit the Indonesian nation starting in March 2020, ICEAT activities were postponed.

The 4th International Conference on Engineering and Applied Technology (ICEAT) 2020 was finally held on 26-27 October 2020 in Magelang, Indonesia. This conference was organized by the Universitas Muhammadiyah Magelang and Asosiasi Sains dan Teknologi Perguruan Tinggi Muhammadiyah (AST-PTM). This conference aims to discuss various times. development and innovation in advanced research in the field of Engineering and Applied Technology as well as providing an attractive forum for engineering scientists to share knowledge and expertise in related issues.

In line with the vision of the University of Muhammadiyah Magelang (UNIMMA) to "Become a superior and Islamic University in the development of science and technology-based on Islamic values for the benefit of the Ummah", and UNIMMA's mission "to organize quality and relevant ***Caturdharma*** activities with national challenges and global". So, UNIMMA will be active through education, research, and community service in providing solutions for the development of Indonesian society.

To achieve that, UNIMMA made a strategic step with efforts to 1) improve the culture and quality of research, entrepreneurial spirit, innovation, and community service to support national independence and provide solutions to national and global problems, 2) and strengthen collaboration and partnerships in education, research, and community service in a dynamic academic climate without boundaries. This is the reason UNIMMA is actively involved in AST-PTM.

AST-PTM is an association of technical personnel who are members of the Muhammadiyah Higher Education Science and Technology Association, intended to advance the engineering and science faculties of Muhammadiyah universities with various activities including Dean Forums, Study Program Forums, ICEAT, SNTT, PKMM, and product exhibitions. The program is packaged in a National Coordination Meeting (Rakornas) every year and a National Conference (Munas) every four years.

As the Rector of UNIMMA and the host of AST-PTM 2020, we wish you a happy activity, hopefully, you will produce the best works in engineering for the progress of the nation and state. From Muhammadiyah for the nation.

Thus, Wassalamu'alaikum wr. wb.

Dr. Suliswiyadi, M.Ag
Rector of Universitas Muhammadiyah Magelang
Yogyakarta, October 27th 2020

Welcome Message from
General Chair ICEAT 2020

Assalamu'alaikum Wr. Wb.

It my pleasure to warmly welcome all of you to the 4th ICEAT 2020 at Magelang, West Java, Indonesia

The International Conference on Engineering and Applied Technology (ICEAT) has been held annually starting from 2017 to 2019 hosted by Universitas Muhammadiyah Mataram, Universitas Muhammadiyah Aceh, and Universitas Muhammadiyah Sorong. Currently, the fourth ICEAT 2020 present is hosted by the Faculty of Engineering, Universitas Muhammadiyah Magelang, Central Java, Indonesia thought Virtual Conference posture in light of the COVID-19 pandemic that we face as a global community.

The 4th ICEAT 2020 is organized by Science and Technology Association of Muhammadiyah Higher Education (AST-PTM) as well as jointly with 11 University; Universitas Ahmad Dahlan, Universitas Muhammadiyah Jakarta, Universitas Muhammadiyah Aceh, Universitas Muhammadiyah Surakarta, Universitas Muhammadiyah Gresik, Universitas Muhammadiyah Buton, Universitas Muhammadiyah Prof Dr Hamka (UHAMKA), Universitas Muhammadiyah Yogyakarta, Universitas Muhammadiyah Purwokerto, Universitas Muhammadiyah Malang, and STT Muhammadiyah Cileungsi. On behalf of the organizing committee, I cordially welcome to all the delegates of the 4th ICEAT 2020.

Being in the fourth event, the 4th ICEAT 2020 is aimed at keeping abreast of the current development and innovation in the advanced research area on Engineering and Applied Technology as well as providing an engaging forum for participants to share knowledge and expertise in related issues. In this conference, we received 74 papers which were covered in five conference tracks. The committee member blindly reviewed as well as provided technical comments to all the submitted papers before ensuring that the submitted paper is qualified. Finally, we are accepting 62 papers to be presented at this conference.

Last but not least, I would like to use this opportunity to express our sincere gratitude to keynote speakers: Minister of Education and Culture of Indonesia Nadiem Anwar Makarim, B.A., M.B.A., Prof. Ismail Rakip Karas, Prof. Morten Holm Van Donk, Prof. Kun Harismah, M.Si., Ph.D., Prof. Dr. Kamarul Hawari Bin Ghozali as well as all the participants for joining and sharing of ideas, knowledge, and friendship in a relaxing environment. I would like to express great appreciation to the organizing team from Universitas Ahmad Dahlan as well as all scientific committees for all their solidity, harmony, and synergy work. We do hope all participants are going to enjoy the conference in terms of both its academic and social atmosphere. Finally, Please stay safe to everyone!

Aster Rahayu, Ph.D.
General Chair
2020 4th International Conference on Engineering and Applied Technology (ICEAT)
Faculty of Industrial Technology, Universitas Ahmad Dahlan
Yogyakarta, October 27th 2020

Conference Committee

General Chair
Aster Rahayu (Universitas Ahmad Dahlan, Indonesia)

Co-Chair
Yun Arifatul Fatimah (Universitas Muhammadiyah Magelang, Indonesia)
Andri Pranolo (Hohai University, China)

Technical Program Committee
A. Electronics, Electrical, Informatics, Computer Engineering
TPC Chair

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Gunawan Ariyanto (Universitas Muhammadiyah Surakarta, Indonesia)
Zulfatman (Universitas Muhammadiyah Malang, Indonesia)
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Slamet Riyadi (Universitas Muhammadiyah Yogyakarta, Indonesia)
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Adhi Prahara (Universitas Ahmad Dahlan, Indonesia)
Ahmad Azhari (Universitas Ahmad Dahlan, Indonesia)
Aji Prasetya Wibawa (Universitas Negeri Malang, Indonesia)
Emanuele Menegatti (Universita degli Studi di Padova, Padua, Italy)
Haviluddin (Universitas Mulawarman, Indonesia)
Anusua Ghosh (Univeristy of South Australia, Adelaide, Australia)
Abdulrazak Yahya Saleh (Universiti Malaysia Sarawak, Malaysia)
Arda Yunianta (Faculty of Computing and Information Technology, King Abdul aziz University, Saudi Arabia)
Sunardi (Universitas Ahmad Dahlan, Indonesia)
Moslem Yousefi (Korea university, Korea)

B. Industrial Engineering

TPC Chair

Yun Arifatul Fatimah (Universitas Muhammadiyah Magelang, Indonesia)

TPC Member

Pedro Hokama (University of Campinas, Brasil)
Wolfgang Keller (University of Colorado, Colorado, US)
Hari Prasetyo (Universitas Muhammadiyah Surakarta, Indonesia)
Eko Setiawan (Universitas Muhammadiyah Surakarta, Indonesia)
Ilyas Mas'udin (Universitas Muhammadiyah Malang, Indonesia)
Siti Mahsanah (Universitas Ahmad Dahlan, Indonesia)
Herry Purnama (Universitas Muhammadiyah Surakarta, Indonesia)

C. Mechanical Engineering

TPC Chair

Dan Mugisidi (UHAMKA Jakarta, Indonesia)

TPC Member

Lukas G. Swan (Dalhousie University, Canada)
Sudarisman (Universitas Muhammadiyah Yogyakarta, Indonesia)
Aris Widyo Nugroho (Universitas Muhammadiyah Yogyakarta, Indonesia)
Muji Setiyo (Universitas Muhammadiyah Magelang, Indonesia)
Marwan Effendy (Universitas Muhammadiyah Surakarta, Indonesia)

D. Chemical Engineering

TPC Chair

Tri Widayatno (Universitas Muhammadiyah Surakarta, Indonesia)
Tri Yuni Hendrawati (Universitas Muhammadiyah Jakarta, Indonesia)

TPC Member

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Nurul Hidayati Fithriyah(Universitas Muhammadiyah Jakarta, Indonesia)
Haryanto (Universitas Muhammadiyah Purwokerto, Indonesia)
Agus Aktawan (Universitas Ahmad Dahlan, Indonesia)

E. Civil Engineering and Architecture

TPC Chair

Agus Setyo Munthohar (Universitas Muhammadiyah Yogyakarta, Indonesia)

TPC Member

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Nurul Hidayati (Universitas Muhammadiyah Surakarta, Indonesia)
Samin (Universitas Muhammadiyah Malang, Indonesia)
Jazaul Ikhsan (Universitas Muhammadiyah Yogyakarta, Indonesia)

F. Architecture

TPC Chair

Ade FAH Alhashimy (Universias Muhammadiyah Sumatera Utara, Indonesia)

TPC Member

Gunawan (Universitas Muhammadiyah Surabaya, Indonesia)
Wisnu Setiawan (Universitas Muhammadiyah Surakarta, Indonesia)

G. Applied Science

TPC Chair

Imam Azhari (Universitas Ahmad Dahlan, Indonesia)

TPC Member

Iwan Tri Riyadi Yanto (Universitas Ahmad Dahlan, Indonesia)
Damar Yoga Kusuma (Universitas Ahmad Dahlan, Indonesia)
Rita Maliza (Universitas Ahmad Dahlan, Indonesia)

2020 4th International Conference on Engineering and Applied Technology (ICEAT)

Program in Glance

Tuesday, October 27th, 2020

08.00 - 08.05 WIB	**Video profile**
08.00 - 09.25 WIB	**Opening Ceremony:** Recite of the Holy Quran The Indonesian National Anthem Report from Head of AST-PTM **Welcome Message** 1. Rector of Universitas Muhammadiyah Magelang 2. Governor of Central Java, Indonesia
09.25 - 12.00	**Keynote Speech** 1. Keynote I : Nadiem Anwar Makarim, B.A, M.B.A 2. Keynote II : Prof. Ismail Rakip Karas 3. Keynote III : Prof. Morten Holm Van Donk 4. Keynote IV : Prof. Kun Harismah, M.Si., Ph.D 5. Keynote V : Prof. Dr. Kamarul Hawari Bin Ghozali
12.00 - 13:00	**Lunch Break**
13.00 - 17.00	**Parallel Session** 1. Mechanical Engineering Track 2. Industrial Engineering Track 3. Civil and Architecture Track 4. Electronic, Electrical, Informatics, Computer Engineering Track 5. Chemical Engineering Track
19.00 - 20.10	**Closing Ceremony and Gala Dinner** 1. Best Paper Award 2. Closing Remark

Parallel Session Program in Detail

13.00 – 17.00	**Parallel Session: Mechanical Engineering Track** **Moderator: Dan Mugisidi**
13.00 - 13.10	(#5) The influence of cutting parameters of conventional lathe on the dimension precision of door hinge product *Alviani Hesthi Permata Ningtyas (Universitas Muhammadiyah Gresik), Moh Jufriyanto (Universitas Muhammadiyah Gresik)*
13.10 - 13.20	(#19) Flow numerical analysis in the process of pouring resin on pelton turbine blade molds using solidworks software *Sudirman Lubis (Universitas Muhammadiyah Sumatera Utara), Munawar Alfansury Siregar (Universitas Muhammadiyah Sumatera Utara), Wawan Septiawan Damanik (Universitas Muhammadiyah Sumatera Utara)*
13.20 - 13.30	(#20) Exergy analysis desalination of single slope solar still *Munawar Alfansury Siregar (Universitas Muhammadiyah Sumatera Utara), Wawan Septiawan Damanik (Universitas Muhammadiyah Sumatera Utara), Sudirman Lubis (Universitas Muhammadiyah Sumatera Utara), Farel H Napitupulu (North Sumatera University), Himsar Ambarita (North Sumatera University), Jandri Fan HT Saragi (Universitas HKBP Nommensen Pematangsiantar)*
13.30 - 13.40	(#21) Effect of solar intensity on performance desalination single slope solar still *Wawan Septiawan Damanik (Universitas Muhammadiyah Sumatera Utara), Munawar Alfansury Siregar (Universitas Muhammadiyah Sumatera Utara), Sudirman Lubis (Universitas Muhammadiyah Sumatera Utara), Jandri Fan HT Saragi (Universitas HKBP Nommensen Pematangsiantar)*
13.40 - 13.50	(#24) Effect of soluble oil emulsion (SOE) oil coolant on surface roughness material steel ST37 in lathe grinding machine *Nasution (Universitas Muhammadiyah Sumatera Utara), Arya R (Universitas Muhammadiyah Sumatera Utara), B. Suroso (Universitas Muhammadiyah Sumatera Utara), M. Rizky (Universitas Muhammadiyah Sumatera Utara), I.Tanjung (Universitas Muhammadiyah Sumatera Utara), Affandi (Universitas Muhammadiyah Sumatera Utara)*

13.50 - 14.00	(#31) Hydrogen gas generation through water electrolysis with fragaria catalyst *Sudarman (Universitas Muhammadiyah Malang), Herry Suprianto (Universitas Muhammadiyah Malang), Achmad Fauzan Hery Soegiharto (Universitas Muhammadiyah Malang), Yepy Komaril Sofi'I (Universitas Muhammadiyah Malang)*
14.00 - 14.10	(#33) Thermoelectric utilization uses parabolic reflektors as an energy source *Faisal Irsan Pasaribu (Universitas Muhammadiyah Sumatera Utara), Noorly Evalina (Universitas Muhammadiyah Sumatera Utara), Partaonan Harahap (Universitas Muhammadiyah Sumatera Utara)*
14.10 - 14.20	(#41) Characterization of heat transfer enhancement and pressure drop in rectangular channel featuring different V-ribs construction *K. Umurani (Universitas Muhammadiyah Sumatera Utara), Muharnif M (Universitas Muhammadiyah Sumatera Utara), Rahmatullah (Universitas Muhammadiyah Sumatera Utara), I.Tanjung (Universitas Muhammadiyah Sumatera Utara)*
14.20 - 14.30	(#42) Performance of SI engine using blended fuel from waste plastic pyrolysis *Eqwar Saputra (Universitas Muhammadiyah Purwokerto), Marwan Effendy (Universitas Muhammadiyah Surakarta)*
14.30 - 14.40	(#45) An experimental study of a sawdust machine feeder performance on a roof tile furnace *Mulyono (Universitas Muhammadiyah Malang) , Achmad Fauzan Hery Soegiharto (Universitas Muhammadiyah Malang), Murjito(Universitas Muhammadiyah Malang), Bayu Sandy Tia(Universitas Muhammadiyah Malang)*
14.40 - 14.50	(#46) Effect of tempering process to the hardness and impact strength on NS 4340 steel *Affandi (Universitas Muhammadiyah Sumatera Utara), I Tanjung (Universitas Muhammadiyah Sumatera Utara), A R Nasution (Universitas Muhammadiyah Sumatera Utara)*
14.50 - 15.00	(#73) An-Nahl, The multifunction transportation system *Gunawan (Universitas Muhammadiyah Surabaya)*

15.00 - 15.10	(#60) Optimization of the type-L savonius wind turbine design *Firmansyah Azharul (Sekolah Tinggi Muhammadiyah Cileungsi), M. Dwi Trisno (Institute Sains and Teknologi Nasional), Dahmir Dahlan (Pancasila University), Wilarso (Sekolah Tinggi Muhammadiyah Cileungsi)*
15.10 - 15.20	(#58) Study of the utilization of thermoelectric generator and thermocline for improvement of solar still performance *Dan Mugisidi (Universitas Muhammadiyah Prof. DR HAMKA), Berkah Fajar (Diponegoro University), Syaiful (Diponegoro University) and Tony Utomo (Diponegoro University)*
13.00 – 17.00	**Parallel Session: Industrial Engineering Track** **Moderator: Ilyas Masudin**
13.00 - 13.10	(#2) Literature review business process management (BPM) level of maturity in msmes in Indonesia *Umi Chotijah (Universitas Muhammadiyah Gresik)*
13.10 - 13.20	(#4) Factor analysis that affects work productivity (case study: employee PDAM pamekasan district) *M Jufriyanto (Universitas Muhammadiyah Gresik), AW Rizqi (Universitas Muhammadiyah Gresik), Hidayat (Universitas Muhammadiyah Gresik), R M Yusron (University of Trunojoyo Madura)*
13.20 - 13.30	(#7) Proposed material requirement planning on slippers products with lot for lot approach *A W Rizqi (Universitas Muhammadiyah Gresik), M. Jufriyanto (Universitas Muhammadiyah Gresik), Hidayat (Universitas Muhammadiyah Gresik)*
13.30 - 13.40	(#10) Optimizing time and cost of project using critical path method in the making “lintel set point” (case study: Ravana jaya co. ltd.) *Muhammad Zainuddin Fathoni (Universitas Muhammadiyah Gresik)*
13.40 - 13.50	(#12) The safety culture in shipbuilding industries *Wisda Mulyasari (Universitas Muhammadiyah Gresik)*
13.50 - 14.00	(#13) Fiber natural powder engineering as a composite alternative material *Mochammad Nuruddin (Universitas Muhammadiyah Gresik)*

14.00 - 14.10	(#15) Hospital performance measurement based on intangible assets using Skandia Navigator model: A case study *Eko Budi Leksono (Universitas Muhammadiyah Gresik)*
14.10 - 14.20	(#16) Instrument to assess supply chain performance for broiler plasma farms *Elly Ismiyah (Universitas Muhammadiyah Gresik)*
14.20 - 14.30	(#17) Manufacturing industry strategy to improve the development of calcium carbonate products with quality function deployment techniques at PT. saribumi gresik- Indonesia *Moh. Dian Kurniawan (Universitas Muhammadiyah Gresik)*
14.30 - 14.40	(#34) Comparative analysis of academic website quality using the webqual method and modified importance performance analysis (MIPA) *DP Restuputri (Universitas Muhammadiyah Malang), A Kariono (Universitas Muhammadiyah Malang), SK Dewi (Universitas Muhammadiyah Malang), I Masudin (Universitas Muhammadiyah Malang)*
14.40 - 14.50	(#38) Manufacturing processes: Skate board from oil palm empty fruit bunch fiber composite *M Yani (Universitas Muhammadiyah Sumatera Utara), B Syam (University of Sumatera Utara), B Wirjosentono (University of Sumatera Utara), R W Lubis (Universitas Muhammadiyah Sumatera Utara), and B Suroso (Universitas Muhammadiyah Sumatera Utara)*
14.50 - 15.00	(#59) The strategy of small auto parts industries in responding to the market demand dynamics *A Efendi (Universitas Muhammadiyah Buton)*
15.00 - 15.10	(#61) Engineering of multicore type cable isolation machine with the DMAIC method to reduce product scrap *Miftahul Imtihan (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi), Suryanto (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi), Wilarso (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi)*

15.10 - 15.20	(#62) Failure bushing small end connecting rod diesel engine 3500 series *Wilarso (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi), Firmansyah Azharul (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi), Awang Surya (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi), Asep Dharmanto (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi)*
15.20 - 15.30	(#63) Reduction losses rate in filling process of stick ice product using the six sigma approach *Suwaryo Nugroho (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi), Miftahul Imtihan (Sekolah Tinggi Teknologi Muhammadiyah Cileungsi)*
15.30 - 15.40	(#65) Evaluating the service quality of third-party logistics service provider using importance-performance analysis *A K Garside (Universitas Muhammadiyah Malang)*
15.40 - 15.50	(#68) Designing System of Performance Measurement and Evaluation of Green Industry for Improving Industrial Sustainability *Ahmad Mubin (Universitas Muhammadiyah Malang)*
15.50 – 16.00	(#32) Student perceptions of supply chain manager skills and competency: comparative study of industrial engineering and management *Ilyas Masudin (Universitas Muhammadiyah Malang), Alfian Alif (Universitas Muhammadiyah Malang), Mohammad Fatkhur Rozi (Universitas Muhammadiyah Malang), Azizatur Ristanti (Universitas Muhammadiyah Malang), Dian Palupi Restuputri (Universitas Muhammadiyah Malang)*

13.00 – 17.00	**Parallel Session: Civil Engineering Track** **Moderator: Meillyta**
13.00 - 13.10	(#8) Application of AHP and TOPSIS methods for optional transportation cargo by freight forwarder (Route: Surabaya - Jakarta) *Rezki Setya Irsadi (Universitas Muhammadiyah Gresik)*
13.10 - 13.20	(#1) Identifying construction waste using lean management in a delay project: Case of emergency department building in Pidie Jaya Regency Hospital, Aceh Province, Indonesia *Hafnidar A Rani (Universitas Muhammadiyah Aceh), Aulina Adamy (Universitas Muhammadiyah Aceh), M Afifuddin (Syiah Kuala University), and Sheragizca Yolanda Situmeang (Syiah Kuala University)*
13.20 - 13.30	(#18) The effect of faunus ater shell as filler in asphalt concrete wearing course (AC-WC) mixtures *Firmansyah Rachman (Universitas Muhammadiyah Aceh), Tamalkhani Syammaun (Universitas Muhammadiyah Aceh), Ramadhansyah Putra Jaya (University of Malaysia Pahang) and Raihan Akmal (University Muhammadiyah Aceh)*
13.30 - 13.40	(#29) Analysis of concrete mixture with marble waste material as sand filler and bagasse ash as cement filler *Fahrizal Zulkarnain (Universitas Muhammadiyah Sumatera Utara), Sri Frapanti (Universitas Muhammadiyah Sumatera Utara), Alamsyah Putra Munthe (Universitas Muhammadiyah Sumatera Utara)*
13.40 - 13.50	(#44) Compare brick calculation as load and as structure with nonlinear analysis of soft storey behavior on buildings *Sri Frapanti (Universitas Muhammadiyah Sumatera Utara), Fahrizal Zulkarnain (Universitas Muhammadiyah Sumatera Utara), Sri Asfiati (Universitas Muhammadiyah Sumatera Utara)*
13.50 - 14.00	(#47) The effect of using silica fume on medium strength concrete *Husnah1, D R Basri (University of Abdurrab), P Ningrum (University of Abdurrab), H Mubarak (University of Abdurrab), M Yazid (University of Abdurrab), M Toyeb (University of Abdurrab), R Tisnawan (University of Abdurrab), R R Husaini (University of Abdurrab), F Ramdhani (University of Abdurrab), and C Veddayana (University of Abdurrab)*

14.00 - 14.10	(#49) Study on river morphology in Pabelan river after the Merapi eruption in 2010 *J Ikhsan (Universitas Muhammadiyah Yogyakarta), U I Rahmawati (Universitas Muhammadiyah Yogyakarta) and A Hairani (Universitas Muhammadiyah Yogyakarta)*
14.10 - 14.20	(#52) Design of sheet metal roll machine for Making Corrugated tile model *B Suroso1 (Universitas Muhammadiyah Sumatera Utara), M Muharnif (Universitas Muhammadiyah Sumatera Utara), M Yani (Universitas Muhammadiyah Sumatera Utara), Nasution, Arya R (Universitas Muhammadiyah Sumatera Utara)*
14.20 - 14.30	(#54) Erosion analysis with USLE model on Sermo Reservoir Catchment Area *Iskahar (Universitas Muhammadiyah Purwokerto)*
14.30 - 14.40	(#66) Level of land degradation in West Lombok *Barzian Ali Aktab (Universitas Muhammadiyah Mataram), Febrita Susanti (Universitas Muhammadiyah Mataram), and Sri Apriani Puji Lestari (Universitas Muhammadiyah Mataram)*
13.00 – 17.00	**Parallel Session: Electronic, Electrical, Informatics, Computer Engineering Track** **Moderator: Ronny Dwi Agusulisty**
13.00 - 13.10	(#9) Literature review of regression testing technique as one of the ways of treatment software *Putri Aisyiyah Rakhma Devi (Universitas Muhammadiyah Gresik)*
13.10 - 13.20	(#25) Improving sustainability performance metrics using usability framework and WCAG 2.0 standard *Gita Indah Marthasari, Yufis Azhar, and Elza Norazizah*
13.20 - 13.30	(#40) A digital forensic analysis on mozilla firefox browser in android operating system *Mukhlis Prasetyo Aji (Universitas Muhammadiyah Purwokerto), Dimara Kusuma Hakim (Universitas Muhammadiyah Purwokerto)*

13.30 - 13.40	(#43) Three dimensional salah guide application based on augmented reality *Y H Winata (Universitas Muhammadiyah Jakarta), R Latifah (Universitas Muhammadiyah Jakarta), and Y Adharani (Universitas Muhammadiyah Jakarta)*
13.40 - 13.50	(#50) Implementation of the multi-factor process evaluation method to determine *mustahiq* priorities *Rita Dewi Risanty (Universitas Muhammadiyah Jakarta), Jumail (Universitas Muhammadiyah Jakarta), Rully Mujiastuti (Universitas Muhammadiyah Jakarta)*
13.50 - 14.00	(#71) Implementation of GPS for tracking of street vendor *Irvan Nauval (Universitas Muhammadiyah Magelang), R Arri Widyanto (Universitas Muhammadiyah Magelang), Agus Setiawan1, Nuryanto (Universitas Muhammadiyah Magelang), Nugroho Agung Prabowo (Universitas Muhammadiyah Magelang), Tuessi Ari Purnomo (Universitas Muhammadiyah Magelang)*
14.00 - 14.10	(#72) Implementation of hajj and umrah Q&A system using case-based reasoning (CBR) *F S Bachtiar (Universitas Muhammadiyah Malang), S Basuki (Universitas Muhammadiyah Malang) and G W Wicaksono (Universitas Muhammadiyah Malang)*
14.10 - 14.20	(#70) IT-based education online learning in the middle of covid-19 pandemic *Doddy Teguh Yuwono (Universitas Muhammadiyah Palangkaraya), Muh. Azhari (Universitas Muhammadiyah Palangkaraya), Siti Juhairiah (Universitas Muhammadiyah Palangkaraya)*
14.20 - 14.30	(#11) Vocal letter classification with audio processing for nursing room notification system with "mel frequency cepstrum coefficient and backpropagation-neural network methods” *Y. A. Suryo (Universitas Muhammadiyah Gresik), J. Siswanto (Universitas Muhammadiyah Gresik), Misbah (Universitas Muhammadiyah Gresik), P. P. S. Saputra (Universitas Muhammadiyah Gresik)*

14.30 - 14.40	(#26) Experimental study of titl angles on the performance of solar panels in Medan *C A Siregar (Universitas Muhammadiyah Sumatera Utara), M A Siregar (Universitas Muhammadiyah Sumatera Utara), A M Siregar (Universitas Muhammadiyah Sumatera Utara), Partaonan Harahap (Universitas Muhammadiyah Sumatera Utara)*
14.40 - 14.50	(#36) The using of ATMega 2560 micro-controller for LPG leakage detection *Noorly Evalina (Universitas Muhammadiyah Sumatera Utara), Faisal Irsan Pasaribu (Universitas Muhammadiyah Sumatera Utara), Abdul Azis H (Universitas Muhammadiyah Sumatera Utara), Zuli Agustina Gultom (Universitas Muhammadiyah Sumatera Utara)*
14.50 - 15.00	(#74) Cellular BTS traffic characterization based on covariance and correlation *Indar Surahmat (Universitas Muhammadiyah Yogyakarta)*
15.10 - 15.10	(#6) Three phase radial generator knock down *Ronny Dwi Agusulistyo (Sanata Dharma University), Martanto (Sanata Dharma University), Dwiseno Wihadi (Sanata Dharma University), Tjendro (Sanata Dharma University)*
13.00 – 17.00	**Parallel Session: Chemical Engineering Track** **Moderator: Rachma Tia Evitasari**
13.00 - 13.10	(#48) The effect of acrylic acid on the characteristics of chitosan based superabsorbent hydrogel *Haryanto (Universitas Muhammadiyah Purwokerto), Angga Yuli Setiawan (Universitas Muhammadiyah Purwokerto)*
13.10 - 13.20	(#51) The characteristics of porous asphalt using styrofoam substitution on 60/70 asphalt with rice husk ash with rock ash filler *Cut Nawalul Azka (Universitas Muhammadiyah Aceh), Rifki Hidayat (Universitas Muhammadiyah Aceh), Tamalkhani Syammaun (Universitas Muhammadiyah Aceh), Suci Mustikasari (Universitas Muhammadiyah Aceh)*
13.20 - 13.30	(#53) The effect of clay and SiO_2 composition on the physical properties of wall tile ceramic body *I Purnawan (Universitas Muhammadiyah Jakarta), A T Prabowo (Universitas Muhammadiyah Jakarta), and S E Rudiatin (Universitas Muhammadiyah Jakarta)*

13.30 - 13.40	(#55) Modification of PVC mechanical and migration properties by substitution of DOP plasticizer with epoxidized rice bran oil *Ahmad M R Triaji (Universitas Muhammadiyah Jakarta), Nurul H Fithriyah (Universitas Muhammadiyah Jakarta), and Ratri A Nugrahani (Universitas Muhammadiyah Jakarta)*
13.40 - 13.50	(#56) Carbon intensity-based approach for analyzing the environmental performance of nickel production in Indonesia *J S Adiansyah (Universitas Muhammadiyah Mataram), D Rahmawati (Universitas Muhammadiyah Mataram), A Alpiana (Universitas Muhammadiyah Mataram)*
13.50 - 14.00	(#64) Effect of temperature on brackish water adsorption in Kemudi village using activated zeolite *F Y Purwaningtyas (Universitas Muhammadiyah Gresik), Z Mustakim (Universitas Muhammadiyah Gresik), and Z N A C Rohmah (Universitas Muhammadiyah Gresik)*
14.00 - 14.10	(#22) Application of chitosan and catechin to improve color intensity and UV protection in the dyeing of cotton fabrics with natural dyes from *Peristrophe bivalvis* *R T Evitasari (Ahmad Dahlan University), E Rahayuningsih (Gadjah Mada University) and A Mindaryani (Gadjah Mada University)*

Parallel Session: Chemical Engineering Track
Moderator: Rachma Tia Evitasari

(#48) The Effect of Acrylic Acid on The Characteristics of Chitosan Based Superabsorbent Hydrogel

Haryanto (Universitas Muhammadiyah Sidoarjo), Angga Yuli Setiawan (Madura State University)

Superabsorbent hydrogel is a hydrophilic polymer with high water absorption capability. The superabsorbent hydrogels have become a potential material for some applications e.g. waste treatment, agriculture media, and health care applications. The chitosanbased superabsorbent hydrogel were synthesized with the variation of acrylic acid concentrations from 0% to 2% (v/v). The effects of acrylic acid on the characteristics of superabsorbent were studied in this research. Superabsorbent hydrogels were successfully synthesized from chitosan and acrylic acid using glutaraldehid as a crosslinker agent and potassium persulfate as an inisiator. The results show that the addition of acrylic acid increased the tensile strength and swelling ratio but decreased the gel fractions and elongation percentage of hydrogel. The highest swelling ratio (608%) was obtained at 2% concentration of acrylic acid.

(#51) The Characteristics of Porous Asphalt Using Styrofoam Substitution on 60/70 Asphalt with Rice Husk Ash with Rock Ash Filler

Cut Nawalul Azka (Universitas Muhammadiyah Aceh), Rifki Hidayat (Universitas Muhammadiyah Aceh), Tamalkhani Syammaun (Universitas Muhammadiyah Aceh), Suci Mustikasari (Universitas Muhammadiyah Aceh)

Asphalt Porus is a flexible pavement technology that can be applied in areas of Indonesia which have a tropical climate with high rainfall which danger of water. One of the innovations that can be used is porous asphalt with styrofoam as polymer added material. The quality of bitumen can also be improved by using fillers in the mixture. The waste of rice husk ash is used as a filler to help the performance of asphalt mixture to improve quality and reduce the damage of environmental. The research is the characteristics of the porous asphalt mixture with the substitution of styrofoam into asphalt penetration of 60/70 with the variation of filler rice husk ash and rock ash.The specimens preparation of Optimum Asphalt Content (OAC) based on the Australian Method by some parameters namely; the value of Cantabro Loss (CL), Asphalt Flow Down (AFD), Voids in Mix (VIM) and Permeability. Open graded aggregate was used and substitution of styrofoam variations were 7%, 9% and 11% with the variation fillers. The results that the Optimum Asphalt Content was 5.58%. The asphalt with Styrofoam substitution with rice husk ash (RHA) and rock ash (RA) filler of the best with the value CL, AFD, VIM, and permeability at the Styrofoam content of 7% using the filler material (RA 25% - RHA 75%). Which all the parameters have required by AAPA (2004). The value of void in mix with substitution styrofoam 7% of filler in the mixture. The increase in asphalt content is the cantabro loss value can be increase, in other words, the resistance of the mixture to the release of grain is getting bigger, while the greater the asphalt content into the asphalt flow down value of the mixture to also increase so that the level of separation of asphalt with aggregate in the mixture is getting bigger.

(#53) The Effect of Clay and SiO2 Composition on the Physical Properties of Wall Tile Ceramic Body

I Purnawan (Universitas Muhammadiyah Jakarta), A T Prabowo (Universitas Muhammadiyah Jakarta), and S E Rudiatin (Universitas Muhammadiyah Jakarta)

Ceramics are used as a body, filler as well as coating material which is not only useful for strengthening but also beautifying buildings or filled/coated material. The material for the manufacture must be carefully selected in order to meet the predetermined criteria. The main ingredients for making ceramics are clay and feldspar which in this research uses SiO_2. The supporting ingredients added are waterglass and water. In this study, the effect of SiO_2 composition was observed in 6 samples, consist of 3 samples with additional SiO_2 composition and another 3 samples with additional clay. The physical tests performed were rheology, residues, shrinkage after drying and firing, water absorption, loss on ignition (LOI) and bending strength. The test results show that additional SiO_2 composition will reduce viscosity, LOI, shrinkage and bending strength, but increase the residue. On the contrary, additional clay composition will increase viscosity, LOI, shrinkage and bending strength, but decrease residue. The addition of SiO_2 as an additive in filler material at certain percentage is taking into account as it has lower LOI and shrinkage values. However, from an economic point of view, additional SiO_2 is also need to be considered as it is more expensive than clay.

(#55) Modification of PVC mechanical and migration properties by substitution of DOP plasticizer with epoxidized rice bran oil

Ahmad M R Triaji (Universitas Muhammadiyah Jakarta), Nurul H Fithriyah (Universitas Muhammadiyah Jakarta), and Ratri A Nugrahani (Universitas Muhammadiyah Jakarta)

Polyvinyl chloride (PVC) is one of widely used and versatile plastic materials. One phthalate plasticizer commonly used in PVC compounding is the toxic dioctyl phthalate (DOP). DOP is easily oxidized and non-renewable. Therefore a non-toxic bio plasticizer of epoxidized rice bran oil (ERBO) was employed to substitute DOP in PVC compounds by 0, 25, 50, 75, and 100 %w/w. Mechanical properties of casted PVC samples were then characterized in terms of hardness, tensile strength, and elongation. Migration property characterisation was also performed. It was revealed that all those properties were influenced by the substitution level of bio plasticizer (calculated *F* values were all higher than the tabulated ones). The influence was significant for hardness and elongation (calculated *t* values were higher than the tabulated ones), but not significant for solvent migration and tensile strength (calculated *t* values were lower than the tabulated ones).

(#56) Carbon intensity-based approach for analyzing the environmental performance of nickel production in Indonesia

J S Adiansyah (Universitas Muhammadiyah Mataram), D Rahmawati (Universitas Muhammadiyah Mataram), A Alpiana (Universitas Muhammadiyah Mataram)

Nickel is one of the mineral commodities that play an essential role in the metals trade. The demand for nickel worldwide trends to be increased year by year with total reserve recorded 89 million tons, and Indonesia currently has the highest nickel deposits. In addition, nickel production requires bulk energy for processing nickel ores, and subsequently, it would contribute to the increase of Greenhouse gas (GHG) concentration in the atmosphere. This study aims to estimate the carbon intensity per ton product of nickel in Indonesia and to identify its main contributors. A nickel processing plant in Indonesia with a production capacity of 250,000

tons that using RKEF technology was taken as a case study. The method that applied for estimating the GHG emission is adapted from the Intergovernmental Panel on Climate Change (IPCC). The result of GHG Emissions is divided by the total product of nickel to generate the carbon intensity per ton nickel product per year. The result showed that a total of 2.6 million tons of CO_2-e per year was generated for nickel production. The total carbon intensity of nickel production was 10.5 ton CO_2-e/ton nickel product that generated by five areas, namely power plant, construction and engineering, processing plant, auxiliary, and transport logistic. The carbon intensity of nickel production in Indonesia appears to be in the range of carbon intensity other nickel companies worldwide. In addition, hydrocarbon-based materials utilization such as coal, diesel fuel was found as the main contributor for generating high GHG emissions.

(#64) Effect of temperature on brackish water adsorption in Kemudi village using activated zeolite

F Y Purwaningtyas (Universitas Muhammadiyah Gresik), Z Mustakim (Universitas Muhammadiyah Gresik), and Z N A C Rohmah (Universitas Muhammadiyah Gresik)

Kemudi village is one of the villages in Gresik district where groundwater is brackish water. The water salinity in this village was 30.11 g / L with a chloride concentration of 9,128.4 ppm. The high concentration of chloride made the water in the village unfit for consumption. One of the desalination technologies that can be used to reduce chloride concentration in water is the adsorption method. The adsorbent used was in the form of natural zeolite that had been physically activated at a temperature of 400 ℃ with a size of 60 mesh. The adsorption temperatures used in this study were 30, 40, and 50 ℃. Activated zeolites had a higher ability to adsorb contaminants in water compared to non-activated zeolites. Activated zeolites could reduce concentration of chloride by up to 12.6% at an operating temperature of 30 ℃. Dissolved iron concentration deceased from 1.02 mg / L to 0.24 mg / L, turbidity decreased to 0 NTU, and the color scale decreased to <0.2 TCU.

(#22) Application of Chitosan and Catechin to improve color intensity and UV Protection in the dyeing of cotton fabrics with natural dyes from *Peristrophe bivalvis*

R T Evitasari (Ahmad Dahlan University), E Rahayuningsih (Gadjah Mada University) and A Mindaryani (Gadjah Mada University)

The use of natural dyes as textile dyes is increasingly in demand since public awareness of the dangers of synthetic dyes have been increasing. Natural dyes produce a weak color intensity and require repeated dyeing to produce the desired color. This paper studied the effect of chitosan and catechin on the intensity and protection of fabrics in natural dyes from *Peristrophe bivalvis* expressed by parameters of UV protection factor (UPF) and color difference values (ΔE). As the concentration of chitosan and catechin increased, the color intensity increased as evidenced by the increase in the ΔE value. The best UPF value was obtained by combination treatment of chitosan and catechin on cotton fabric with the concentration of chitosan and catechin, respectively 15 g/L and 0.5 g/L in the treatment before and after dyeing resulted in UPF value of 7.22 and a color difference (ΔE) of 36.09. The best lightfastness obtained by a combination treatment of chitosan and catechin with the results increased to 3-4 (good).

Application of Chitosan and Catechin to Improve Color Intensity and UV Protection in the Dyeing of Cotton Fabrics with Natural Dyes from *Peristrophe bivalvis*

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Abstract. The use of natural dyes as textile dyes is increasingly in demand since public awareness of the dangers of synthetic dyes have been increasing. Natural dyes produce a weak color intensity and require repeated dyeing to produce the desired color. This paper studied the effect of chitosan and catechin on the intensity and protection of fabrics in natural dyes from *Peristrophe bivalvis* expressed by parameters of UV protection factor (UPF) and color difference values (ΔE). The effects were observed between chitosan treatment and combination of chitosan and catechin treatment of dyed cotton fabric in various concentration. The application on cotton fabric treatment were done before dyeing process, after dyeing process, and combination of both. In result, as the concentration of chitosan and catechin increased, the color intensity increased as evidenced by the increase in the ΔE value. The best UPF value was obtained by combination treatment of chitosan and catechin on cotton fabric with the concentration of chitosan and catechin, respectively 15 g/L and 0.5 g/L in the treatment before and after dyeing resulted in UPF value of 7.22 and a color difference (ΔE) of 36.09. The best lightfastness obtained by a combination treatment of chitosan and catechin with the results increased to 3-4 (good).

1. Introduction

With increasing awareness of the dangers of synthetic dyes to the environment, the use of natural dyes as textile dyes become a trend. However, the performance of natural dyes as fabric dyes is not as great as synthetic dyes. Synthetic dyes produce bright and long-lasting colors while natural dyes produce low color intensity. Dyeing cotton fabrics with natural dyes often requires repeated dyeing to produce the desired color, so it takes a long time to get the final product. Besides, the non-variety of colors produced is also the reason for the lack of commercial use of natural dyes as fabric dyes.

Natural dyes that produce red shades are still very limited, one source of natural dyes that are promising as a source of natural red coloring is *Peristrophe bivalvis* leaves. *Peristrophe bivalvis* contains the pigment phenoxazine which produces red color [1]. Research on the use of natural dyes from *Peristrophe bivalvis* on fabrics has been carried out by Evitasari, et al. [2], the optimum color intensity produced is K/S of 0.597 using $FeSO_4$ as mordant to increase affinity of fabric to the dye, with a concentration of 10.96 o.w.f. % at dyeing temperature of 61^oC.

To increase the color intensity and fastness, several ways can be done, one of which is by adding chemicals to the coloring process. In dyeing fabrics with natural dyes from *Peristrophe bivalvis*, this has been done with the addition of a UV absorber by Evitasari and Rahayuningsih [3]. In that study, a benzophenone and benzotriazole UV absorber were used. The addition of UV absorbers to natural dyes

from *Peristrophe bivalvis* can increase the fabric's protection against UV rays but does not increase the intensity of the color. This research will increase the color intensity of the fabric using natural sources. Chitosan has begun to be used as an additive in fabrics to improve various functions of fabrics, including increasing sun fastness, increasing anti-bacterial properties, and anti-wrinkling in fabrics [4], [5]. Chitosan comes from crustaceans, so it is environmentally friendly. Other natural compounds that can be used as additives after the dyeing process are the catechin in green tea. Catechin is a polyphenol and antioxidant compound in green tea. Green tea contains about 30% - 42% by weight of catechin. Catechin can increase the sun-resistant properties of fabrics because they reduce the penetration of ultraviolet rays on fabrics [6]–[9].

This paper studied the effect of chitosan and catechin on the intensity and protection of fabrics in natural dyes from *Peristrophe bivalvis* expressed by parameters of UV protection factor (UPF) and color difference values (ΔE). Observations were made on variations in the concentration of chitosan and catechin as well as variations in the application process of chitosan and catechin before and after dyeing and the combination of both to see the effect of chitosan and catechin on the fabric coloring process.

2. Materials and Methods

2.1. Materials

The fabric used was 100% bleached cotton from Yogyakarta. The Mordant used in this research was ferrous sulfate ($FeSO_4$) provided by Gamaindigo. *Peristrophe bivalvis* was grown and cultivated in Yogyakarta. Chitosan (degree of deacetylation 90%) was provided by ChemMix. Catechin was extracted from local green tea.

2.2. Methods

2.2.1. Chitosan Solutions. Chitosan was dissolved in a 0.5% v/v acetic acid solution at various concentrations of 5, 10, and 15 g/L. In the treatment before the dyeing process, the fabric was soaked for 15 minutes in a solution of chitosan at 50°C as much as 20 mL. In the treatment after the dyeing process was carried out without heating.

2.2.2. Catechin Solutions. Fabrics were treated with 15 g/L chitosan and then treated with catechin. The concentration of green tea added was 0.05; 0.1; and 0.5 g/L. In the treatment before the dyeing process, the fabric was soaked for 15 minutes in a 20 mL green tea solution at a temperature of 50°C. In treatment after the dyeing process was done without heating.

2.2.3. Dyeing Process. The pre-mordanting process used ferrous sulfate as mordant with a concentration of 10.96%. Then dyed with natural dye from *Peristrophe bivalvis* leaves at 61°C for one hour in a shaker bath.

2.2.4. UV Protection Factor (UPF) Analysis. Samples were analysed by taking the reflectance value between 290 nm to 400 nm using Shimadzu Spectrophotometer UV-2401PC. The UV Protection Factor (UPF) values were calculated by equation 1, where S_λ is spectrum source (Wm^2nm^{-1}), E_λ is response spectrum, T_λ is transmittance, and $\Delta\lambda$ is the wavelength (nm).

$$UPF = \frac{\sum_{290nm}^{400nm} E_\lambda S_\lambda \Delta\lambda}{\sum_{290nm}^{400nm} E_\lambda S_\lambda T_\lambda \Delta\lambda} \quad (1)$$

2.2.5. Analysis of Color Difference (ΔE). Analysis of color difference values was calculated to determine the change in color intensity based on the parameters of CIELab color coordinates L *, a *, and b *. The L *, a *, and b * values respectively indicate brightness, red-green shades, and yellow-blue shades. The

difference in color compared was the fabric treated with the addition of chitosan and catechin to the fabric without the addition of additives. The color difference value (ΔE) is calculated by equation 2.

$$\Delta E = \left[(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2\right]^{1/2} \quad (2)$$

2.2.6. Color Fastness Test. Fabrics that have been dyed and treated with chitosan and catechin are tested for lightfastness, rubbing, and washing. The test is carried out based on the Indonesian National Standard (SNI). The test results in the visual form expressed in greyscale.

3. Results and Discussions

3.1. Chitosan Treatment on Dyed Cotton with Peristrophe bivalvis

In this study, chitosan treatment on cotton fabric dyed with natural dyes from *Peristrophe bivalvis* leaves can increase the fabric's protection against ultraviolet rays. Physically, there is a significant increase in the color intensity of the fabric with the addition of chitosan. The higher the concentration of chitosan added, the darker the resulting color. Besides, the fabric becomes stiffer. The stiffness of this fabric is due to the antistatic and anti-wrinkle properties of chitosan [10].

The value of UV Protection Factor (UPF) on fabrics dyed with natural dyes from *Peristrophe bivalvis* increases with the addition of chitosan concentrations. The UPF value with the addition of chitosan treatment is presented in Figure 1. The UPF value of untreated dyed cotton was 2.36 based on the previous study [3], the addition of chitosan before staining with a concentration of 5 g/L increased the UPF value to 4.13. The addition of the chitosan concentration value will increase the UPF value, at a concentration of 10 g/L and 15 g/L the UPF value is 4.36 and 4.37 in the application before the dyeing process. The increase in the UPF value along with the increasing chitosan concentration is due to the more evenly the chitosan is bound to the surface of the fabric, thus providing better protection.

The increase in different UPF values occurred in variations in the treatment process of chitosan application on cotton fabrics, before dyeing, after dyeing, and the combination of both. The highest UPF value resulted from the addition of chitosan before and after dyeing, followed by treatment before dyeing, and the lowest UPF value was in the addition of chitosan after the dyeing process. The highest UPF value was obtained when the addition of 15 g/L of chitosan was 6.16 in the addition process before and after dyeing. Followed by treatment before the dyeing process produces a UPF of 4.79 and the lowest is 3.31 in the chitosan application process after dyeing.

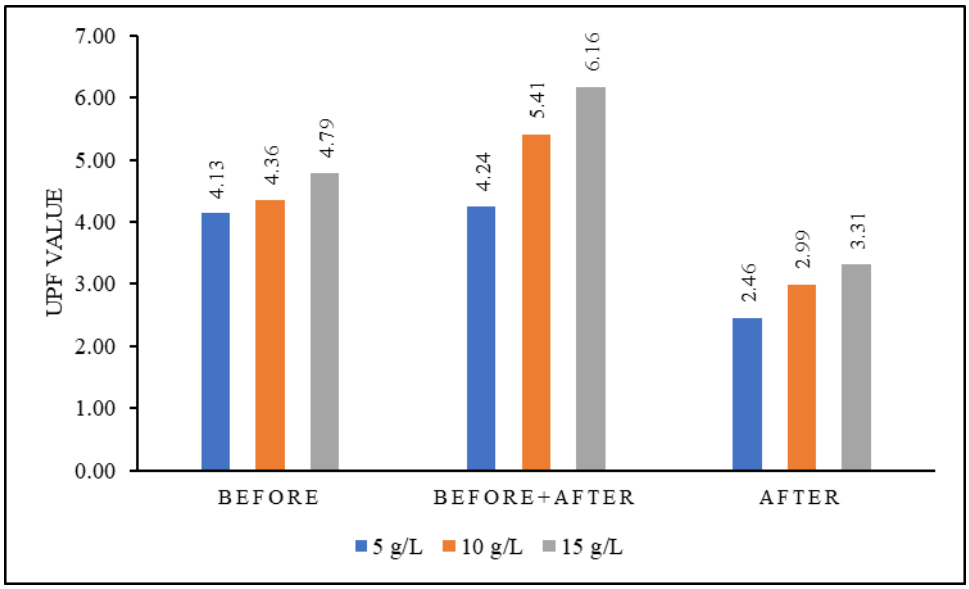

Figure 1. UPF Result with Chitosan Treatment.

Analysis of the color coordinate values and color difference (ΔE) on untreated fabrics and Chitosan treated fabrics are presented in Table 1. The higher the ΔE value, the darker the resulting color will appear, in other words, the higher the color intensity. The highest value of ΔE color difference in the addition of chitosan before and after dyeing was 32.53 at a concentration of 15 g/L. in the addition of chitosan before dyeing the difference was only slightly lower, at 31.56 in the same concentration. However, in the addition of chitosan after dyeing process, it only slightly increased the intensity of the color difference to 9.55 at a chitosan concentration of 15 g/L.

Table 1. Color Coordinates and Color Difference (ΔE) Value on Chitosan Treatment.

Treatment	Chitosan Concentration	L*	a*	b*	ΔE	Shades
Before	5 g/L	47.99	41.05	22.06	25.88	
	10 g/L	49.01	42.26	27.68	29.60	
	15 g/L	40.70	38.49	24.50	31.56	
Before + After	5 g/L	52.44	44.25	24.29	26.50	
	10 g/L	46.34	42.38	26.98	30.67	
	15 g/L	39.05	39.30	23.51	32.53	
After	5 g/L	65.26	32.22	6.00	3.08	
	10 g/L	65.41	32.72	5.66	3.64	
	15 g/L	55.73	32.42	6.25	9.55	

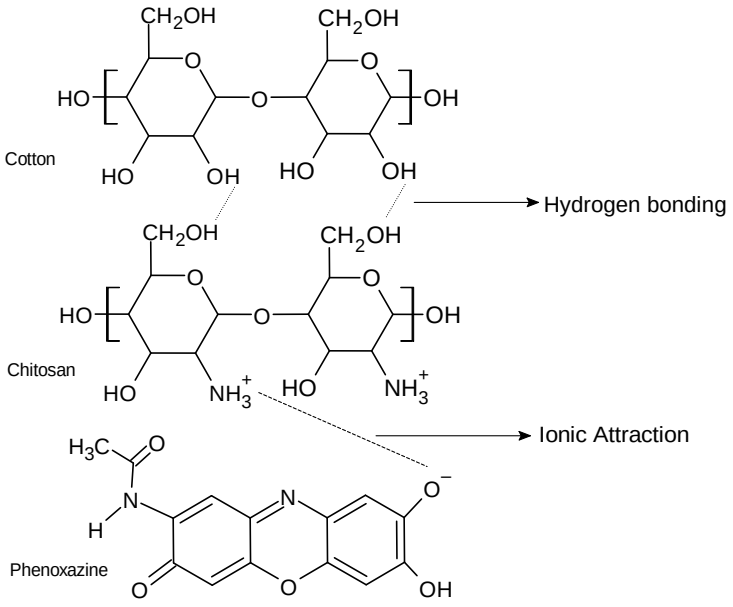

Figure 2. Bonding Mechanism between Cotton, Chitosan, and Phenoxazine.

The increasing amount of dye absorbed into the cotton fabric is caused by the amine group in chitosan, so there is an empty site to be filled with phenoxazine dyes [11]. Cotton fabrics have a low affinity for dyes because they are both negatively charged (anions) in solution. Chitosan acts as a mordant in fabrics because chitosan is positively charged (cation) in acidic conditions, so chitosan becomes a bridge between cotton fabric and dyes, in this study phenoxazine [6], [9]. Chitosan will form hydrogen bonds with cotton fabric, and form ionic bonds with phenoxazine dyes. The bonding mechanism that occurs between cotton, chitosan, and phenoxazine is presented in Figure 2.

3.2. Combination of Chitosan and Catechin Treatment on Dyed Cotton with Peristrophe bivalvis

In this study, the addition of a combination of chitosan and catechin from green tea to fabrics dyed with natural dyes from *Peristrophe bivalvis* leaves was intended to increase the fabric's protection against ultraviolet rays. The color produced on the cotton fabrics with the addition of chitosan and catechin was darker than the fabric treated with chitosan only. The higher the catechin concentration added, the darker the resulting color.

The value of UV Protection actor (UPF) on fabrics stained with natural dyes from *Peristrophe bivalvis* leaves with a combination treatment of chitosan and catechin is presented in Figure 3. The lowest UPF value with the addition of catechin after dyeing is with a concentration of 0.05 g/L, the UPF value is 2.61. The highest increase in UPF was achieved at the addition of the catechin concentration of 0.5 g/L by the treatment before and after the dyeing process at 7.22, the UPF value increased by 205%.

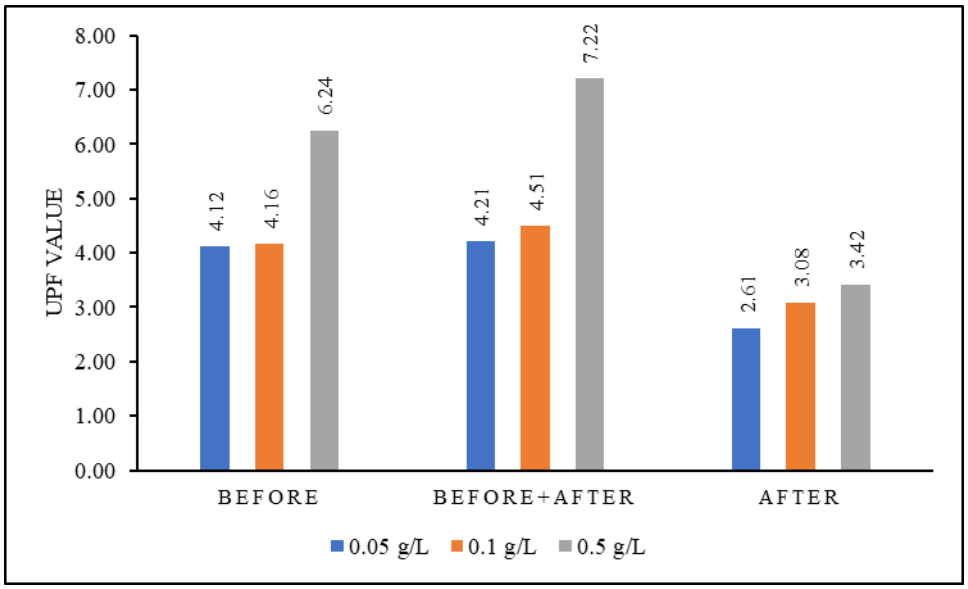

Figure 3. UPF Result with Combination of Chitosan and Catechin Treatment.

In the variation of treatment, the highest UPF value resulted from the addition of catechin before and after dyeing, followed by treatment before dyeing, and the lowest UPF value was in the addition of chitosan and catechin after the dyeing process. The increase in the UPF value occurred due to the addition of chitosan which functions as a mordant, and the addition of catechin as antioxidants so that they can ward off ultraviolet rays. The catechin extracted from green tea had a light brown color. This has an impact on the resulting fabric to be darker than the original color. Although catechin gave a dark color, they did not change the purplish-red color produced by phenoxazine from *Peristrophe bivalvis* leaf extract.

Analysis of color coordinate values and color difference (ΔE) on the combination treatment of chitosan and catechin are presented in Table 2. The higher the ΔE value, the darker the color will be. The highest value of ΔE color difference in the addition of chitosan before and after coloring was 36.09 at a concentration of 15 g/L. The addition of chitosan before dyeing obtained ΔE 33.61 at the same concentration. However, in the addition of chitosan after coloring, there was only a slight difference in color to 13.78 at a concentration of 15 g/L. The insignificant increase in the value of ΔE in the

application process of chitosan and catechin after dyeing shows that chitosan does not have the ability like mordant metal. Mordant metals such as $FeSO_4$ have the ability to darken natural dyes in fabrics. The application of chitosan after dyeing was able to lock the color on the cotton but did not increase the color intensity.

Table 2. Color Coordinates and ΔE on Combination of Chitosan and Catechin Treatment.

Treatment	Catechin Concentration	L*	a*	b*	ΔE	Shades
Before	0.05 g/L	51.48	45.52	25.34	28.38	
	0.10 g/L	43.06	38.41	25.31	30.28	
	0.15 g/L	34.68	31.29	15.81	31.59	
Before + After	0.05 g/L	38.70	34.87	20.98	30.43	
	0.10 g/L	41.83	41.81	27.40	33.61	
	0.15 g/L	42.98	43.30	31.38	36.09	
After	0.05 g/L	68.08	36.22	7.46	7.87	
	0.10 g/L	63.89	41.53	8.77	12.61	
	0.15 g/L	63.68	41.73	11.90	13.78	

Catechin bonds to fabrics just like phenoxazine dyes bond to fabrics. Catechin can be bound to the metal mordant and chitosan. The mechanism for the formation of complex compounds between cotton, chitosan, and catechin is presented in Figure 4.

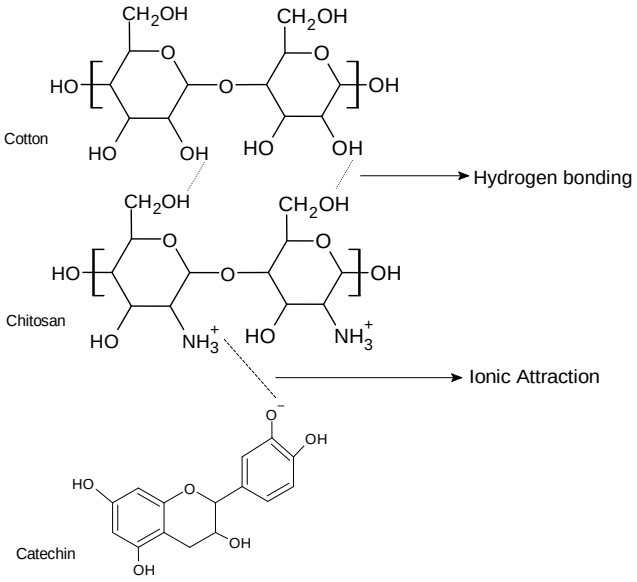

Figure 4. Bonding Mechanism between Cotton, Chitosan, and Catechin.

3.3. Color Fastness Properties

The fabric dyed with natural dyes from the leaves of *Peristrophe bivalvis* without treatment has fair fastness to sunlight and washing with a value of 2-3 for both [2]. The treatment of chitosan and catechin in dyeing fabrics with natural dyes from *Peristrophe bivalvis* leaves increased the fastness value, both from sunlight and washing. The best fastness resistance is obtained in fabric treatment with a combination of chitosan and catechin with a fastness rating to sunlight and washing of 3-4 or good and 3 or fair, respectively.

Table 3. Fastness Rating to Sunlight, Washing and Rubbing.

Treatment	Fastness		
	Sunlight	Washing	Rubbing
Untreated	2 – 3 (Fair)	2 – 3 (Fair)	4 – 5 (Good)
Chitosan	3-4 (Good)	3 (Fair)	4 – 5 (Good)
Chitosan & Catechin	3-4 (Good)	3 (Fair)	4 – 5 (Good)

4. Conclusion

The addition of chitosan and catechin can increase the color intensity of the fabric dyeing with natural dyes from *Peristrophe bivalvis*. As the concentration of chitosan and catechin increased, the color intensity increased as evidenced by the increase in the UPF and ΔE value. The best UPF value was obtained by combination treatment of chitosan and catechin on cotton fabric with the concentration of chitosan and catechin, respectively 15 g/L and 0.5 g/L in the treatment before and after dyeing resulted in UPF value of 7.22 and a color difference (ΔE) of 36.09. Supported by the results of the fastness to sunlight obtained by a combination treatment of chitosan and catechin with the results increased to 3-4 (good).

Acknowledgments

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