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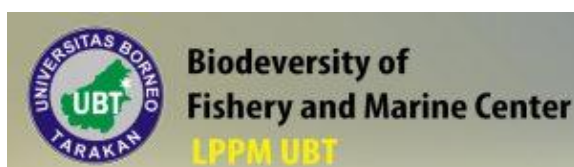
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CABE 2021

International Conference on Climate Change, Agriculture, Biodiversity, and Environment Study (CABE 2021)

Tarakan, North Kalimantan – Indonesia, 23-24 December 2021

Organized By:



Preface

International Conference on Climate Change, Agriculture, Biodiversity, and Environment Study (CABE 2021) was held in Tarakan, Indonesia. CABE 2021 was hosted by Biodiversity of Fishery and Marine Center LPPM UBT.

The conference is organized by the Research and Community Services Center of Borneo Tarakan University, Indonesia. The primary objective of The CABE 2021 is to promote effective interaction and cooperation among scientists and technicians who are involved in agriculture research and development in the world with the view of encouraging and facilitating research activity, implementing research findings, sharing of information and publication of research results. The CABE 2021 focuses on both theory, design and applications. In addition to the technical sessions, there will be invited sessions, panel sessions and keynote addresses.

At the moment, we are facing a new situation that has never happened before, the Global Pandemic caused by Coronavirus Disease of 2019 (Covid-2019). This issue has affected the lives of people globally, Including the lives of academics in education. The Covid-19 pandemic is an unprecedented phenomenon for us all. The situation is continually evolving, and we must face new challenges every day. With the appeal above, the International conference on Conference on Climate Change, Agriculture, Biodiversity, and Environment Study has been switch into virtually mode. Originally the coference was planned in a physical conference. However, until mid-September 2021, the conditions for Covid-19 were not normal. The participants really need the publication results as an annual performance report. In this case, all participants refuse if the conference is postponed. At 23-24 December 2021, all participants were invited virtually for preparation and simulation. In the conference day, all committee were organizing the conference in virtually using zoom application from Tarakan, Kalimantan, Indonesia. The structure were similar with the physical conference as indicated in the following conference program. The keynote speakers session was cunducted in the morning and continued with parallel sessions after lunch break. In the parallel session, each participant was preset their paper for 15 minutes including questions and answers. The CABE 2021 were attended around 170 audience with 121 presenters from academicians, students, scientists, and other related professionals.

Our special thank also goes to all individuals and organizations such as the international program committees (IPC), the conference organizers, the reviewers, and the authors, for their contribution in making CABE 2021 not only a successful international conference but also as a memorable gathering event. We are also grateful for the support of the publication service of IOP. We hope that it should give you a beautiful memory to bring home in addition to new insights and friends gathered during the conference. We are truly grateful for your contribution and interest. We hope that you will get pleasure from CABE 2021 in this beautiful city, Tarakan, Indonesia.

Best regards,

Dr. Ratno Achyani, S.Pi, M.Si (General Chair of CABE 2021)

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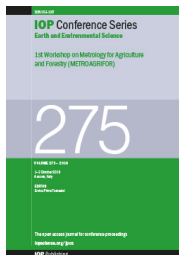
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- **Conference submission management system:** Edas
- **Number of submissions received:** 191
- **Number of submissions sent for review:** 191
- **Number of submissions accepted:** 121
- **Acceptance Rate (Submissions Accepted / Submissions Received × 100):** 63.4
- **Average number of reviews per paper:** 2
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Table of contents

Volume 1083

2022

◀ Previous issue Next issue ▶

International Conference on Climate Change, Agriculture, Biodiversity, and Environment Study 22/12/2021 - 24/12/2021 Online

Accepted papers received: 24 August 2022

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Open all abstracts

Preface

OPEN ACCESS	011001
Preface	
+ Open abstract View article PDF	

OPEN ACCESS	011002
Peer Review Statement	
+ Open abstract View article PDF	

List Paper CABE 2021

OPEN ACCESS	012001
The Content of Bioactive Compounds, Nutrients, and Antioxidant Activity of Karamunting Fruit from Tarakan Island	
T Ismandari	
+ Open abstract View article PDF	

OPEN ACCESS	012002
The Effect of Dosage and Biochar Types On the Availability Of Phosphorus Nutrients In Acid Soil In Sebatik, Indonesia	
N.I Mansyur, E.H Pudjiwati and T.N Rizki	
+ Open abstract View article PDF	

OPEN ACCESS	012003
The Potency of Karamunting Borneo Plants From Weeds Into Herbs	
E Jumiaty, T Ismandari, Amarullah and Willem	
+ Open abstract View article PDF	

OPEN ACCESS	012004
Ichthyofauna in Kayan Watershed Bulungan Regency, North Kalimantan	
Abdul Jabarsyah, Dori Rahmawati, Amrullah Taqwa and Ricky Febrinaldy Simanjuntak	
+ Open abstract View article PDF	

OPEN ACCESS	012005
The Effect of Shrimp Waste Fertilizer Application on Spinach (<i>Amaranthus tricolor</i> L.) with the Presence of Weeds	
A Murtalaksono, R A Septiawan, F Hasanah and M Adiwena	
+ Open abstract View article PDF	

OPEN ACCESS	012006
Image Road Surface Classification Based on GLCM Feature Using LGBM Classifier	
Robet, Carles Julandy, Andi, Hendri, Jackri Hendrik and Feriani Astuti Tarigan	
+ Open abstract View article PDF	

OPEN ACCESS	012007
The Activity of Strawberry Extract as Sunscreen on Guinea Pigs Exposed to Sunlight	
Elisa Sari Pratiwi, Chandra Novanda Candra, Muhammad Nur Hafid and Laila Chumaili	

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012008

The Impact of COVID-19 Pandemic Towards Complete Basic Immunization for Children

Suri Kusuma Putri, Muhammad Aditya Kurnia, Perry Boy Chandra Siahaan, Pahala Maringan J. Simangunsong, Christhin Ester Siregar, Christine and Buenita Sinurat

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012009

Manufacture of LDPE Plastic Waste Briquettes a Mixed Pine Needles and Clay with Various Compositions as Alternative Fuels

Fitriani, Haswin and A Basir

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012010

The Relation of Cultural Value Orientation to the Poverty of Communities Around Mangrove Forests and Peatlands in Kayan Sembakung Delta

A Sutrisno, Zulhafandi, E Wahyuni, J Sidik and S Usman

[+ Open abstract](#) [View article](#) [PDF](#)

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012011

A Comparative Analysis of Essential Oils from Three Species of Cinnamomum Growing Wild in East Kalimantan

Harlinda Kuspradini, Agmi Sinta Putri, Dewi Ardiana and Saat Egra

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012012

The Effect of Cooking Process on Nutritional Composition of Lais Fish (*Cryptopterus* sp.)

Stephanie Bija, Novi Luthfiyana and Anhar Rozi

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012013

Introducing the Ferns through Comics: Visualisation of Ethnopteridology Study of Dayak Lundayeh Tribe

Fadhlan Muchlas Abrori, Saraswati, Fitri Wijarini and Fatmawati

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012014

Heavy Metal Contents Of Hg, Cd, Pb, And Cu In Blue Swimming Crab (*Portunus Pelagicus*) In Banten Bay, Indonesia

Hanifah Nedy, Djamar TF Lumban Batu and Sulistiono

[+ Open abstract](#) [View article](#) [PDF](#)

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012015

Food Security and Welfare Of Lowland Rice Farmers Analysis In The Border Area Of North Kalimantan

Anang Sulisty, Khaerunnisa and Suhaena

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012016

Analysis of Willingness to Pay And Willingness to Accept for The Existence of Broiler Chicken Farm

Etty Wahyuni, Septwinda Tasia Ranti, Anang Sulisty and Hendris

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012017

Convective Cloud Classification Model for Reconstruction of Heavy Rain That Triggers the Flood and Landslide in Parapat, North Sumatera

Humuntal Rumapea, Muhammad Zarlis, Poltak Sihombing, Syahril Efendi, Marzuki Sinambela and Immanuel Jhonson A. Saragih

[+ Open abstract](#) [View article](#) [PDF](#)

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012018

Characteristics of Keraca (*Thalamita* sp.) Crab Shell Flour as Functional Food Ingredients

Novi Luthfiyana, Nusaibah, Sumartini and Asniar

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OPEN ACCESS	012019
Relationship between Work Position and Musculoskeletal Complaints among Vegetable Farmers	
Frans Judea Samosir, Buenita Sinurat and Nova Oktalia Pasaribu	
+ Open abstract View article PDF	
OPEN ACCESS	012020
Antibacterial and Natural Pesticide Properties of Nyiri (<i>Xylocarpus granatum</i>)	
Saat Egra, Hartini, Mardhiana, Nurjannah, Muhammad Adiweni, Dwi Santoso, Harlinda Kuspradini and Tohru Mitsunaga	
+ Open abstract View article PDF	
OPEN ACCESS	012021
Natural Enemies of Pest in Rice Cultivation of Sesayap Watershed Area, Tana Tidung Regency	
Abdul Rahim, Yudi Rahmawandi, Nurmaisah, Muh Adiweni, Paolus Donatus Haka and Anggun Setiawan	
+ Open abstract View article PDF	
OPEN ACCESS	012022
Analysis of Flow Overview Using Empirical Equations In The River Kampung Bugis Tarakan City	
Asta and M. Ramadhan	
+ Open abstract View article PDF	
OPEN ACCESS	012023
COVID-19 Prevention Behavior in Pregnant Women	
Ekadianto, Liena, Sri Lestari Ramadhani Nasution, Adrian Khu and Putranto Manalu	
+ Open abstract View article PDF	
OPEN ACCESS	012024
The Effect of Organic Matter on The Soil Inoculated Mycorrhizal on The Percentage of Root Infection and Growth of Mung Bean Plants	
St. Subaedah, Netty, Maimunah Nonci and Ida Rosada	
+ Open abstract View article PDF	
OPEN ACCESS	012025
The Effect of <i>Beijerinckia fluminensis</i> G3 and <i>Rhizobium pusense</i> G4c on Germination of rice Var. Ciherang and red rice Var. Barak Cenana	
Johan Sukweenadhi, Kevin Sutanto, Ida Bagus Made Artadana, Wina Dian Savitri and Se Chan Khang	
+ Open abstract View article PDF	
OPEN ACCESS	012026
Effect of temperature and relative humidity on the respiration rate of coated banana (<i>Musa acuminata</i>)	
Rahmiyati Kasim, N Bintoro, S Rahayoe and Y Pranoto	
+ Open abstract View article PDF	
OPEN ACCESS	012027
Analysis of Diseases in the Elderly Affecting Covid-19	
Sindi Achmad Zamali, Ermi Girsang, Maya Sari Mutia and Tan Suyono	
+ Open abstract View article PDF	
OPEN ACCESS	012028
Policies To Reduce The Risk Of Extreme Weather In Central Java Province	
Mussadun and Mohammad Muktiali	
+ Open abstract View article PDF	
OPEN ACCESS	012029
Analysis of Morphometric and Gene of Bombay-duck (<i>Harpodon nehereus</i>) in Tarakan Waters	
Amrullah Taqwa, Andi Iqbal Burhanuddin, Andi Niartiningih, M. Natsir Nessa and Irmawati	
+ Open abstract View article PDF	
OPEN ACCESS	012030
Response Characteristics of Sensor Array of Fresh Meat Detection Circuit using Conducting Polymer Sensor	

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Benrad Edwin Simanjuntak Hasrullah, Marhaposan Situmorang, Syahrul Humaidi and Marzuki Sinambela

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012031

Lemon Pepper's Kidney Protection Effect against Kidney Injury Induced by Cadmium in Male Wistar Rats

Sutanto Tanaka, Chrismis Novalinda Ginting, Linda Chiuman and Ali Napih Nasution

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012032

Prevention Strategy for Covid-19 by Healthy Mobility

Widya Yanti Sihotang, Santy Deasy Siregar, Masryna Siagian, Rapael Ginting, Hartono, Herbert Wau, Buenita Sinurat, Eka Lolita and Eliyanti Pakpahan

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012033

The Sand Column Utilizing for Clay Soil Reinforcement

Hasrullah, Miftahul Iman and Fuad Harwadi

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012034

Legal Management of Natural Resources in Coastal Region of Indonesia

Liza Shahnaz and Aditia Syaprih

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012035

The Hospital Health Promotion Toward Clean Healthy Living Behavior in the Covid-19 Era

Ade Rizky Sianturi, Chrismis Novalinda Ginting, Sri Wahyuni Nasution and Suci Erawati

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012036

Identification of Fatty Acids in Virgin Coconut Oil (VCO), Cocoa Beans, Crude Palm Oil (CPO), and Palm Kernel Beans Using Gas Chromatography

St Sabahannur and Suraedah Alimuddin

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012037

The Role of Institutions in the Downstream Agribusiness Palm oil (Elaeis Sp) Subsystem

Rayhana Jafar, Khaerunnisa, Adi Sutrisno, Anang Sulisty, Ahmad Mubarak, Nia Kurniasih, M Nurlela and Sakti Abimayu

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012038

Environmental Spatial Planning In The Perspective of Law 11/2020 Concerning Job Creation

Yahya Ahmad Zein and Nurasikin

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012039

Translating The Water Law Into Dynamic Modelling of The Mathematical Structural Equation : A Case of Medan North Sumatera

Tan Kim Hek, Corinna Wongsosudono and Ripka Seriidahnaita Ginting

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012040

Non-Destructive Prediction of Piperine in Javanese Chilli (Piper Retrofractum Vahl) Based on Color and Texture Analysis Using Artificial Neural Network

B Rohmatulloh, M N Lee, R M Alatiffa, R P Megatama, R A C Napitupulu, Y Hendrawan and M Lutfi

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012041

Automatic Toll Payments in Smart Transportation

Bryan Givan, Mareanus Lase, Stanty Aufia Rachmat, Matdio Siahaan, Deni, Dian Gustina, Nurlaelah, Susi Purtiningrum, Arman Syah Putra and Winanti

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012042

Role and Strategy of Csr (Corporate Social Responsibility) Pt. Medco E and P on Women Farmer Groups in Kampung Salak of Tarakan City

Nia Kurniasih Suryana, Sekar Inten Mulyani and Olivia Oktaviana

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012043

Navigation Robot Covid With 3D LiDAR Using RTAB-MAP Method

Muhamad Ardiansyah Putra Wibowo, Sami Fauzan Ramadhan and Arjon Turnip

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012044

Synthesis Of Spherical Chitosan-Zeolite Composite (Ch-Z Spherical) From Shrimp Shells Using Crosslinking Method As Adsorbent Of Metal Ca (Ii) And Mg (Ii)

Tuty Alawiyah, Uzlifatul Azmiyati, M. Gandri Haryono and Reni Tri Cahyani

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012045

The potential of rice bran waste (*Oryza sativa* L.) and shrimp shell waste as chitin nanowhisker with glycerol plasticizer in the production of bioplastic

J V Setiawan, R Adhitama, M T Goeltom, T D Askitosari, D C Yang and J Sukweenadhi

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012046

Analysis of heavy metals content Hg, Cd, Pb, and Cu of green mussel *Perna viridis* (Linnaeus, 1758) in Bojonegara Coastal Waters of Banten Bay, Indonesia

D I Susilowati, R Affandi and Sulistiono

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012047

Analysis of Wound Healing Activity from Rose Petal Extract Ointment in Wistar Rats.

Swastina Pinky Latcuba, Linda Chiuman, Ali Napih Nasution and Chrismis Novalinda Ginting

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012048

Factors that Influence The Application of Health Protocols in The Pratama Serasi Clinic Medan Helvetia Subdistrict

S Buenita, Mafe Robbi Simanjuntak and Widya Annisahaqmi Mahdali

[+ Open abstract](#) [View article](#) [PDF](#)

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012049

Study of Mud Crab Species (*Scylla* Spp.) In Brackish Waters North Kalimantan Province

Heppi Iromo, Zainuddin and dan Syawaluddin

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012050

Macrozoobenthic Community Structure in the Kemayungan-Linduk Waters, Banten Bay

A Ibrahim, J Sudarso and Sulistiono

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012051

A Quasi-Experimental Study of Young Coconut Water in Reducing Fatigue on Construction Workers

Santy Deasy Siregar, Frans Judea Samosir, Victor Trismanjaya Hulu, Baby Tio Ivana Kumakauw and Refi Ikhtiari

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012052

The Reduction Of Armyworms On Mustard Greens Using The Extract Of Papaya Leaf And Kipahit Leaf

Ulina Karo-Karo, Dameria Gultom, Rapael Ginting, Muhammad Aditya Kurnia, Mira Helia Cristy Pasaribu, Elisabet Siagian and Cronika H. Manurung

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Characterization of powdered *S. japonica* as carrier material for natural food preservatives

Y Putra, E A Siahaan, R Pangestuti, L Ali and A Wahab

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012054

The Application of Different Probiotics for Prevention of Motile Aeromonas Septicemia Disease on African Catfish (*Clarias gariepinus*)

D Maulianawati, R Rukisah, D Ramadani and H Irawati

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012055

The impact of motivation on the willingness of farmers to become entrepreneurs in the sebatik sub-district in the Indonesia-Malaysia border region

A Mubarak, Rayhana Jafar, Hendris and MW Agang

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012056

Study Of The Ground Cover Species Important For Agriculture In Peat Swamp Forest Area Tengku Dacing Village

Mardhiana, Rosnauli Panjaitan, Rita Diana and Tati Harryati

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012057

Heavy Metal Contents of Hg, Cd, Pb, and Cu in Mud Crab (*Scylla Serrata*) in Banten Bay, Indonesia

Dita Fatryani, Sulistiono and Djamar TF Lumban Batu

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012058

Implementation of Greedy Algorithm for Profit and Cost Analysis of Swallow's Nest Processing Dirty to Finished Products

Evta Indra, Angelin, Siti Aisyah, Mardi Turnip, Delima Sitanggang and Oloan Sihombing

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012059

Butterfly (Lepidoptera: Rhopalocera) Preference Host Plant and Food Plant in North Borneo

Nursia, Fitriyani and Nur Fitriana Sam

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012060

A Sequential Auto Irrigation for Smart Chili Farming

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012061

Implementation LoRaWAN End Node Tracking

Albert Sagala, Ramot Lubis, Herwin Sitanggang, Rondy Sinaga and Suprianto Hutapea

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012062

Diversity and Habitat Preferences of Orchids in Tarakan Forest

Fitri Wijarini, Muhammad Abrar Putra Siregar, Aidil Adhani, Nur Elisia, Susi Yantika Siahaan and Jamardi Sinaga

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012063

Effect of Maturity Level and Fruit Size on Mechanical Properties of Tomato Fruit (*Solanum lycopersicum*)

Y Safitri, N Bintoro and J N W Karyadi

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OPEN ACCESS	012064
Morphological adaptation of cocoa fine roots under shaded of langsat tree in exploring stony soil	
AR Saleh, S Gusli, A Ala, R Neswati and S Sudewi	
+ Open abstract View article PDF	
OPEN ACCESS	012065
Preliminary Study of Beef and Pork FTIR Spectra: PCA Analysis	
M N Hudha, Y L Ni'mah, K A Madurani, M E Andrayani and F Kurniawan	
+ Open abstract View article PDF	
OPEN ACCESS	012066
Development and Implementation of Smart Irrigation for Precision Farming	
Farouq Enesi Saheed, Fikri Rida Pebriansyah, Parlindungan Sitorus, T George Michael and Arjon Turnip	
+ Open abstract View article PDF	
OPEN ACCESS	012067
Evaluation of Multi-temporal Imagery and Vegetation Indices for Mangrove Mapping (Case Study of The East Coast of Lampung)	
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Nephroprotective Effect of Ethanol Extract of Carica Papaya Seed on Rats Induced Rifampicin and Isoniazid	
Etty Kartika Chandra, I Nyoman Ehrich Lister and Edy Fachrial	
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<i>Melastoma malabatricum</i> L as Potential Inducer in Spawning Process and Number of Daphnia sp. Offspring	
Nurul Farizah, Muhammad Zairin Jr, Latifah K Dariusman, Arief Boediono and Muhammad Agus Suprayudi	
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Antibacterial Activity of Garlic Extract (<i>Allium Sativum</i>) using Fermentation and Non Fermentation towards <i>Propionibacterium Acne</i>	
Annisa Fajryana, Chrismis Novalinda Ginting, Linda Chiuman and Sahna Ferdinand Ginting	
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Relationship of diatom phytoplankton (Bacillariophyceae) diversity with water quality and heavy metal in Angke and Grogol Rivers, Jakarta City	
Ayu Maulida Sukma and Noverita Dian Takarina	
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A Preliminary Earthquake Detection from The Seismic Temporary Network in The Opak Fault	
Andrean V H Simanjuntak, Naikson Fandier Saragih, Muhajir Anshori, Marzuki Sinambela, Ar Razi, Umar Muksin, Afriyanti V Simangunsong, Noviana Sihotang, Yusran Asnawi and Indra Kelana Jaya	
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 Bioactivity of extracts from *Syzygium aromaticum*, *Annona muricata*, and *Piper retrofractum* against *Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae)
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 Characteristics Of The Distribution Polycyclic Aromatic Hydrocarbon Contaminants (Pahs) In Coastal Waters, Tarakan City, North Kalimantan, Indonesia
 Ratno Achyani and Syamsiyah
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-
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 The Relationship of P and N Nutrient Contents with Chlorophyll-a Concentration in Tarakan Island Waters
 Ermawaty Maradhy, Rizal Syarief Nazriel, Surjono Hadi Sutjahjo, Meika Syahbana Rusli, Widiatmaka and M. Fedi Alfiadi Sondita
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 Characteristics of Nanochitosan from Soft Shell Crab Culture Waste in Tarakan Using The Ionic Gelation Method
 Novi Luthfiyana, Stephanie Bija, Effionora Anwar, Dian Ratih Laksmiawati, Christine Dyta Nugraeni, Nusaibah and Mutmaina
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 Fatty acid profiles and biological activity of *Nannochloropsis oculata* and *Isochrysis galbana*, clone t-ISO
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 Development of an Irrigation System for Predicting Watering Time with ANFIS Method for Chili Plants
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 Performance Improvement of Grid Mapping K-Means with the Average Value at Grid Point
 Salomo Ginting, Syahril Efendi and Saib Suwilo
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 Characteristics of Model Growth And Mortality of White Shrimp (*Penaeus merguensis de Man 1888*) in The Estuaria of Bengara, Regency Bulungan
 Gazali Salim, Hendrikus, Agus Indarjo, Lukman Yudho Prakoso, Muhammad Gandri Haryono, Aris Irawan and Julian Ransangan
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 Study on stomach contents of sailfin silversides, *Telmatherina sarasinorum* Kottelat 1991, in Matano Lake, South Sulawesi, Indonesia
 A F K Rasuna, M M Kamal, R Affandi, A Chadajah and Sulistiono
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 The Influence of Facility Infrastructure and Personal Contact on Inpatient's Trust
 Budio Satya Sinuraya, Sri Lestari Ramadhani Nasution, Sri Wahyuni Nasution and Ermi Girsang
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The potential of rice bran waste (*Oryza sativa* L.) and shrimp shell waste as chitin nanowhisker with glycerol plasticizer in the production of bioplastic

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Abstract. Bioplastics are plastics made from biopolymers as an alternative to commercial plastics to reduce environmental pollution. Starch from rice bran waste is an essential biopolymer material, and chitin from shrimp shell waste; can be converted into chitin nanowhiskers (CNWs) that can strengthen biopolymer materials. A glycerol plasticizer was added to improve its elasticity. This research aims to determine the potential of starch from rice bran waste and CNWs from shrimp shell waste as ingredients in the production of bioplastics with the addition of glycerol plasticizer and its degradation property through soil burial testing. This fundamental research consists of chitin extraction, CNW production, starch extraction, bioplastic production, tensile strength testing, water uptake testing and soil burial testing on the sand, humus, and compost. The use of rice bran starch and shrimp shell CNW as ingredients in the production of bioplastics are deemed potential. This bioplastic exhibited low mechanical properties such as tensile strength and water uptake but outstanding degradation in the soil burial testing.

Keywords: *Bioplastics, Biopolymer materials, CNWs, potential of starch.*

1. Introduction

Waste is an unresolved problem in Indonesia. The increase in population and human activities increases the volume of waste. Dependency on plastic materials is caused by activities carried out by humans who use plastic as necessary [1]. In total, the waste production in Indonesia reaches 189-kilo tons per day, much larger than other Southeast Asian countries [2]. Indonesia uses 100 billion plastic bags annually, which places Indonesia as the second-largest plastic user country after China [3].

Synthetic plastic is hard to degrade even though it has been buried completely for decades. The properties of plastic do not decompose naturally, ultimately causing environmental problems [4,5]. One solution is developing environmentally-friendly plastics or bioplastics derived from natural materials. The advantage of bioplastics is that they can decompose naturally quickly and improve soil quality because their decomposition products increase nutrients in the soil [6,7].

So far, bioplastics that have been produced often using starch from cassava [6,8,9], potato [10,11] and corn [12-14] with high starch content and the results are good, but these are non-waste materials that are still widely used by many communities as a main source of food; so, it has caused some disapproval of certain parties [11]. Besides, the technology is not yet widely developed, so production is substantially more expensive than synthetic plastics. In the end, people still chose to use synthetic plastics [15].



Rice bran is considered as a waste because its utilization is still limited, mostly known as a low-quality animal feed ingredient [16,17] and starting to be used as functional food, but obstructed due to the quality of the rice bran which is not standardized [18,19]. Rice bran waste is a suitable raw material in the form of biopolymer for the development of bioplastic [20] to be used as a source of starch which is hydrophilic [21]. Meanwhile, shrimp shells are the biggest pollutant of seafood production [22,23], which contains chitin that can be processed further into nanowhisker chitin (CNW) that functions as an alternative to synthetic reinforcement [24]. CNW can increase the mechanical strength of bioplastics by forming intermolecular hydrogen bonds [25,26]. Meanwhile, hygroscopic glycerol plasticizer functions to give elastic properties, locating between biopolymer bond chains and can interact by forming hydrogen bonds [27,28].

Chitin from shrimp shells is extracted by performing deproteinization to remove protein and demineralization to remove minerals [29,30], as it is the most general and simplest method for chitin extraction because sodium hydroxide and hydrochloric acid are easy to procure. Then CNW is produced by performing acid hydrolysis to disperse chitin into rod-shaped particles [31], for it is the most commonly used method, continued by being frozen at -80°C , then freeze-dried to remove excess water in the form of ice by sublimation, following the reference method for which the equipment was readily available. According to a statement from previous research, a specific freezing temperature of -80°C shapes CNW in a sheet-like structure [32]. The CNW was then analyzed with the scanning electron microscope (SEM), the easiest equipment accessible to view its structure.

Starch extraction from rice bran waste is carried out by centrifugation to save time and to ensure all starch settles as pellets rather than by manual precipitation. Distilled water is used in this process because it is easy to obtain, inexpensive, non-toxic, and does not damage the hydrogen bonds in starch [33]. Starch is not soluble in cold water; it can be easily separated [34]. The starch content is then measured by the staining value of the starch-iodine chromogenic complex versus the iodine standard curve and then read at its maximum wavelength [35], for it is the simplest method for the qualitative and quantitative analysis of starch.

Bioplastic production is a physical mixing process where rice bran starch is mixed with CNW, glycerol, distilled water and then heated to undergo gelatinization to produce a gel where the starch-forming bonds form closely together [7]. A high amylopectin content is desirable in starch gelatinization because it makes a lot of space in the starch granules, which utilizes hydrogen interactions between chains that occur. After all, O or H atoms of CNW interact and bond with O and H atoms of starch which consists of amylose and amylopectin [36]. Meanwhile, according to Industrial Research and Consultation Institute in 2016, rice bran contained approximately 14.05% amylose and 21.8% amylopectin [37].

The novelty and contribution of this paper are in the form of fundamental research aimed to investigate the potential of materials that differ from previous methods for the production of bioplastic. The materials used in this research are starch from rice bran waste, integrated with shrimp shells waste in the form of CNW and glycerol plasticizer. Starch from rice bran waste and CNW from shrimp shells waste are still rarely researched individually and have never been integrated into bioplastic production.

2. Material and methods

2.1. Materials

Materials used were shrimp shells from a fresh seafood stall Yeni Putra & Bu Yatmini Gede market in Surakarta, rice bran from a rice mill in Boyolali, pure chitin, pure cassava starch, glycerol, distilled water, demineralized water, hydrochloric acid, sodium hydroxide, iodine reagent, conventional minimarket plastic bag (PM), plastic clip (PC), cassava starch commercial bioplastic bag (PS), humus from Lidah Kota forest in Surabaya, compost from a corn plantation behind Lembah Harapan housing in Surabaya and sand from a construction site in Universitas Surabaya. Equipment used were blender, oven, UV-Vis spectrophotometer, centrifuge, Metrotex MBT 15 – 1000P Bonding tensile tester,

magnetic bar, magnetic stirrer, analytical balance, freeze dryer, -80°C freezer, vortex, pH test strips, desiccator, fume hood, watch glass, spoon, pestle, mortar, 100 mesh sieve, a nylon filter, thermometer, beaker glass, filter paper, aluminum foil, glass funnel, pipette, filler, measuring cylinder, falcon tube, cuvette, test tubes and a 16 x 8 cm (2.3 x 1.8 cm) silicone mold.

2.2. Methods

2.2.1. Chitin extraction from shrimp shell waste

Shrimp shells are washed and dried in the sun [29], then crushed and sieved using a 100 mesh sieve to obtain a reasonably uniform shrimp shell powder. Then for deproteinization, 90 g of shrimp shell powder was added with 900 mL of 4% sodium hydroxide. The mixture was then heated at 80°C for 1 hour while being stirred constantly. This mixture was cooled off, filtered using filter paper, washed with distilled water until the pH was neutral and then dried in an oven at 60°C for 24 hours. After that, demineralization was carried out by adding the results of the deproteinization with 500 mL of 1M hydrochloric acid and constantly stirring at room temperature for 1 hour. The mixture was then filtered using filter paper and washed with demineralized water until the pH was neutral and then dried in an oven at 60°C for 24 hours [38]. The chitin yield was determined as $\% \text{ yield} = (\text{dry weight of chitin recovered from extraction} \times 100) / \text{dry weight of shrimp shells (g)}$ [39].

2.2.2. CNW production.

A total of 15 g of shrimp shell chitin powder was added with 450 mL of 3M hydrochloric acid and was stirred constantly while being heated to boil for 1.5 hours. This mixture was then cooled at room temperature and centrifuged at 4000 rpm for 20 minutes. The supernatant was discarded, while the pellets were taken and washed with demineralized water until the pH was neutral. The washed pellets were then put into plastic clips to be frozen in the freezer at -80°C and then freeze-dried for 48 hours [31,40]. The CNW yield was determined as $\% \text{ yield} = (\text{dry weight of CNW recovered from production} \times 100) / \text{dry weight of chitin (g)}$ [39].

2.2.3. CNW SEM analysis.

SEM analysis was carried out on CNW produced from shrimp shell waste and CNW produced from pure chitin. This analysis was conducted at the Department of Materials and Metallurgy Engineering, Faculty of Industrial Technology and Systems Engineering (FT-IRS), Sepuluh Nopember Institute of Technology (ITS), located on the second floor of the ITS Sukolilo campus, Surabaya, East Java 60111.

2.2.4. Starch extraction from rice bran waste.

500 g of rice bran are added with distilled water and then blended. The result is then filtered and squeezed using a nylon filter to separate the filtrate and dregs. The dregs were discarded, and the filtrate obtained was centrifuged at 4000 rpm for 30 minutes. The supernatant was discarded, while the starch pellets were taken and flattened in a petri dish to be dried in an oven at 40°C for 24 hours [41,42]. The starch yield was determined as $\% \text{ yield} = (\text{dry weight of starch recovered from extraction} \times 100) / \text{dry weight of rice bran (g)}$ [39].

2.2.5. Rice bran starch content analysis.

The rice bran starch content was carried out by mixing 1 mL of the sample solution with 1 mL of iodine reagent. This mixture was then immediately homogenized using a vortex and then added with distilled water until the volume was 50 mL. The sample was then poured into a cuvette, and the absorbance was read using a UV-Vis spectrophotometer at λ 580 nm. The rice bran starch's content was determined using the absorbance read from the sample, put into the equation of the iodine standard curve and multiplied by the dilution factor. The iodine standard curve was made using the same technique, but pure cassava starch solution was used as a standard solution with modifications in several concentrations (20, 10, 5, 2.5, 1.25, 0.625 mg/mL).

2.2.6. Bioplastic production.

The formula to make bioplastics using CNW consist of 2.5 g of rice bran starch, 0.125 g of CNW and 0.625 mL of glycerol are mixed then added with 50 mL of distilled water. This mixture is then heated at 80°C [20] for 20 minutes and constantly stirred [7,41]. 1 mL of the gelatinized mixture is then poured into a 2.3 x 1.8 cm silicone mold, then dried in an oven at 45°C for 20 hours [43]. The same method was then repeated using pure cassava starch and pure CNW for comparison. Pure cassava starch bioplastic without pure CNW is coded as BS, rice bran starch bioplastic without CNW is coded as BB, pure cassava starch bioplastic with pure CNW is coded as BSK, and rice bran starch bioplastic with CNW is coded as BBK.

2.2.7. Tensile strength testing.

PM, PC, PS, BS, BSK, BB and BBK samples measuring 2.3 x 1.8 cm as many as three pieces each for replication were tested for tensile strength using the Metrotex MBT 15 – 1000P Bonding tensile tester. The data results in the form of the distance traveled by the puller from the beginning to the breaking of the samples were recorded [44,45]. Then the tensile strength value of each sample and its replications was then averaged. This test was conducted at PT. Grand Premier Plaspak, located at Jalan Raya Krikilan 436, Dusun Larangan, Krikilan, Kecamatan Driyorejo, Gresik, East Java 61177. Specifically, the tensile strength values of BS with BSK samples and BB with BBK samples were further analyzed statistically with two sample T-test ($P < 0.05$) using Minitab 2018 software to see if there is a significant difference in the tensile strength value by the addition of CNW. The tensile strength values are compared to ASTM D882 – 12 standard for LDPE plastic types.

2.2.8. Water uptake testing.

PM, PC, PS, BSK and BBK samples measuring 2.3 x 1.8 cm as many as three pieces each for replication were weighed initially using an analytical balance and then immersed in distilled water for 1 minute. After, the samples were removed and dried on a tissue for about 15 seconds. These steps were repeated until the samples were destroyed or the sample weight became constant [46]. The water uptake value of each sample was determined as $\% \text{ water uptake} = ((\text{final sample weight} - \text{initial sample weight}) / \text{initial sample weight}) (\text{g}) \times 100$ [36]. Each sample's initial weight and final weight and its replications were weighed, put into the $\% \text{ water uptake}$ formula. Each sample's obtained $\% \text{ water uptake}$ and its replications were then averaged. The water uptake values are compared to ASTM D570 – 98 standard for all types of plastic.

2.2.9. Soil burial testing.

PM, PC, PS, BSK and BBK samples measuring 2.3 x 1.8 cm as many as three pieces each for replication were weighed initially using an analytical balance and then wholly buried in 3 types of soil, namely humus, compost and sand, each with a humidity of $\pm 50\%$ and temperature of $\pm 27^\circ\text{C}$ for 15 days. The final sample weight on day 15 was compared with the initial sample weight [47]. The weight loss value of each sample was determined as $\% \text{ weight loss} = ((\text{initial sample weight} - \text{final sample weight}) / \text{initial sample weight}) (\text{g}) \times 100$ [48,49]. The initial weight and final weight of each sample and its replications were weighed, put into the $\% \text{ weight loss}$ formula, then averaged the obtained $\% \text{ weight loss}$ of each sample and its replications. Then the $\% \text{ weight loss}$ of each sample was further analyzed statistically with Tukey 5% ($P < 0.05$) using Minitab 2018 software to see if there is a significant difference in the weight loss value of various types of samples in each type of soil. The weight loss values are compared to ASTM 5336 standard for PLA and PCL plastic films.

3. Results and discussion

3.1. Chitin extraction from shrimp shell waste and CNW production

From this process, as much as 18.373 g of chitin is obtained from 90 g of shrimp shell with a yield value of 20.414% and a light brown color, as seen in Figure 1. Then, as much as 4.1852 g of CNW is obtained from 15 g of chitin with a yield value of 27.901% and a dark brown color, as seen in Figure 2.



Figure 1. Chitin extracted from shrimp shell waste.



Figure 2. CNW produced from shrimp shell waste chitin.

3.2. CNW SEM analysis

The SEM analysis shows that the CNW produced from shrimp shell waste shows that the structure mainly was random sheets with smooth surfaces, as seen in Figure 3. This result agrees with previous research that states at a freezing temperature of -80°C , the structures formed will be sheet-like.

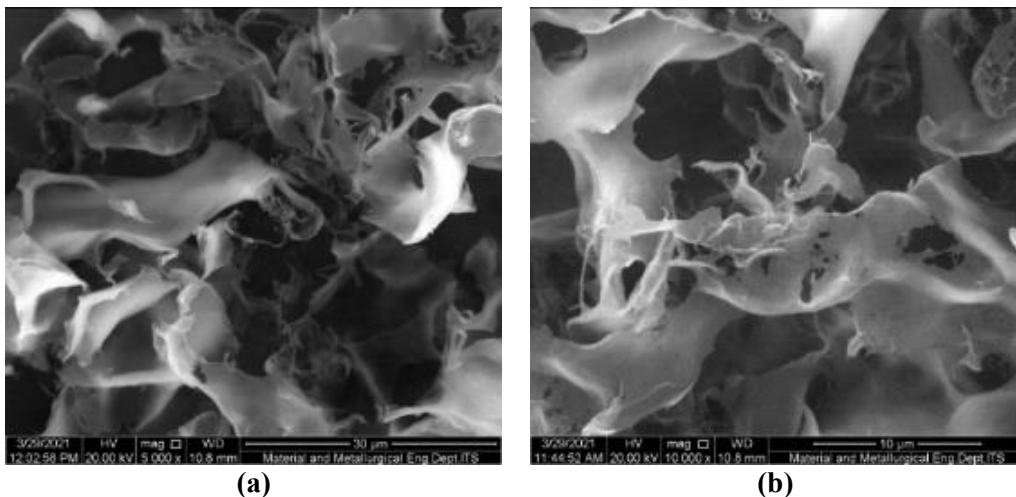


Figure 3. Magnification of CNW produced from shrimp shell waste, **(a)** 5000 x, **(b)** 10000 x.

3.3. Starch extraction from rice bran waste

From this process, 87.88 g of starch is obtained from 500 g of rice bran waste with a yield value of 17.576% and a light brown color, as seen in Figure 4.

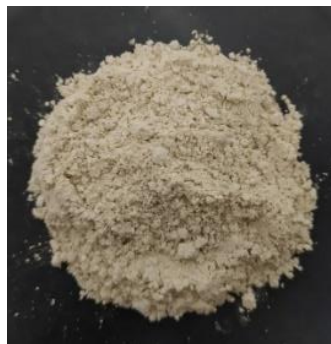


Figure 4. Starch extracted from rice bran waste.

3.4. Rice bran starch content analysis

Then the rice bran starch's content was calculated using the absorbance read from the sample, which is 0.629, put into the equation of the iodine standard curve, which is $y = 0.1523x + 0.1978$ and multiplied by its dilution factor, which is 10. The starch concentration of rice bran was 28.313 mg/mL.

3.5. Bioplastic production

Bioplastic made from the extracted rice bran starch resulted in brown color and a smooth surface without trapped air bubbles, as seen in Figure 5. The resulting bioplastic also has different surface textures. One side has a rough surface from direct contact with the air because there is no surface barrier, and the other is smooth from direct contact with the mold [16]. The solution formed from the rice bran starch gelatinization was not too dense due to rice bran starch's low amylopectin content.

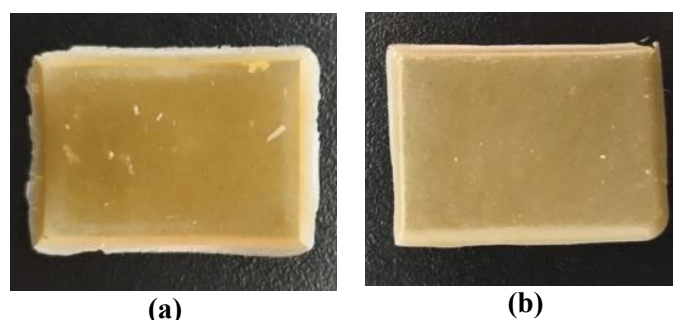


Figure 5. Extracted rice bran starch bioplastic, (a) without CNW produced from shrimp shell waste chitin, (b) with CNW produced from shrimp shell waste chitin.

3.6. Tensile strength testing

The results from the tensile strength testing is compared to the ASTM D882 – 12 standard for LDPE plastic types, which is 0.024 MPa. The BS sample met the standard while the BB sample did not, as seen in Table 1. Then from the results of the statistical test of the two sample T-test, it can be seen that there is a significant difference in the tensile strength value of BS with BSK samples and BB with BBK samples due to the addition of CNW. Bioplastic samples that contain CNW showed an increase in tensile strength values up to almost two times compared to samples that did not contain CNW. This result agrees with the statement that the integration of CNW can double the value of tensile strength. When compared again with the ASTM D882 – 12 standard for LDPE plastic types, the BSK sample already met the standard, while the BBK sample still has not met the standard, as seen in Table 1.

Table 1. Data result of tensile strength testing

Sample code	Replication			Tensile strength value (MPa)*
	1	2	3	
PM	0.043	0.043	0.044	$0.043 \pm 1.4 \times 10^{-4}$
PC	0.044	0.043	0.043	$0.043 \pm 3.8 \times 10^{-4}$
PS	0.063	0.061	0.062	$0.062 \pm 5.9 \times 10^{-4}$
BS	0.031	0.030	0.031	$0.031^a \pm 2.6 \times 10^{-4}$
BSK	0.060	0.060	0.061	$0.060^b \pm 0.9 \times 10^{-4}$
BB	0.011	0.010	0.010	$0.011^a \pm 4.4 \times 10^{-4}$
BBK	0.020	0.020	0.021	$0.020^b \pm 3.2 \times 10^{-4}$

*Compared to ASTM D882 – 12 standard for LDPE: 0.024 MPa.

**Averages followed by different notation on BS-BSK sample and BB-BBK sample show significant differences ($P < 0.05$).

PM : conventional minimarket plastic bag

PC : plastic clip
 PS : cassava starch commercial bioplastic bag
 BS : pure cassava starch bioplastic without pure CNW
 BB : rice bran starch bioplastic without CNW
 BSK : pure cassava starch bioplastic with pure CNW
 BBK : rice bran starch bioplastic with CNW

The tensile strength value of the BBK sample has not met the standard due to the excess addition of plasticizer, which is hygroscopic, resulting in more interactions between the biopolymer molecules. Thus, the bioplastic became too flexible, and its tensile strength value decreased.

3.7. Water uptake testing

The results obtained from water uptake testing show that the BBK sample has low water resistance. That low value is due to the high water-absorbing properties of bioplastics, caused by starch and glycerol, which forms free spaces and increase the mobility of molecules to form hydrogen bonds. Compared with the ASTM D570 – 98 standard for all types of plastic, which is 0.01%, both the BSK and BBK samples did not meet the standard, as seen in Table 2.

Table 2. Data result of water uptake testing.

Sample code	Replication			Water uptake value (%) [*]
	1	2	3	
PM	0	0	0	0 ± 0
PC	0.909	0.917	0.446	0.758 ± 0.516
PS	35.135	33.043	40.271	36.150 ± 2.147
BSK	260.134	242.065	211.451	237.883 ± 14.208
BBK	55.491	58.188	33.368	49.016 ± 7.863

^{*}Compared to ASTM D570 – 98 standard: 0.01%

3.8. Soil burial testing

The weight loss values obtained from the soil burial testing in 15 days show that the BSK and BBK samples had good degradation results in three different soil types. The degradation that occurs is characterized by cracks, leading to damage of small pieces until some are even entirely degraded. Through the Tukey 5% test, it can be seen that there is a significant difference in the weight loss of various types of samples in each type of soil. The BBK sample degraded the best, which was indicated by the high weight loss values in the tested soil types. Compared with the ASTM 5336 standard for PLA and PCL plastic films in 60 days, which is 100%, the BSK and BBK samples both have met the standard, as seen in Table 3.

Table 3. Data result of soil burial testing

Sample code	Weight loss (%) in 15 days [*] , ^{**}		
	Sand	Humus	Compost
PM	12.842 ^a ± 1.493	50.593 ^a ± 20.222	36.610 ^a ± 10.187
PC	11.526 ^b ± 3.579	42.963 ^b ± 20.188	33.193 ^b ± 20.495
PS	29.119 ^c ± 13.604	55.549 ^c ± 8.938	44.737 ^c ± 22.806
BSK	10.856 ^d ± 5.525	75.143 ^d ± 15.623	89.432 ^d ± 10.568
BBK	50.714 ^e ± 5.675	86.166 ^e ± 8.361	100 ^e ± 0

^{*}Compared to ASTM 5336 standard: 100% in 60 days.

^{**}Averages followed by different notation within the same column show significant differences (P < 0.05).

The BBK samples produced had an excellent degradation character in various types of soil due to the humid environment that supports the growth of microorganisms by providing a suitable habitat and the conditions of the sample caused by the hydrophilic nature of starch also the hygroscopic nature of glycerol that accelerates the rate of degradation. There is not much degradation in the sand because it's neither dense nor compact so that water is not retained and evaporates quickly. This causes the sand to be poor in water and microorganisms so that the degradation that occurs in the sample runs slowly compared to other soils [50]. Humus and compost, on the contrary, trigger an excellent degradation evenly because it is rich in various microorganisms and can draw water from the atmosphere [51] because it often rained during the testing period.

4. Conclusion

Based on the results of this research, it was concluded that starch from rice bran waste and CNW from shrimp shell waste has potential as a material for making bioplastics. The bioplastic from this research has been successfully made with a tensile strength value just below the standard; still, the presence of CNW almost doubled its value, compared to without using CNW. This bioplastic also has low water resistance with a water uptake value of 49.016%. And it has an outstanding degradation character in the soil burial testing; within 15 days, it was degraded with a weight loss value of 50.714% in the sand, 86.166% in humus and 100% in compost.

Thus, based on these results, there is an urgent need and a promising opportunity for the use of rice bran waste and shrimp shells waste in the production of bioplastics. Further research, beyond this successful proof of concept, should be able to improve the process, yield, and results – making this an important contribution for the production of bioplastics in the near future.

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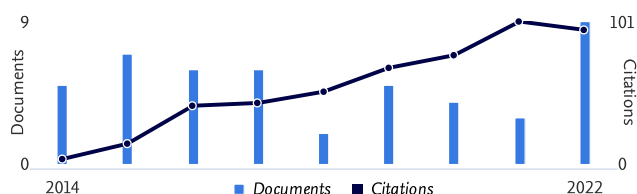
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Reviews

2 Meta Reviews

Review 1

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Originality	Significance of Topic	Presentation	Recommendation
Weak Accept (6)	Weak Accept (6)	Neutral (5)	Weak Accept (7)

Strengths/Weakness (What are the major reasons to accept/reject the paper? [Be brief.])

- Strengths/Weakness:
- The paper format is out of IOP style, it must be revised
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Review 2

Originality	Significance of Topic	Presentation	Recommendation
Neutral (5)	Weak Accept (6)	Neutral (5)	Neutral (6)

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