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It is our pleasure to welcome you to the 7th International Conference on Biological Sciences 2021. This conference is a biennially event held by the Faculty of Biology, Universitas Gadjah Mada, in collaboration with the Faculty of Applied Science and Technology, Universiti Tun Hussein Onn Malaysia. This year the conference's theme is "Contributing to Global Issues: Current Advances in Biodiversity and Health Research in the Face of Climate Change". Along with the theme, we have 7 conference topics ranging widely from biosystematics to bioengineering.

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This year the conference's theme is "Contributing to Global Issues: Current Advances in Biodiversity and Health Research in the Face of Climate Change". Along with the theme, we have 7 conference topics ranging widely from biosystematics to bioengineering.

This year's conference is also the first time held online due to the global pandemic situation. However, it becomes a blessing in disguise, because the

conference becomes accessible to a wider audience and participants from all over the world. The number of participants registered is 223. Among them, 183 participants will present their research. Most of the participants are from Indonesia, but also we have participants from Malaysia, Philippines, Pakistan, and India.

Besides the participants, the online nature of this conference also allows us to invite speakers from Europe and Australia. There will be Prof. Craig Moritz from Australian National University, Prof. Datin Maryati Mohammed from Universiti Tun Hussein Onn, Malaysia, Dr. Ahmed Abd El Wahed from University of Leipzig, Germany, Prof. Joana Falcao Salles from University of Groningen Netherlands, and Dr. Nastiti Wijayanti from the Faculty of Biology, Universitas Gadjah Mada, Indonesia. Because of the time difference, the speakers from Europe will give their talks on the afternoon of the first and second day of the conference.

The output of this conference will be published in the Advances in Biological Sciences Research as a conference proceeding, the Indonesian Journal of Biotechnology, and the Journal of Tropical Biodiversity and Biotechnology.

Finally, I would like to acknowledge the Indonesian Biology Consortium and the Publishers and Publications Board of Universitas Gadjah Mada which supported this conference. And I also like to thank you for our sponsors which make this conference possible.

I hope this conference will be fruitful for everyone. We look forward to seeing you all at the next ICBS conference.

Dr. Miftahul Ilmi, S.Si., M.Si
Chairman of 7th ICBS 2021

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Tomato Leaf Curl New Delhi Virus Associated with Yellow Mosaic Disease of Cucumber (*Cucumis sativus*) in Bengkulu, Indonesia

Mimi Sutrawati, Sipriyadi Sipriyadi, Yuni Kristina Serlyani Sihotang, Cindy

Margareth Hutasoit, Parwito Parwito, Ewa Aulia

Cucumber mosaic virus, Papaya ringspot virus, Squash mosaic virus, Cucurbit aphid-borne yellows virus, Cucurbit aphid-borne yellows virus Tobacco mosaic virus, Tomato yellow leaf curl New Delhi virus and Zucchini yellow mosaic virus were among the viruses that infected cucumbers in Java, according to...

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The Application of a New Drying Method on the Quality of Voucher Specimen

Mohd Amril Ramzi Bin Mohd Rahimi, Furzani Pa'ee

Drying the specimens is one of the crucial steps in plant preservation and the process of making Herbarium voucher specimens. This research was conducted to investigate the effect of the drying method on specimens in the laboratory using the standard method (oven) and drying in the field using a novel...

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From Invasive to Creative: Transforming *Salvinia molesta* in Taman Botani Sri Medan into Cosmeceutical Solid Soap

Nurul Syamimi Muzaini, Furzani Pa'ee

Salvinia molesta is invasive species and is also known as the worst weed that invaded Malaysia's native wide range of aquatic ecosystem. This study was conducted to identify the potential metabolites *Salvinia molesta* invasive plant species from family Salviniaceae in Taman Botani Sri Medan, Batu Pahat,...

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Antioxidant Activity Evaluation of Agarwood *Aquilaria malaccensis* Lamk. Leaves Extract Using DPPH, FRAP and ABTS Assays

Aprilliani Prissilla Halim, Nastiti Wijayanti, Lisna Hidayati, Tri Rini Nuringtyas

Indonesia has been known to have large forest areas and rich in biodiversity, which could be the source of primary and secondary metabolites. Along with the technological development and research in medicine, agarwood, which was initially used only for topical body treatments, room fragrances, and religious...

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Hematology Profile of Female Guinea Pig (*Cavia porcellus* (Linnaeus, 1758)) with Diet Variations

Naila Nabila Rahmani, Ayu Aziza Ar Rachid, Laksmindra Fitria

Guinea pigs (*Cavia porcellus* (Linnaeus, 1758)) is a rodent other than rats and mice that are commonly used in biomedical research because of its physiological similarity to humans. To meet the requirement as a standard laboratory animal, the care management of GP needs to be controlled, one of which...

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The Genetic Diversity of *Moringa Oleifera* on Poteran Island-Madura Based on Petiole Colors Using ISSR (*Inter Simple Sequence Repeat*) Method

Wirdhatul Muslihatin, Triono Bagus Saputro, Nur Isma Latifah, Chusnul Eka Safitri Himayani

Moringa oleifera, which is endemic of Pulau Poteran, Madura, is one of a genetic variation of *Moringa*. It is native Indonesian germplasm, which must be preserved to maintain the genetic biodiversity of *Moringa*. Known locally as kelor, the plant has four different color of petiole: red, white, purple,...

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Hematology Profile of Guinea Pigs [*Cavia porcellus* (Linnaeus, 1758)] Based on Sex and Age

Laksmindra Fitria, Sri Lestari, Asti Nur Istiqomah, Novita Paradhita Wulandari, Anggadiah Shinta Wardani

Guinea pigs or *Cavia porcellus* (Linnaeus, 1758) is small herbivorous rodent from South America. Guinea pigs (GP) are commonly used as experimental animals, pets, food, and animal-assisted therapy (AAT). Based on these benefits, the health of GP must be considered. Blood is essential biological sample...

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Molecular Comparison between Two Similar Asteraceae

Species (*Synedrella nodiflora* (L.) Gaertn. and *Eleutheranthera ruderalis* (Swartz) Sch._Bip) by the Use of *trnL*(UAA) - *trnF*(GAA) Intergenic Spacer

Murni Dwiati, Indrawati Indrawati, Agus Hery Susanto

Synedrella nodiflora (L.) Gaertn and *Eleutheranthera ruderalis* (Swartz) Sch.-Bip. are two Asteraceae species showing very similar morphological appearances. Both are broad-leaf weed species in some crops throughout many tropical areas. Nevertheless, the individual species can be potentially utilized...

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The Potential of Production and Characteristic of Oleoresin Tapped from *Dipterocarpus verrucosus* as Natural Ingredient for Multi Purposes

Andrian Fernandes, Rizki Maharani

Keruing (*Dipterocarpus*) is one of the Dipterocarpaceae family which produces oleoresin. *Dipterocarpus* species diversities will give the difference in oleoresin obtained from tapping, and its physical and chemical properties. This research aimed to determined the distribution of tapped oleoresin of D...

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Metabolite Profiling of *Davallia* in The Mentawai Islands, West Sumatra, Indonesia

Mildawati Mildawati, Sobir Sobir, Sulistijorini Sulistijorini, Tatik

Chikmawati

This study revealed the metabolite compounds of the Davallia species in the Mentawai Islands, West Sumatra, through metabolite profiling. This study aimed to determine the chemical compounds in the leaves of the Davallia species. Leaf samples of three species, *D. denticulata* (Burm. f.) Kuhn var. *denticulata*,...

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In Vitro Anthelmintic Activity of *Limonia acidissima*, L. Leaves Aqueous Extract on *Haemonchus contortus* (Rudolphi, 1803)

Muh. Andhi Hardianto, Slamet Widiyanto

Mortality, loss of production, slowed growth, poor weight gain, and even death are all common economic losses caused by haemonchosis. Due to the emergence of anthelmintic resistance and the expensive expense of chemical anthelmintic treatments, medicinal plants have been investigated as potential anthelmintics....

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Developing RAPD-derived SCAR (Sequence Characterized Amplified Region) Marker for Flowering Time in Chili Pepper

Estri Laras Arumingtyas, Bunga Rizky Elfa Agustina, Joni Kusnadi

The selection step of plant breeding is a crucial stage in the process of developing new varieties which usually take a considerable long time in a

conventional breeding. The development of molecular markers for selection has been carried out to reduce the time required. A Sequence Characterized Amplified...

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UV Protectant Ability of *Attacus atlas* L. (Lepidoptera: Saturniidae) Sericin Extract to Increase Nucleopolyhedrovirus Effectiveness against Beet Army Worm, *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae)

Hana Widiawati, Sukirno Sukirno, Siti Sumarmi, Hari Purwanto, R.C. Hidayat Soesilohadi, Ignatius Sudaryadi

Spodoptera exigua (Lepidoptera: Noctuidae) is the common pest known for attacking shallot crop. Baculovirus (Nucleopolyhedrovirus: NPV) is a biological agent that is widely used as the pest control agent. However, the activity of NPV is deteriorated when applied in the field due to the influence of ultraviolet...

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The Effect of UV Radiation and Fruit Feedings (Banana and Guava) on the Survival Rate and Morphological Changes of Reproductive Organ of Fruit Fly (*Drosophila melanogaster* Meigen, 1830)

Hipny Alwandri, Nafisa Kusumawati, Ignatius Sudaryadi

The increasing ozone concentration in the upper stratosphere was not significant enough to be able to protect from the detrimental effect that

ultraviolet (UV) light radiates. One solution to counter this problem is by using antioxidants as protectants, such as those contained in fruits. In order to...

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Diversity of Macroalgae in the Intertidal Zone of Gili Ketapang Beach, Probolinggo, Jawa Timur, Indonesia

Natasya Meri Auliadani, Faradilla Faradilla, Abdul Razaq Chasani

Indonesia is a country that has high potential in biodiversity, especially in the marine areas. As the primary producer of marine ecosystems, macroalgae provide food for many species. Macroalgae have very varied structures but are generally divided into three groups based on their color of thallus i.e....

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Diversity of Insect Based on Growth Stages of Rice (*Oryza sativa* L. 'IR 64') at High Altitude in Kepurun Village, Manisrenggo Sub-district, Klaten District, Central Java

Aryo Seto Pandu Wiranto, Nindita Sabila Ningtyas, Regina Diah Rachmawati, Rahmatullah Rahmatullah, Sukirno Sukirno

Rice (*Oryza sativa* L.) is one of the biggest commodities in Indonesia. Rice is cultivated in monoculture, so it affects the diversity of insects present in rice fields. The purpose of this research is to study the diversity of insect present at different 'IR 64' rice growth stages including seedling...

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Application of Rhizobacteria and NPK for Growth and Productivity of Sweet Corn (*Zea mays* L.)

M. Shovitri, S.K. Sugianto, N.D. Kuswytasari, N.H Alami, E. Zulaika

Soil fertility is one of the limiting factors for sweet corn crops. To overcome it, the wise use of fertilizer is a must to maintain long soil sustainability. Our previous study showed that a rhizobacteria consortium had a significant positive effect on crop growth and productivity; even the chemical...

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Antibacterial Activity and Toxicity Study of Selected *Piper* Leave Extracts Against the Fish Pathogen (*Aeromonas hydrophila*)

Norashikin Anjur, Siti Fatimah Sabran, Hassan Md Daud, Nor Zalina Othman

The extensive use of antibiotics in aquaculture has resulted in the emergence of bacterial resistance strains. The medicinal importance of the herb such as *Piper betle*, *Piper sarmentosum*, and *Piper nigrum* evidently proved as one of the most promising commercial botanicals with earlier reported to possess...

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Numerical Taxonomy of Marine Macroalgae Gracilariaceae from Southern Coast of Gunungkidul Based on Morpho-Anatomical and Phytochemical Characters

Adinda Nur Anisa, Abdul Razaq Chasani

Gracilariaceae is a macroalgal family of Rhodophyta which can be found abundantly in tropical waters, including in Southern Coasts of Gunungkidul D.I.Yogyakarta, Indonesia. Coral and sand dominate the substrate of Southern Coasts of Gunungkidul, so it is an ideal habitat for Gracilariaceae. Along with...

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A Year of COVID-19 Outbreak in Indonesia #2: Variant Development Based on *Spike (S)* Mutations

Nicholas Gerry Andreanto, Dwita Novitasari, Delia Wahyu Pangesti, Rizqi Layli Khusufi, Annasa Sabatia, Irwansyah Nur Oktafian, Nur Alfi Maghfirotus Sa'adah, Reni Krisdayana, Salsabila Kasta Hygiea Iswara, Dwi Listyorini

SARS-CoV-2 has infected millions of people in Indonesia and taken thousands of lives by bonding Spike (S) protein and Angiotensin-Converting Enzyme 2 (ACE2) human cell receptor. Spike gene has a higher mutation rate compared to other genes, which suggested to increase its virulence, transmission and...

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The Effect of UV Radiation and Treatment to Orange (*Citrus sinensis* L. Osbeck) Fruit Feeding on the Survival Rate and

Colony Sex-ratio of Fruit Fly (*Drosophila melanogaster* Meigen, 1830)

Ignatius Sudaryadi, Yulia Maulita Janah, Nafisa Kusumawati

Ultraviolet (UV) is a form of physical stress that forces living organisms to respond to the challenge of DNA alteration. UV light causes oxidative stress by causing the creation of reactive oxygen species (ROS). Antioxidants are substances that can interfere with the production of reactive oxygen species...

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Diversity and Origin of Mammal Collection in Mini Zoo in Sleman, Yogyakarta Special Region

Dea Evani Amelia, Bambang Agus Suropto

The mini zoo that became a local tourist spot manifests the ex-situ conservation of mammal species. Animal welfare principles play an important role in long-term sustainability during the animal care and management period. Mini zoos in Sleman, Yogyakarta Special Region were assumed that their diversity...

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Carbon Sequestration of Tree Community in Urban Green Spaces of Bekasi City, Indonesia

Kristian Briantama, Adi Basukriadi

Bekasi City is experiencing climate problems, one of which is a decrease in rainy days. The existence of the Patriot Bina Bangsa City Forest and Bekasi

City Park is expected to reduce the impact of climate change through the role of the tree communities in it as a carbon sink. The problem faced is the...

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Histological Observation, Identification, and Secondary Metabolites Content in Endophytic Fungi of Mahogany Tree (*Swietenia mahagoni* Jacq)

Utami Sri Hastuti, Sulisetijono Sulisetijono, Chomisatut Thoyibah, Siti Hartina Pratiwi, Khusnul Khotimah

The mahogany (*Swietenia mahagoni* Jacq.) tree is a sort of medicinal plant. The phytochemical analysis by previous research has proved that the mahogany bark methanol extract is contained i.e alkaloid, tannin, saponin, phenol hydroquinone, and flavonoid. Some medicinal plant that has mutualism symbiotic...

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Species Diversity of Insects on Tobacco (*Nicotiana tabacum* L. 'Bligon' and 'Grompol') Plantation in Sokorini Village, Muntilan, Magelang, Central Java

Aryo Seto Pandu Wiranto, Siti Sumarmi

Tobacco is an agricultural export commodity important for Indonesia. Therefore, tobacco farming, especially in optimizing production, is an attractive point for research. The challenges in optimizing tobacco production are insect pests causing loss on tobacco production. This study aimed to identify...

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Effect of Altitude on Odonata Biodiversity in the Paddy Field of Sleman Regency, Special Region of Yogyakarta

Nariswari Salsabiela, Amanda Novitasari, Agustina Citra Windianingsih, Reza Bagus Alfian, Anggun Setyaningrum, Besta Eins Yudharta, Okti Alfiyatus Safa'ah, Sukirno Sukirno

Odonata acts as a natural enemy in the paddy field ecosystem. The Odonata diversity is highly related to habitat condition. This research analyzed the effect of altitude on the diversity of Odonata in paddy field ecosystems in Sleman Regency, Special Region of Yogyakarta. This research was conducted...

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The Activity of Lactate Dehydrogenase in Sapera, Saanen, and Ettawa Crossbred Goats in the Different Physiological Statuses

Sarmin Sarmin, Irkham Widiyono, Devita Anggraeni

The enzyme that catalyzes the conversion of lactate to pyruvate is called lactate dehydrogenase (LDH), essential in producing energy present in cells for various tissues, including the liver, heart, and skeletal muscle. Although the increased LDH activity is due to vascular thrombosis, bleeding, and...

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Computational Study of Natural Compounds in Melon Fruit (*Cucumis melo* L. 'GMP') as Inhibitor of Epidermal Growth Factor Receptor Protein

Wiko Arif Wibowo, Teuku Nanda Saifullah Sulaiman, Supriyadi Supriyadi, Budi Setiadi Daryono

'GMP' melon is a breeding cultivar that has a bitter taste and fragrant aroma. The bitter taste character indicates the presence of potential natural compounds that can be used as anti-cancer. This study aims to reveal the natural compounds of 'GMP' melon and its use as an anti-cancer computationally....

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Occurrence of Pest, the Management of Zoological Museum Specimens Collection and Climate Change

Arney Sapaat, Siti Fatimah Sabran, Maryati Mohamed

This study aims to assess the occurrence of pests of zoological specimen collections at natural history museums, management of the specimens with climate change patterns in Malaysia. The objective of this study was to determine the causes that damaged zoological specimens and the effectiveness of the...

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Morphological Characters and Plant Pigments Content of

Three Varieties of Chrysanthemum Induced by Paclobutrazol Treatments

Intani Quarta Lailaty, Laurentius Hartanto Nugroho

Chrysanthemum is one of the favorite ornamental plants as a potted flower. Consumers currently prefer potted flowers with short stems, lush leaves, also uniform and compact flowers. It is necessary to form the potted flowers by applying paclobutrazol (PBZ). This research aimed to determine the effectiveness...

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The Potency of Red Betel (*Piper crocatum* Ruiz & Pav.) Methanolic Extract as α -Amylase and α -Glucosidase Inhibitor

Yustina Sri Hartini, Dewi Setyaningsih

Methanol is an effective menstruum for attracting compounds with various pharmacological activities from *Piper crocatum* Ruiz & Pav. Several studies reported that laboratory tests for reducing blood sugar content of red betel extract such as aqueous, ethanolic, and ethyl acetate extracts. This study...

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Application of Deep (Machine) Learning for Phytoplankton Identification Using Microscopy Images

Arief Rachman, Aulia Salsabella Suwarno, Susanna Nurdjaman

As a hot spot of marine diversity, between 150 – 400 phytoplankton species have been reported in various Indonesian marine ecosystems. However,

phytoplankton identification in Indonesia is mainly made manually by a human expert, which is a time-consuming process with many limitations. Thus, this study...

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Molecular Docking of Anthocyanin Compound as Anti-Hyperlipidemia Against PPAR α , HMG-CoA Reductase and ACAT Proteins

Noor Nailis Sa'adah, Elshinta Riantica, Awik Puji Dyah Nurhayati, Nova Maulidina Ashuri, Dewi Hidayati

Hyperlipidemia can increase the risk of cardiovascular diseases, such as coronary heart disease (CHD), the number one cause of death worldwide each year. Therefore, needed efforts to reduce the prevalence of cardiovascular disease, one of which is parijoto fruit (*Medinilla speciosa*), which has a high...

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Application of Chitosan-*Aloe vera* Gel Based Coating on Postharvest Quality and Storability of Red Chili (*Capsicum annum* L.)

Yora Faramitha, Fitria Febriyanti, Tiana Fitrilia, Firda Dimawarnita, Siswanto Siswanto

Red chili pepper (*Capsicum annum* L.) is a high-demand horticultural commodity in Indonesia but is vulnerable to quality deterioration. Postharvest treatment is needed to maintain the quality and extend the shelf life of red chilies. One of the promising preservation technologies to

prolong the shelf-life...

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Effect of UV-B Radiation Intensity on *Hsp70*, *mtHsc70-1*, and *cpHsc70-2* Gene Expression in *Synedrella nodiflora* (L.) Gaertn. Leaf Under Field Conditions

Maria Celinna, Andi Eko Maryanto, Andi Salamah

Increased expression of genes encoding Heat Shock Protein 70 (Hsp70) is one of the plant defense responses against UV-B stress. *Synedrella nodiflora* may be tolerant to relatively high UV-B intensity. The research has been conducted to compare expression levels of genes encoding cytosolic, mitochondrial,...

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Isolation and Characterization of *Vanda Orchid Homeobox* Gene from *Vanda tricolor* var. *Suavis* Lindl. form Merapi

Viantius Ruben, Muhammad Dylan Lawrie, Endang Semiarti

Vanda tricolor var. *Suavis* Lindl. form Merapi is one of the crucial Indonesian orchid species. Due to natural disasters or deforestation of their natural habitat, the population of this orchid continues to decline and is threatened to be extinct. Therefore, a strategy for mass propagation of this plant...

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Genetic Variations and Phenetic Relationships of Hairy Bittercress (*Cardamine hirsuta* L.) Accession in Java based on *Inter-Simple Sequence Repeat*

Tania Agnesa, Purnomo Purnomo, Budi Setiadi Daryono

Cardamine hirsuta from the Family Brassicaceae is a potential plant that can be used as an object of comparative study with *Arabidopsis thaliana* (L.) Heynh. Plant comparative studies involving closely related species with similar traits are used to investigate the genetic pathways underlying morphological...

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Molecular Docking Simulation of Trisindolina 1 Compound Against Pi3k Protein in Hepatocellular Carcinoma

Evira Nadila Oktyasti, Awik Puji Dyah Nurhayati

The increased cancer burden globally, from 12.7 million new cases in 2008 to a predicted 22.2 million in 2030, makes cancer a critical global problem with high unmet medical needs. Hepatocellular carcinoma (HCC) is the fifth most frequently diagnosed cancer worldwide, and HCC is the third leading cause...

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Determination of Lectin Genes in Superior Mutant of Rodent Tuber Bogor Accession (*Typhonium flagelliforme*) Based on

PCR Amplification

Nesti Fronika Sianipar, Reflinur Reflinur, Muhammad Dzulkifly Ashan, Khoirunnisa Assidqi, Dwityantari Widyaningrum, Ragapadmi Purnamaningsih

Rodent tuber (*Typhonium flagelliforme*) is one of the Indonesian herbs that has not yet been developed as an anticancer drug. The local name rodent tuber plant has produced superior mutant strains with higher levels and bioactive compounds. Compared to the mother plant, GCMS analysis detected four new...

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Effectiveness of N-Hexane and Ethanol Extract of Giant Calotrope (*Calotropis gigantea* L.) Leaves as Insecticide Against Shallot Pest *Spodoptera exigua* (Hübner)

Elvian Indah Nilamsari, L. Hartanto Nugroho, Sukirno Sukirno

Shallot (*Allium ascalonicum*) is one of the high-value plants. However, shallot productivity has been decreased due to some disturbing organisms. *Spodoptera exigua* is one of the pests on shallot farming and causes a yield reduction of up to 70%. Farmers use excessive synthetic pesticides to overcome the...

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Mutation Analysis of PRD-domain of ROR2 and Ig-domain of FLNA in Breast Cancer Development: A Case Study in Malang

Rizqi Layli Khusufi, Delia Wahyu Pangesti, Dwita Novitasari, Vina Rizkiana, Reni Krisdayana, Salsabila Kasta Hygiea Iswara, Dwi Listyorini

ROR2 is a WNT receptor involved in non-canonical Wnt signaling pathways. PRD and IgFLNA domains are functional domains for binding to downstream proteins that lead to cancer development. This study aimed to analyze mutations in the PRD-IgFLNA-ROR2 domain also the role of the WNT5A-ROR2 pathway involved...

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LC50 and Effect of Sublethal Concentration of K₂Cr₂O₇ on Different Developmental Stages of *Osteochilus vittatus*

Gratiana E. Wijayanti, Sharon Hillary, Ani Septiani, Anisa Aulia, Anastasia E. Sintanora

Chromium in form of hexavalent had been reported to be genotoxic and carcinogenic, affects some physiological, and reproductive features. The ability of aquatic animals including fish to tolerate chromium may vary according to different developmental stages. Therefore, this research was conducted to...

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Phenotypic Characters Stability of Melon (*Cucumis melo* L. 'Kinaya')

Amir Muhammadi, Budi Setiadi Daryono

Melon is an important commodity in Indonesia and still dominated by imported melons such as Action 434 and Sun Lady. The 'Kinaya' cultivar is a crossbreed between 'Kinanti' and 'Sonya' cultivars. The development of

'Kinaya' cultivar as Indonesian superior local melon is needed to improve the quality...

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Computational Model of Trisindoline 1 Conjugate to Protein P53 and P53R2: Targets For Breast Cancer Therapy

Shabrina Syifa Ghaissani, Awik Puji Dyah Nurhayati, Vencka Azzahra Putri

In 2020, there were 2.3 million women diagnosed with breast cancer with average, 7 percent to 11 percent of women with early breast cancer experience a local recurrence during this time. Resistance mechanisms in breast cancer include DNA repair mechanisms that protect cancer cells from endogenous or...

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Sexual Dimorphism of *Leptocorisa oratorius* Fabricius (Hemiptera: Alydidae) from Special Region of Yogyakarta

Fanuel Triaswanto, Erik Lawijaya, Ananto Puradi Nainggolan, IGM Raka Alpin Aditya, RCH Soesilohadi

Sexual dimorphism (SD) is a common phenomenon in animals, especially in invertebrates and poikilothermic vertebrates, which can cause body size differences of males and females in a species. Rice ear bugs [*Leptocorisa oratorius* Fabricius (Hemiptera: Alydidae)] are a significant rice pest in Indonesia,...

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The Potency of Inulin to Increase Curcumin Aqueous Solubility as a Co-Processing Material with *Curcuma longa* in Solid Dispersion Approach

Dewi Setyaningsih, Elizabeth Vianita Kurniawan, Yustina Sri Hartini

Curcumin, an identical compound of *Curcuma longa* extract, shows limited bioavailability due to its lipophilicity. Inulin of degree of polymerization (DP) of 11 is a carbohydrate member that can potentially increase aqueous solubility and dissolve lipophilic compounds. This study aimed to investigate...

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CO₂ Mitochondrial Gene Identification of *Nisaetus cirrhatus*

as a Part of Indonesian Elang Brontok Genetic Conservation

Reni Krisdayana, Rizqi Layli Khusufi, Dwita Novitasari, Annasa Sabatia, Delia Wahyu Pangesti, Salsabila Kasta Hygiea Iswara, Dwi Listyorini

The Elang Brontok, scientifically named as *Nisaetus cirrhatus* is included in the least Concern in appendix II. The use of the COI gene for taxonomic in our previous study put our samples in a complex species taxonomical position. Further research needs to be done using other mitochondrial genes such...

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Pollen Diversity and Propolis's Bioactive Compounds of Stingless Bees (*Tetragonula laeviceps*, Smith 1857) From Kedungpoh Meliponiculture, Gunungkidul, Yogyakarta.

Fiola Oktaweni, Sutikno Sutikno, Ignatius Sudaryadi

The progression of many diseases due to viruses and bacteria makes for an increase in natural alternative medicine. One source of natural medicine is honey and propolis of stingless bees. Efficacy physical and chemical properties of honey are influenced by the type of pollen and the environment, while...

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Effects of Water Availability on Physiological Factors of Cayenne Pepper Plant *Capsicum frutescens* L.

Fiana Lathifah, Dwi Umi Siswanti

Chili pepper is a vegetable plant that is consumed by many people and has

high economic value. Chili peppers contain secondary metabolite compounds, capsaicin which is synthesized in the epidermis cells. Capsaicin acts as a spicy taste in chili peppers, so chili peppers are favored by the public. Environmental...

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Miocene Giraffids (Giraffidae; Mammalia) from the Lower Siwalik of Pakistan

Kiran Aftab, Muhammad Akbar Khan, Sumera Afsheen, Mubashar Hussain, Areej Arif

New dental material of Giraffidae is recorded from the Lower Siwalik, Punjab, Pakistan. The specimens are assigned to two genera, Giraffokeryx and Giraffa. The new material comprises isolated teeth, maxilla, and mandible fragments. The material was recovered from Lower Siwalik localities, Chabbar Sayadan...

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Application of Growth Regulatory Substances CPPU and GA3 on the Growth of Porang Plants from Bulbil

Tutik Nurhidayati, Kristanti Indah Purwani, Zulfan Febriawan, Firda Fortuna Nasich

Porang is known as an alternative food source. The main obstacle for porang production is the long harvest period with growth time needed ranging between 4-5 months and 7-8 months of dormancy. The application of plant growth regulators (PGR) such as CPPU and GA3 could be used to break porang's dormancy....

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The Importance of Purification and Activity Analysis of the Purified Product of Thrombolytic Protease from *Bacillus* sp. HSFI-12– A Review

Nurul Islamiyah, Stalis Norma Ethica, Muhammad Ardi Afriansyah, Ana Hidayati Mukaromah, Dewi Seswita Zilda

Mortality and morbidity of Cardio-vascular diseases (CVDs) have been the major issue in the group of non-communicable diseases worldwide. However, the existing antithrombotic drugs to combat CVD still have many shortcomings in terms of price and safety. *Bacillus* sp. HSFI-12 had been previously reported...

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Introduction to Plant Metabolism, Secondary Metabolites Biosynthetic Pathway, and In-Silico Molecular Docking for Determination of Plant Medicinal Compounds: An Overview

Risanti Dhaniaputri, Hadi Suwono, Mohamad Amin, Betty Lukiati

Natural ingredient produced by plants are widely used for therapeutic treatment, because they are believed to have fewer side effects and are cheaper than synthetic drugs. Plants used as treatment media contain natural secondary metabolites compounds derived from primary and secondary metabolism. Primary...

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The Effectiveness of Bio-catharanthine on Peanut (*Arachis hypogea* L.) Lurik Cultivar

Dwi Indahning Rohmah, Melza Mulyani, Laras Nur Janah, Adi Pancoro, Miftahudin Miftahudin, Anjar Tri Wibowo, Budi Setiadi Daryono

The productivity of peanut (*Arachis hypogea* L.) in Indonesia from 2017 until 2021 is estimated to have average production growth minus 11,82% per year and cannot meet the domestic need of the peanut. According to that statistic, Indonesia is the world's second largest importer of peanuts. Looking for...

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Detection of Terpenoid and Flavonoid of Five Species of Mistletoes at *Stelechocarpus burahol* (Bl.) Hook.f. & Th and *Lagerstroemia speciosa* (L.) Pers. by using Thin Layer Chromatography Method

Djoko Santosa, SM. Widyastuti, Ummi Rosyidah, Betha Silmia

Mistletoe is a parasitic plant that is well known for causing significant damage to forestry plants; nevertheless, its value in traditional medicine has yet to be proven. This study aims to investigate terpenoid and flavonoid compounds of *Macrosolen cochinchinensis* (Lour.) Tiegh, *Scurrula atropurpurea*...

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Prospective *In Vivo* Assays on the Antithrombotic Potential of Protease Extracted from *Bacillus* sp. HSFI-12

Okta Yosiana Dewi, Stalis Norma Ethica, Andri Sukeksi, Maya Dian Rakhmawatie, Sri Darmawati

CVD (cardiovascular disease) is a group of non-communicable diseases and a global cause of cardiovascular death. The search for agents inhibiting blood clot formation (thrombus) and enhancing antithrombotic activity are important for the prevention and treatment of CVD. Previous study reported that bacteria...

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Prospective Purification and Assay of Thrombolytic Protease from *Bacillus* sp. HSFI-10 Isolated from Sand Sea Cucumber for Antithrombotic Agent Development

Bio Putri Ayanti, Stalis Norma Ethica, Ayu Rahmawati Sulisytaningtyas, Sri Sinto Dewi, Dewi Seswita Zilda

Thrombosis is a cardiovascular disorder due to the formation of a blood clot (thrombus), which can cause a blockage in a blood vessel. Such abnormality is responsible for more than millions of deaths per year in the world. In addition to cardiovascular disease, thrombosis can also occur in patients with...

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A Literature Review on the Potential of the Biodiversity of Thrombolytic Protease-Producing Bacteria Isolated from

Brown Seaweeds *Chnoospora* sp.

Nurhilaliyah Nurhilaliyah, Stalis Norma Ethica, Wikanastri
Hersoelistyorini, Aditya Rahman Ernanto, Wijanarka Wijanarka

Bacterial proteases with antithrombotic activities can be used to treat cardiovascular disease (CVD), one of the leading causes of death in the world. Indonesia is known for its high marine biodiversity, including its brown seaweed varieties and their symbiotic bacteria. The high biodiversity of proteolytic...

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Potential of *Dendrobium* spp. Secondary Metabolites as Medicinal Source for SARS-CoV-2

Muhamad Rafli, Tri Rohmiati, Anggiresti Kinasih, Alim El Hakim, Endang Semiarti

Coronaviruses have long been a severe issue due to their capacity to mutate and infect the respiratory tract. *Dendrobium* orchids are the most diverse orchid species in Indonesia. Polysaccharides, bibenzyl, phenanthrene, coumarin, sesquiterpenoids, alkaloids, and steroids were among the phytochemical...

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Behavior and Food of Reintroduced Bornean Orangutan (*Pongo pygmaeus wurmbii*) at Feeding Site and Forest Area in Lamandau Wildlife Sanctuary

Yulia Raudhatul Balaqis Zahro, Ani Mardiasuti, Dede Aulia Rahman

The Bornean orangutan (*Pongo pygmaeus wurmbii*) is a Critically Endangered large Asian primate. Reintroduction had been implemented to recover their population in the wild. The research was conducted in February-April 2021 at Lamandau Wildlife Sanctuary, aimed to identify behavior differences at the feeding...

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Lipolytic and Proteolytic Activities of Fibrolytic Bacteria from Buffalo (*Bubalus bubalis*) Rumen

Siti Lusi Arum Sari, Triyanto Triyanto, Zuprizal Zuprizal, Irfan Dwidya Prijambada

The use of plant-based feed ingredients in aquaculture is expected to reduce feed costs. However, plant ingredients generally have a low protein content and are difficult to be digested by monogastric animals. The fermentation process is proven to increase the digestibility and nutritional value of plant...

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Comparison of the 12S rRNA and COI Regions of Mitochondrial DNA for eDNA Detection of Alligator Gar (*Atractosteus spatula*)

Patricia Agustin, Andi Eko Maryanto, Noviar Andayani

Alligator gar (*Atractosteus spatula*) has been introduced to many places outside its native range. The fish is considered as an invasive alien species that needs to be eradicated upon encounter in Indonesia due to its aggressive behavior. Despite existing regulations in Indonesia, the fish is

still bred...

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Comparison of the Diversity of Nepenthaceae, Orchidaceae and Zingiberaceae in Disturbed and Undisturbed Forests in Johor, Malaysia

Vinod Kumar Sivarajah, Alona Cuevas Linatoc

This study was carried out to compare the diversity of Nepenthaceae, Orchidaceae, and Zingiberaceae families in central Johor. The chosen locations are the Belumut Forest-Eco Park, Mo'akil Permanent Forest Reserve, and Soga-Perdana Permanent Forest Reserve, which have forest types categorized as, undisturbed...

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Effects Leaf Ethanol Extract of *Graptophyllum pictum* L. Griff. to Inhibit Vaginal Atrophy of Menopausal Mouse

Listijani Suhargo, Sri Puji Astuti W., Alfiah Hayati

Menopausal condition with low estrogen level caused vaginal atrophy that it is a condition where vaginal lining become dryer and thinner and it would be easier to get inflammation. So, it was important to find out the treatment to inhibit it. This research was aimed to determine the effects of *Graptophyllum*...

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Construction, Cloning, and Overexpression of Staphylococcal Enterotoxin B Gene Synthetic (SEBSyn) in pET-28a(+): Pre-development Bacterial-Toxin Therapy for Cancer

Achmad Rodiansyah, Marselina Irasonia Tan, Husna Nugrahapraja

Staphylococcal enterotoxin B (SEB) from *Staphylococcus aureus* could be considered as a therapeutic agent to eliminate cancer cells. SEB can activate immune response, which furthermore could induce apoptosis of various cancer cells. This study was proposed to design a SEBSyn coding sequence suitable for...

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Antibacterial Effectiveness of Synthesized Copper Nanoparticles by Ultrasonication Assisted Method

Ainul Fitria Mahmudah, Yuni Kusumastuti, Himawan Tri Bayu Murti Petrus, Yekti Asih Purwestri

Antibiotic resistance among pathogenic bacteria has become a problem in the medical community. Copper nanoparticles (CuNPs) have become one method of combating antibiotic resistance in bacteria. The antibacterial activity of Synthesized Copper nanoparticles (CuNPs) from sigma 774103-5G against various...

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Weight Growth of the Hybrid Chicken (*Gallus gallus domesticus*, Linnaeus 1758) Crossing Result of Female Pelung with Male F₃ Golden Kamper

Salma Dewi Pratita, Nareta Defiani, Afifah Nur Hidayah, Nurul Hidayah, Putri Shafira Setyowati, Budi Setiadi Daryono

Backcross is a cross between an offspring and its parents, or an individual that is genetically similar to its parents, to minimize the genetic variation of the resulting offspring. A female Pelung cross with a male F3 Golden Kamper is a type of backcross. Golden Kamper chicken is a breed of chicken...

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The Immunostimulant Effects of Alang-Alang (*Imperata cylindrica*) Roots Extract on BALB/c Male Mice (*Mus musculus*)

Rosnizar Rosnizar, Fajar Muliani, Iskandar Muda Ramli, Kartini Eriani

Alang-alang (*Imperata cylindrica* L.) is an annual rhizomatous grass and traditionally well known for its therapeutic values, especially in treating fever, muscle soreness, nosebleed and respiratory asphyxia. It has been reported to contain different classes of secondary metabolites and attracted scientists'...

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Study of Digestive Tract Diseases in Cats

Soedarmanto Indarjulianto, Yanuartono Yanuartono, Alfarisa Nururrozi,

Slamet Raharjo, Hary Purnamaningsih, Irkham Widiyono, Sri Hartati, Juni Claudia Dami, Luh Putu Eka Damayanti

The cat's digestive tract is one of the vital systems that often facing the deadly diseases. This study aims to identify digestive system disorders/diseases in cats. A total of 100 cats of various breeds and ages with one or more symptoms of digestive disorders was used in this study. All cats were physically...

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Pyridinoline and Deoxypyridinoline in Oral Fluids of Menopause Women as Predictor Alveolar Bone Resorption

Agustin Wulan Suci Dharmayanti, Hendy Hendarto

Menopause presents menstrual cessation that occurs physiologically and is associated with osteoporosis and periodontitis. Osteoporosis and periodontitis are silent diseases that present clinically in the late stage, which alveolar bone resorption causing tooth loss represents both of these disorders....

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Growth and Productivity of Lurik Peanuts (*Arachis hypogaea* L. var. Lurikensis) after Biofertilizer-Sludge Biogas Application

Dwi Umi Siswanti, Nur Hidayah Pangestuti, Niken Wulansari

One of the most important crop commodities in Indonesia is peanut. Ipeanutse peanut production can be done in various ways, including plant

breeding, and improving land quality through organic fertilization. The effect of the use of biofertilizer combined with sludge on crop productivity of peanuts,...

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Potential High Conservation Value of Mount Ungaran as a Step-stone for Essential Ecosystem Area Plan

Margareta Rahayuningsih, Nana Kariada Tri Martuti, Dyah Kartikasari, Lutfian Nazar

High conservation value (HCV) helps stakeholders conduct sustainable forest management by considering social and environmental aspects. It requires a high level of protection to ensure the high conservation value of an area persists in the long term. Mount Ungaran is one of the essential areas in Central...

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A Meta-Analysis Study on *Spodoptera exigua* and *Spodoptera litura* Control: Biopesticides vs. Synthetic Pesticides

Nadya Sofia Siti Sa'adah, Hipny Alwandri, Laurentius Hartanto Nugroho, Sukirno Sukirno, Tri Rini Nuringtyas

Polyphagous lepidopterans like *Spodoptera exigua* (Hübner) and *S. litura* (F.) (Lepidoptera: Noctuidae) are well-known economic importance insect pests that defoliate a variety of economically important crops. Currently, the most widely used control for both is the use of insecticides. Applying large amounts...

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Effectiveness of Bio-Catharantin Induction to Increase Red Spinach (*Alternanthera amoena* Voss.) Production

Nabila Shafura, Laras Nur Janah, Muhammad Syafi'atol Huda, Budi Setiadi Daryono

Red spinach (*Alternanthera amoena* Voss.) is a plant with high nutritional value and contains anthocyanin compounds that act as antioxidant compounds to prevent the formation of free radicals in the body, besides that anthocyanin can also treat anemia. The increase in demand for red spinach in the market...

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The Effects of High-Fat Diet and CCl₄ Administration on Liver Function and Lipid Profile in Non-Alcoholic Fatty Liver Disease Rat Model

Marwan Rosada, Widya Wasityastuti, Yanasta Yudo Pratama, Ken Siwi, Dewiyani Indah Widasari, Tutik Sri Wahyuni

Non-alcoholic fatty liver disease (NAFLD) is often encountered in the field of hepatology. The disease has a broad spectrum ranging from non-inflammatory fat-accumulating macrovesicles (simple steatosis) and develops to fibrous and cirrhosis. The rate of NAFLD is 15-30% in western countries and around...

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Reproductive Aspect and Embryonic Development of Wader pari Fish (*Rasbora lateristriata* Bleeker 1854) from Malang East Java

Hilyatuz Zahro, Khoirudin Anshori, Sandi Fransisco, Amalia Audina Rosa, Bambang Retnoaji

Indonesia is well known for its high freshwater fish diversity. Wader pari (*Rasbora lateristriata*) is one of the endemic fish, which is very popular, but experienced massive exploitation in wild, due to high market demand. High demand and high economic value of this fish in the market induced a massive...

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Cytological Analysis of *Aerides odorata* Lour. from Sleman, Special Region of Yogyakarta

Kireida Asta Nugraheni, Febri Yuda Kurniawan, Anindita Della Rosa Riyadi, Anggiresti Kinasih, Hadyan Pratama Lutfi Ilmam, Endang Semiarti

Aerides odorata is a species that belongs to the Orchidaceae family and lives as epiphytic orchids. This orchid is distributed across Southeast Asia, India, and China. This orchid occupies one type of habitat. Morphological characters of flowers in this species vary, depending on the habitat occupied....

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Reproductive Aspect and Embryonic Development of Wader

Fish (*Rasbora lateristriata* Bleeker, 1854) from Purworejo, Central Java

Inayah Rizkia Lailiati, Devi Annisa Suci, Amalia Audina Rosa, Veronica Aurelia Fernanda, Bambang Retnoaji

Indonesian native fish "Wader pari" (*Rasbora lateristriata*) from Purworejo is one of the fish has high economic value, which is related to the community enthusiasts and high requests for the fish stock. The demand for fish availability and supply is increasing drastically, which caused fish population...

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In Vitro Selection and Total Phenol Analysis of Moon Orchid [*Phalaenopsis amabilis* (L.) Bl.] Results of Induced With Fusaric Acid

Endang Nurcahyani, Risma Rasmani, Hardoko Insan Qudus

Phalaenopsis amabilis (L.) Bl. is an orchid that is included in the list of endangered plant species. The Fusarium wilt disease on *P. amabilis* is a vital disease caused by *Fusarium oxysporum*, which of one constraint and up to now days is not well yet managed. Disease control that does not cause negative...

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Anti-Infective Properties of a Sea Cucumber Associated Actinobacteria *Kocuria* sp. HL 55

Joko Tri Wibowo

“Antibiotics golden era” can end when resistant strains spread immensely. To find new anti-infective agents, we examined sea cucumber associated bacteria isolated from the intestinal part of the echinoderm *Holothuria leucospilota*. Partial identification using 16S rRNA gene Sanger sequencing revealed...

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Study of N, P, K, and C on Degradation of Indigosol Batik Dye Effluent by *Aspergillus* sp. GPN

Ratna Stia Dewi, Mardiyah Kurniasih

Indigosol dye batik effluent is toxic since it excesses contain decreasing agent sodium hydrosulfite that is oxidized to alkali and alkaline earth metal sulfate (SO₄²⁻), sulfite (SO₃²⁻), and thiosulfate (S₂O₃²⁻) that very corrosive. Therefore, the role of environmental biotechnology in the technology...

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Availability and Information Needs of Traditional Medicine in Urban Community, Surabaya, Indonesia

Oeke Yunita, Fernanda Rizky Putri Heriwana, Erlin Theterissa, Jimmy Jimmy

Indonesian traditional medicine has been widely used in the urban community to treat several symptoms and prevent diseases before accessing the hospital for professional help. Information is critical in modern culture, since it aids in the development of people's health knowledge. The purpose of this...

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The Effect of Bokashi and Rabbit Urine Addition on The Tubber of Shallots (*Allium ascalonicum* L.)

Muh. Alwi Husen, Sugiyarto Sugiyarto, Esna Dilli Novianto

Shallots (*Allium ascalonicum* L.) have been cultivated intensively in Indonesia for a long time. These horticultural crops have high potential and economic value. However, the domestic production itself is not able to meet national demands. Continuous use of chemical agents will negatively impact the...

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The Effect of Variations in Sugar Types and Fermentation Time on Enzyme Activity and Total Titrated Acid on Eco-Enzyme Results of Fermentation

Imam Abu Hanifah, Ni Putu Vidya Primarista, Sasangka Prasetyawan, Anna Safitri, Tri Adyati, Arie Srihadyastutie

Eco-enzyme (EE) production is an alternative for reducing organic waste such as fruit peels and vegetables. EE is widely used as natural organic fertilizer, purification of contaminated groundwater, pesticides, herbicides, and natural insecticides. EE is made through a fermentation process for 3 months...

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Ethnobotanical Study of Hindu Society in Tabanan Bali and The Conservation Efforts

Putri Sri Andila, Tri Warseno, Winda Syafitri, I Gede Tirta

Balinese have traditionally preserved plants for the ethnobotany used hereditary, such as the utilization of plants for traditional medicine and Hindu ceremonies. Most of the Tabanan people are still live in the villages traditionally. They have used plants for the traditional purpose for hundreds of...

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Diversity and Estimated Above Ground Biomass of Shade Trees in Some Coffee-based Agroforestries, Banyuwangi Regency

Jehan Ramdani Hariyati, Dian Siswanto, Endang Arisoesilaningsih, Luchman Hakim

This study was aimed to assess the diversity and estimate the above-ground biomass (AGB) of the shade tree in several coffee-based agroforestries in Banyuwangi, East Java. The data was collected from three villages, i.e. Gombengsari, Papring, and Kependukuh. Vegetation analysis and biomass measurement...

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Initial Survey of Tadpole Species Richness on the Upstream

of Pelus River, Limpakuwus, Sumbang, Banyumas

I Gusti Agung Ayu Ratna Puspitasari, Hafizh Aulia Khairy Rakananda, Nugroho Dwi Septianto, Meyta Pratiwi, Eko Setio Wibowo

The southern slopes of Mount Slamet are the upstream areas of many rivers, which become the breeding habitat of Anuran. Anuran tadpole species richness can indicate the diversity of Anuran in the area and should be considered as important as the adult Anuran species richness. Moreover, the sampling of...

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Dhole's Ecology and Legal Status: Conservation and Management Implication in Human-Dominated Landscape of Java, Indonesia

Sandy Nurvianto, Muhammad Ali Imron, Sven Herzog

The success of conservation and management of endangered species is highly dependent on the manager's understanding on the biology and ecology of the target species. However, most wildlife management and conservation activities in developing countries are not based on scientific data, but more on the...

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Case Report: Therapy of Streptococcal Pneumonia in a Cat

Riskha Nurmi Nataria, Soedarmanto Indarjulianto, Yanuartono, Alfarisa Nururrozi, Slamet Raharjo, Hary Purnamaningsih, Heldiar Soedarmanto, Puveanthan Nagappan Govendan

Pneumonia is a lung infection that can be caused by bacteria, including Streptococcus sp. Identification of the cause of pneumonia in cats is very necessary so that diagnosis and therapy will be more precise. This study reports on the diagnosis and therapy of streptococcal pneumonia on a cat.

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Antioxidant Activity, Total Phenolic Content, and Chemical Composition of Liquid Smoke Derived from Wood Sawdust

Ria Suryani, Rafelinta Daradwinta, Syahida Az-Zahra, Syifa' Aulia Rahmah, Wahyu Anggo Rizal, Tri Hadi Jatmiko, Wuri Apriyana, Yekti Asih Purwestri

Liquid smokes result from the process of pyrolysis of biomass as a raw material which generally contains high content of lignin, cellulose, and hemicellulose. The phenolic compounds, acid compounds, and carbonyl compounds are the main components in liquid smoke and show antioxidant activity. One of the...

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1

The Potency of Inulin to Increase Curcumin Aqueous Solubility as a Co-Processing Material with *Curcuma longa* in Solid Dispersion Approach

Dewi Setyaningsih^{1,*} Elizabeth Vianita Kurniawan¹ Yustina Sri Hartini¹

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ABSTRACT

Curcumin, an identical compound of *Curcuma longa* extract, shows limited bioavailability due to its lipophilicity. Inulin of degree of polymerization (DP) of 11 is a carbohydrate member that can potentially increase aqueous solubility and dissolve lipophilic compounds. This study aimed to investigate inulin DP 11 at various drug loads of curcumin on the solubility and dissolution of curcumin. The inulin and *C. longa* extract were co-processed using a solid dispersion (SD) technology on a spray dryer and were analyzed for curcumin solubility as well as dissolution. The drug content (drug load) of SD formulations was prepared at 10%-30% w/w. As the control, the corresponding drug load was designed without applying the SD technology, called physical mixture (PM) formulations. The results suggest that employing the SD technique, inulin DP 11 co-processed with curcumin enhances the aqueous solubility of curcumin compared to the corresponding PM formulations. The dissolution as analyzed for dissolution efficiency (DE) of the SD samples was enhanced by factors 1.7, 2.9, and 3.3 for the drug load of 10%, 20%, and 30% w/w, respectively. To conclude, inulin DP 11 is favorable to enhance curcumin aqueous solubility and dissolution using an SD platform.

Keywords: Curcuminoids, Dissolution, Extracts, Spray drying.

1. INTRODUCTION

Turmeric (*C. longa*) rhizomes contain curcuminoids, which are natural polyphenolic compounds. Curcuminoids are comprised of curcumin, dimethoxy curcumin, and bis-dimethoxy curcumin, all of which are yellow-colored molecules, with curcumin being the most abundant component in this combination [1]. Curcumin's medicinal potential has been demonstrated in numerous research, particularly those relating to its anti-oxidant and anti-inflammatory characteristics [2]. Curcumin has poor absorption and inconsistent bioavailability upon oral dosing despite its countless favorable pharmacological properties, limiting its potential as a pharmaceutical agent [3]. Curcumin, a lipophilic molecule with an estimated log P 3.2, has a minimal water solubility (11 ng/mL) [4], allowing it to easily precipitate in the gastrointestinal milieu's aqueous environment. As a

result, improving curcumin solubility is critical to ensuring an adequate amount of bioavailable curcumin.

Co-processing material using solid dispersions (SD) approach has been gaining interest during the last half-century to improve the aqueous solubility and bioavailability of lipophilic drugs. SD consists of a lipophilic drug(s) incorporated into a hydrophilic carrier (matrix), e.g., by fusion or solvent evaporation method, providing an improved release profile [5]. Polyvinylpyrrolidone or polyethylene glycol was the most popular matrix material used in SD applications study. We recently used an oligosaccharide called inulin DP 11. Inulin is a fructan family of indigestible carbohydrates, a water-soluble storage polysaccharide. Inulin has been demonstrated in multiple studies to have various health benefits, including feeding healthy gut flora, lowering the risk of gastroenteritis and other digestive problems, and boosting the immune system [6]. As a hydrophilic compound with its high-water

solubility, inulin can affect in helping wetting of lipophilic compounds to increase the water solubility. We propose using inulin to be applied in an SD approach to enhance the aqueous solubility of curcumin. This study aimed to examine the potential use of inulin to improve curcumin aqueous solubility and dissolution using a co-processing way with the SD approach.

2. MATERIALS AND METHODS

Curcumin as a standard compound (>98% purity) was obtained from Sigma-Aldrich (St. Louis, USA). High curcuminoids content of *C. longa* extract of > 97% was given by PT Phytochemindo Reksa, Bogor, Indonesia. Inulin of degree polymerization of 11 (Inulin DP 11) was kindly provided by Dr. W.L.J Hinrichs from the Department of Pharmaceutical Technology and Biopharmacy, University of Groningen, the Netherlands. Methanol, sodium lauryl sulfate (SLS), and sodium dihydrogen phosphate (NaH₂PO₄) were purchased from Merck (Darmstadt, Germany). Purified water was supplied using Milli-Q water equipment.

2.1. Preparation of the SDs formulation

Inulin-based SDs were prepared at 10%, 20%, 30% w/w drug load of curcumin. In brief, ethanolic solution *C. longa* extract was prepared at 10.0 mg/mL. Inulin DP 11 of 50 mg/mL was dissolved in pre-heated water under magnetic stirring for 15 minutes. Curcumin-ethanolic and inulin DP 11 aqueous solutions were mixed under magnetic stirring [7], followed by 40 minutes of ultrasonication in a sonicated bath. The solution mixtures were prepared as follows; 10%, 20%, 30% w/w drug load were prepared from the mix of 10/18, 20/16, 30/14 volume ratios of extract and inulin solutions. The mixed solutions were spray-dried at a flow rate of 6 mL/min via a two-way channel with a nozzle diameter of 0.7 mm on a Büchi B-290 micro spray dryer fitted with a B-295 dehumidifier (Büchi, Flawil, Switzerland). The solvent was evaporated at 105°C inlet temperature, 100 percent aspiration, 6 mL/min feeding rate, and 500 L/h atomization pressure. The output temperature was found to be between 60-65 degrees Celsius. The yield was calculated, and the SD products were dried and stored in a desiccator until the sample was characterized. Drug load evaluation of the solid dispersion samples was conducted a UV-Vis spectrophotometry (Shimadzu 1800, Shimadzu Co. Ltd., Kyoto, Japan) at 421 nm. Curcumin content was quantified based on a calibration sample in which it demonstrates the linear equation of $y = 0.146x + 0.0193$ at the correlation coefficient of 0.9966.

2.2. Preparation of PM sample

PM samples were used as the control experiment. In brief, *C. longa* extract and inulin DP 11 at the

corresponding drug load were gently mixed on a mortar and sieved using a 60-mesh size.

2.3. Solubility evaluation

The SD and PM formulations were subjected to a solubility test. An excess amount of powder was poured into an aqueous sodium phosphate buffer of pH 6.0 at the buffer concentration of 20 mM. Sampling was conducted within 48 hours. Curcumin concentrations of the samples were determined using a double beam UV-VIS spectrophotometer at λ of 429 nm (Shimadzu 1800, Shimadzu Co. Ltd., Kyoto, Japan) based on the linear equation of $y = 0.1279x + 0.009$ and correlation coefficient (r) of 0.9974.

2.4. Dissolution study

Curcumin release was studied on a USP type 2 SOTAX AT7 dissolution tester. The solid dispersion samples and the corresponding physical mixture formulations were filled into capsules of 00 size. The tablets were placed in a dissolution vessel that contained a dissolution medium of 900 mL of 0.5% SLS in 20 mM of sodium phosphate buffer of pH 6.0. The dissolution test was operated at $37 \pm 0.5^\circ\text{C}$ and agitation of 75 rpm for 120 minutes. At predetermined time intervals, a 5.0 mL volume was sampled and replaced by a fresh dissolution medium to maintain the sink condition during the study. Curcumin concentration in the dissolution samples was quantified using the validated UV-VIS spectrophotometry method at λ of 429 nm (Shimadzu 1800, Shimadzu Co. Ltd., Kyoto, Japan). The concentration was obtained using the linear equation of $y = 0.12790x + 0.0090$ and correlation coefficient (r) of 0.99740. Furthermore, the dissolution profile obtained in 120 minutes study was analyzed using a Dissolution Efficiency (DE) approach based on Equation 1.

$$DE_t = \left(\frac{\int_{t_1}^{t_2} y \cdot dt}{y_{100.t}} \right) \times 100\% \quad (1)$$

- DE : The dissolution efficiency at a pre-determined time
- y : The area under the curve (AUC) of the dissolved drug at the time
- y_{100.t} : the area of a rectangle assumed for total drug (100%) dissolved at a particular time

2.5. Statistical analysis

Statistical calculations were conducted on the solubility and dissolution tests on the SD and PM formulations. The dissolution test performed statistical analysis to see the difference in dissolution profile (DE₁₂₀) between the SD and the PM and between the SD

formula. The test carried out is the normality test using the Shapiro-Wilk test. If the data is normally distributed, then it is tested its significance with the T-test. If the data is not normal, the test is carried out with the Mann-Whitney test and Kruskal-Wallis test for data more than two on a 95% confidence level.

3. RESULTS AND DISCUSSION

Co-processed material consisting of *C. longa* extract and inulin DP 11 using the SD approach on the spray drying method yields 73.31%, 69.99%, and 67.86% w/w for the drug load of 10% w/w, 20% w/w, and 30% w/w, respectively. The results show the higher the proportion of inulin DP11 over the *C. longa*, the more the yield is obtained.

The drug load of the SD samples was found at a recovery of $94.43 \pm 0.16\%$ w/w; $96.05 \pm 0.16\%$ w/w; and $92.78 \pm 0.32\%$ w/w. The recovery results show satisfaction. According to the USP monograph on curcuminoids dosage form, the active ingredient content in dosage form products should be between 90.0 and 110.0 percent. As a result, the curcumin detected in the co-processed material of *C. longa* – inulin DP 11 in the SD formulation meets the USP monography's product standard [8].

The solubility test aims to see the solubility of the SD compared to the PM formulations at the corresponding drug load. A solubility test was carried out by dissolving the powder at an excess amount in a specific buffer volume. Due to the stability concern of curcumin, in that curcumin was most stable at pH 6.0 [4], a phosphate buffer solution (pH 6.0) was used as the media to dissolve the PM and SD powder.

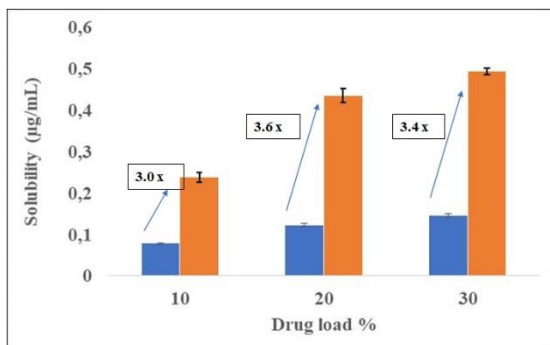


Figure1. Solubility of curcumin in water. Blue color: PM and orange color: co-processed SD. The experiment was replicated with the N=3

Figure 1 shows the solubility test for curcumin in the SD and the PM formulations prepared at various drug loads. After 48 hours, the amount of aqueous soluble curcumin was found of $0.078 \mu\text{g/mL}$, $0.123 \mu\text{g/mL}$, and $0.146 \mu\text{g/mL}$ in the PM formulations of 10%, 20%, and 30% drug load, respectively. The aqueous solubility of

curcumin demonstrated by the SD was significantly higher than the PM formulations; the amount of curcumin dissolved in the SD increased to $0.234 \mu\text{g/mL}$, $0.435 \mu\text{g/mL}$, and $0.493 \mu\text{g/mL}$ in the accordingly drug load. Furthermore, using the solid dispersions approach, co-processing material of *C. longa* with inulin DP 11 dramatically enhanced the curcumin solubility by a factor of 3.0, 3.6, and 3.4 for 10%, 20%, and 30% drug load ($p < 0.05$). From this data, it can be concluded that co-processing *C. longa* extract with inulin DP 11 using solid dispersions approach to magnify the aqueous solubility of curcumin.

Dissolution studies demonstrated the release profile of curcumin from the inulin DP 11 based SD formulations and provided a comparison with the corresponding PM formulations. The dissolution profiles were analyzed for the dissolution efficiency (DE) values to compare dissolution profiles obtained in 120 minutes dissolution study. The DE values are presented in Figure 2.

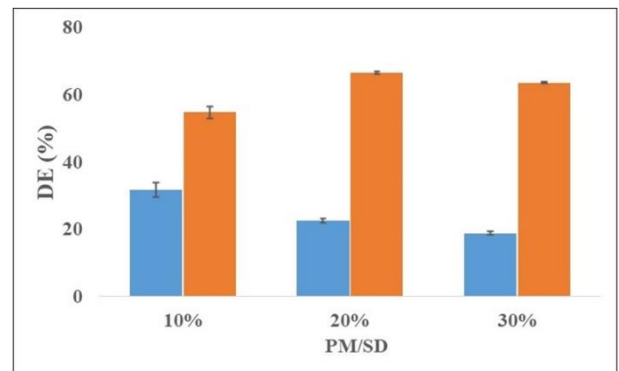


Figure 2. Dissolution efficiency (DE) of the PM and SD formulas. PM: blue color; SD: orange color. The experiment was replicated with the N=3

The DE values found in the PM formulation were 31.57%, 22.52%, and 18.80% for the drug load of 10%, 20%, and 30%, respectively. In accordingly drug load, the SD formulations demonstrated higher DE than the PM formulations, which are 54.71%, 66.53%, and 63.54%. The incorporation of *C. longa* demonstrated the enhancement in curcumin release into solid dispersion formulation in which the dissolution increased by factors 1.73, 2.89, 3.41 for the drug load of 10%, 20%, and 30%, respectively. Others found an increase in curcumin dissolution in co-processed formulation with inulin. Fares and Salem [9] reported the formation of the curcumin-inulin conjugate facilitated the enhancement of curcumin dissolution. Another study found that the use of inulin DP23 increased the dissolution of a lipophilic compound of an HIV viral inhibitor, TMC240; 80% of the drug was released during 30 minutes dissolution study [10].

These data prove that co-processing *C. longa* and inulin DP 11 using solid dispersions approach increased the dissolution efficiency of curcumin at all drug loads used in this experiment.

Inulin DP 11 enhances curcumin aqueous solubility and dissolution by processing it with solid dispersions approach using spray drying method. Inulin DP 11 is applicable in processing *C. longa* extract with an improved dissolution of curcumin. The increment in curcumin dissolution of curcumin by incorporating *C. longa* extracts into inulin-based solid dispersions reaches up to three times as compared to the physical mixture formulation.

AUTHORS CONTRIBUTIONS

Dewi Setyaningsih: Conceived and designed the experiments; analyzed and interpreted the data; contributed reagents, materials, analysis tools, or data; Wrote the paper. Elizabeth Vianita Kurniawan: Performed the experiments. Yustina Sri Hartini: Analyzed and interpreted the data.

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