PENINGKATAN KANDUNGAN FENOL DAN FLAVONOID PADA KALUS DAUN INSULIN (*Tithonia diversifolia* (Hemsl.)) SECARA *IN VITRO* MELALUI PEMBERIAN PREKURSOR L-FENILALANIN DAN L-TIROSIN

SKRIPSI

UIN SUNAN AMPEL
S U R A B A Y A

Disusun oleh:

NUR AINIYYATUROHMAH

NIM. 09040122064

PROGRAM STUDI BIOLOGI

FAKULTAS SAINS DAN TEKNOLOGI

UNIVERSITAS ISLAM NEGERI SUNAN AMPEL

SURABAYA

2026

PERNYATAAN KEASLIAN

Saya bertanda tangan di bawah ini,

Nama : Nur Ainiyyaturohmah

NIM : 09040122064

Program Studi : Biologi

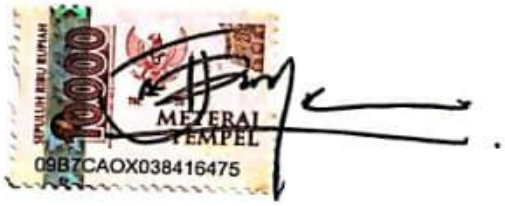
Angakatan : 2022

Menyatakan dengan sesungguhnya bahwa skripsi yang berjudul "Peningkatan Kandungan Fenol dan Flavonoid Pada Kalus Daun Insulin (*Tithonia diversifolia* (Hemsl.)) Secara *In Vitro* Melalui Pemberian Prekursor L-fenilalanin dan L-tirosin" merupakan hasil karya saya sendiri dan tidak mengandung unsur plagiarisme. Apabila di kemudian hari terbukti terdapat unsur plagiarisme dalam skripsi ini, maka saya bersedia menerima sanksi sesuai dengan ketentuan yang berlaku.

Demikian pernyataan ini saya buat dengan sebenar-benarnya untuk dapat dipergunakan sebagaimana mestinya.

Surabaya, 9 Juni 2026

Yang Menyatakan,



Nur Ainiyyaturohmah

NIM. 09040122064

HALAMAN PERSETUJUAN

Skripsi

Peningkatan Kandungan Fenol dan Flavonoid pada Kalus Daun Insulin (*Tithonia diversifolia* (Hemsl.)) secara *In Vitro* Melalui Pemberian Prekursor L-Fenilalanin dan L-Tirosin

Diajukan oleh:
Nur Ainiyyaturohmah
NIM: 09040122064

Telah diperiksa dan disetujui
di Surabaya, 9 Juni 2026

Dosen Pembimbing Utama	Dosen Pembimbing Pendamping
Misbakhul Munir, S.Si., M. Kes.	Hanik Faizah, S.Si., M.Si.
NIP 198107252014031002	NIP 199008062023212045

LEMBAR PENGESAHAN

Skripsi Nur Ainiyyaturohmah ini telah
dipertahankan di depan tim penguji skripsi.
di Surabaya, 19 Juni 2026

Mengesahkan,
Dewan Penguji

Penguji I

Misbakhul Munir, S.Si., M. Kes.
NIP. 198107252014031002

Penguji II

Hanik Faizah, S.Si., M.Si.
NIP. 199008062023212045

Penguji III

Dr. Risa Purnamasari, S.Si., M.Si.
NIP. 198907192023212031

Penguji IV

Yuanita Rachmawati, M.Sc.
NIP. 198808192019032009

Mengetahui,
Dekan Fakultas Sains dan Teknologi
UIN Sunan Ampel Surabaya

Dr. A. Saepul Hamdani, M.Pd.
NIP. 196507312000031002

KEMENTERIAN AGAMA
UNIVERSITAS ISLAM NEGERI SUNAN AMPEL SURABAYA
PERPUSTAKAAN
Jl. Jend. A. Yani 117 Surabaya 60237 Telp. 031-8431972 Fax.031-8413300
E-Mail: perpus@uinsby.ac.id

LEMBAR PERNYATAAN PERSETUJUAN PUBLIKASI
KARYA ILMIAH UNTUK KEPENTINGAN AKADEMIS

Sebagai sivitas akademika UIN Sunan Ampel Surabaya, yang bertanda tangan di bawah ini, saya:

Nama	: Nur Ainiyyaturohmah
NIM	: 09040122064
Fakultas/Jurusan	: Sains dan Teknologi/Biologi
E-mail address	: Nurainiyya44@gmail.com

Demi pengembangan ilmu pengetahuan, menyetujui untuk memberikan kepada Perpustakaan UIN Sunan Ampel Surabaya, Hak Bebas Royalti Non-Eksklusif atas karya ilmiah :
■ Skripsi ☐ Tesis ☐ Desertasi ☐ Lain-lain (.....)
yang berjudul :

PENINGKATAN KANDUNGAN FENOL DAN FLAVONOID PADA KALUS DAUN INSULIN (*Tithonia diversifolia* (Hemsl.)) SECARA *IN VITRO* MELALUI PEMBERIAN PREKURSOR L-FENILALANIN DAN L-TIROSIN

beserta perangkat yang diperlukan (bila ada). Dengan Hak Bebas Royalti Non-Ekslusif ini Perpustakaan UIN Sunan Ampel Surabaya berhak menyimpan, mengalih-media/format-kan, mengelolanya dalam bentuk pangkalan data (database), mendistribusikannya, dan menampilkan/mempublikasikannya di Internet atau media lain secara ***fulltext*** untuk kepentingan akademis tanpa perlu meminta ijin dari saya selama tetap mencantumkan nama saya sebagai penulis/pencipta dan atau penerbit yang bersangkutan.

Saya bersedia untuk menanggung secara pribadi, tanpa melibatkan pihak Perpustakaan UIN Sunan Ampel Surabaya, segala bentuk tuntutan hukum yang timbul atas pelanggaran Hak Cipta dalam karya ilmiah saya ini.

Demikian pernyataan ini yang saya buat dengan sebenarnya.

Surabaya, 18 Juni 2026

Penulis

(Nur Ainiyyaturohmah)

ABSTRAK
PENINGKATAN KANDUNGAN FENOL DAN FLAVONOID PADA KALUS DAUN INSULIN (*Tithonia diversifolia* (Hemsl.)) MELALUI PEMBERIAN PREKURSOR L-FENILALANIN DAN L-TIROSIN SECARA *IN VITRO*

Tithonia diversifolia merupakan tanaman antidiabetes potensial yang kaya akan senyawa fenol dan flavonoid. Penelitian ini bertujuan menganalisis pengaruh L-fenilalanin dan L-tirosin sebagai prekursor terhadap pertumbuhan kalus serta akumulasi total fenol dan flavonoid secara *in vitro*. Eksplan daun muda *T. diversifolia* dikultur pada media *Murashige dan Skoog* (MS) yang ditambahkan 4 mg/L NAA dan 0,5 mg/L BAP untuk induksi kalus. Kalus berumur 35 hari dengan berat 200 mg kemudian disubkultur pada media MS yang mengandung L-fenilalanin (1; 1,5; 2; dan 2,5 mg/L), L-tirosin (1; 1,5; 2; dan 2,5 mg/L), serta kombinasi L-fenilalanin 1,5 mg/L + L-tirosin 2 mg/L. Kultur diinkubasi pada suhu 22–26°C selama 21 hari dalam kondisi terang. Analisis total fenol dan flavonoid dilakukan menggunakan spektrofotometri UV-Vis. Hasil penelitian menunjukkan bahwa penambahan prekursor meningkatkan akumulasi metabolit sekunder dan menghasilkan kalus remah berwarna kuning hingga kuning keunguan dengan peningkatan biomassa dibandingkan tanpa penambahan prekursor. Kadar total fenol tertinggi diperoleh pada perlakuan L-fenilalanin 2,5 mg/L sebesar 10,82 mg GAE/g, sedangkan kadar total flavonoid tertinggi diperoleh pada perlakuan L-tirosin 2,5 mg/L sebesar 14,74 mg QE/g. Penelitian ini menunjukkan bahwa penggunaan prekursor efektif meningkatkan produksi metabolit sekunder pada kultur kalus *Tithonia diversifolia* serta mendukung pengembangan bahan baku alami untuk fitofarmaka antidiabetes yang berkelanjutan.

Kata Kunci : *T. diversifolia,* Kultur kalus, L-fenilalanin, L-tirosin, total fenol dan flavonoid.

ABSTRACT
EFFECT OF L-PHENYLALANINE AND L-TYROSINE ON TOTAL PHENOLIC AND FLAVONOID CONTENTS IN LEAF CALLUS CULTURES OF *Tithonia diversifolia* Hemsl.

Tithonia diversifolia is a medicinal plant with potential antidiabetes properties due to its rich content of phenolic and flavonoid compounds. This study aimed to analyze the effects of L-phenylalanine and L-tyrosine as precursors on callus growth and the accumulation of total phenolic and flavonoid contents under in vitro conditions. Young leaf explants of *T. diversifolia* were cultured on Murashige and Skoog (MS) medium supplemented with 4 mg/L NAA and 0.5 mg/L BAP for callus induction. 35 days old calli with an initial weight of 200 mg were subsequently subcultured onto MS medium containing L-phenylalanine (1; 1.5; 2; and 2.5 mg/L), L-tyrosine (1; 1.5; 2; and 2.5 mg/L), and a combination of L-phenylalanine 1.5 mg/L + L-tyrosine 2 mg/L. Cultures were incubated at 22–26°C under continuous light conditions for 21 days. Total phenolic and flavonoid contents were analyzed using UV-Vis spectrophotometry. The results showed that precursor supplementation enhanced secondary metabolite accumulation, producing friable yellow to yellowish-purple calli with increased biomass. The highest total phenolic content was obtained at 2.5 mg/L L-phenylalanine (10.82 mg GAE/g), while the highest total flavonoid content was recorded at 2.5 mg/L L-tyrosine (14.74 mg QE/g). These findings indicate that precursor supplementation effectively enhanced secondary metabolite production in *Tithonia diversifolia* callus cultures for antidiabetic phytopharmaceutical development.

Keywords: *Tithonia diversifolia*, callus culture, L-phenylalanine, L-tyrosine, total phenolic and flavonoid content.

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

DAFTAR LAMPIRAN

DAFTAR PUSTAKA

Adi Sucandra, F.S. dan A.E.Y. (2015) 'Uji Pemberian Beberapa Konsentrasi Glisin Pada Media Vacin And Went (Vw) Terhadap Pertumbuhan Plantlet Anggrek (Dendrobium sp.) Secara In Vitro', *Jom Faperta*, 2 No.1, pp. 1–11.

Adil, M. *et al.* (2018) 'Effect of explant type and plant growth regulators on callus induction, growth and secondary metabolites production in Cnidium officinale Makino', *Molecular Biology Reports*, 45(6), pp. 1919–1927. Available at: https://doi.org/10.1007/s11033-018-4340-3.

Admojo, L., Indrianto, A. and Hadi, H. (2014) 'Perkembangan Penelitian Induksi Kalus Embriogenik Pada Jaringan Vegetatif Tanaman Karet Klonal (Hevea brasiliensis Muell. Arg)', *Warta Perkaretan*, 33(1), p. 19. Available at: https://doi.org/10.22302/ppk.wp.v33i1.46.

Adzim, R.A., Fatikasari, S. and Yoga, A.T.R.I. (2018) 'Pengaruh Hormon Napthalen Acetic Acid Terhadap Inisiasi Akar Pada Mahkota Tanaman Nanas (Ananas comosus (L .) Merr .) Effect of Napthalene Acetic Acid Hormone of Root Initiation on The Crown of Pineapple Plants (Ananas comosus (L .) Merr .)', *Prosiding Seminar Nasional Sains, Teknologi dan Analisis* [Preprint].

Afolayan, F.I.D. *et al.* (2016) 'Antimalarial actions of Lawsonia inermis, Tithonia diversifolia and Chromolaena odorata in combination', *Journal of Ethnopharmacology*, 191, pp. 188–194. Available at: https://doi.org/10.1016/j.jep.2016.06.045.

Ai, A.Y.R. and Hanny, H.H.N. (2021) 'Modifikasi Media Pada Induksi Kalus Kopi Arabika (Coffea Arabica L.) Berbuah Kuning', *Agro Wiralodra*, 4(2), pp. 42–49. Available at: https://doi.org/10.31943/agrowiralodra.v4i2.60.

Ain, Q.U. *et al.* (2016) 'Plant alkaloids as antiplatelet agent: Drugs of the future in the light of recent developments', *Frontiers in Pharmacology*, 7(SEP), pp. 1–9. Available at: https://doi.org/10.3389/fphar.2016.00292.

Al-khayri, J.M. *et al.* (2022) 'Biotechnological Approaches for Production of

Artemisinin ', *Molecules*, 27(3040), pp. 1–22. Available at: https://doi.org/https://doi.org/10.3390/.

Al-Mahalli, J., & As-Suyuthi, J. (2008) *Tafsir Al-Jalalain Diterjemahkan Bahrun Abu Bakar : Terjemahan Tafsir Jalalain Berikut Berikut Asbabun Nuzul Jilid 1. Bandung : PT Refika Aditama.*

Al-Sheikh, A. (1994) *Tafsir Ibnu Katsir Jilid 1. Bogor: Pustaka Imam Syafi'i. Kementerian Agama RI. (2013). Al-Qur'an dan Terjemahannya: Juz 1-3. Jakarta: CV. Alfatih Berkah Cipta*.

Alfred Ngenge Tamfu, Ndoubalem Roland, A.M.M., Selcuk Kucukaydin, Monde Gaye, A.V.B. and Mehmet Emin Durug, R.M.D. (2022) 'Phenolic composition , antioxidant and enzyme inhibitory activities of Parkia biglobosa (Jacq .) Benth ., Tithonia diversifolia (Hemsl) A . Gray , and', *Arabian Journal of Chemistry*, 15(4), p. 103675. Available at: https://doi.org/10.1016/j.arabjc.2021.103675.

Amanatie, E.S. (2015) 'Structure Elucidation of the Leaf of Tithonia diversifolia (Hemsl) Gray', *Jurnal Sains dan Matematika*, 23(4), pp. 101–106. Available at: https://doi.org/10.1007/978-1-4020-4585-1_2668.

Aminah, Nurhayati Tomayahu, dan Z.A. (2017) 'Penetapan Kadar Flavonoid Total Ekstrak Etanol Kulit Buah Alpukat (Persea Americana Mill .) Dengan Metode Spektrofotometri Uv-Vis', *Jurnal Fitofarmaka Indonesia*, 4(2), pp. 226–230.

Ammaria Wulandari, M. *et al.* (2022) 'Pengaruh 2,4-Dichlorophenoxyacetic Acid (2,4-D) DAN Benzyl Amino Purine (BAP) Terhadap Induksi Kalus Dari Berbagai Jenis Eksplan Tanaman Duku (Lansium domesticum Corr.)', *STIGMA: Jurnal Matematika dan Ilmu Pengetahuan Alam Unipa*, 15(01), pp. 38–45. Available at: https://doi.org/10.36456/stigma.15.01.5606.38-45.

Andressa Blainski, G.C.L. and J.C.P. de M.* (2013) 'Application and Analysis of the Folin Ciocalteu Method for the Determination of the Total Phenolic Content from Limonium Brasiliense L.', *Molecules*, 18, pp. 6852–6864. Available at: https://doi.org/10.3390/molecules18066852.

Apriliyania, R. and Wahidah, B.F. (2021) 'Apriliyani, R., & Wahidah, B. F.', *Jurnal Mahasiswa Biologi,* 1(2), pp. 33–46.

Arbiyani, E. *et al.* (2023) 'Identifikasi Flavonoid Dari Tanaman Dewandaru (Eugenia Uniflora L.) Dengan Metode Spektrofotometri Uv-Vis : Literatur Review Articel', *Jurnal Ilmiah Wahana Pendidikan*, 21(1), pp. 181–183. Available at: https://doi.org/10.5281/zenodo.7732420.

Ariani R Y U Anggraito, E.S.R. (2016) 'RESPON PEMBENTUKAN KALUS KORO BENGUK (MUCUNA PRURIENS L.) PADA BERBAGAI KONSENTRASI 2,4-D DAN BAP', 39(1), pp. 20–28.

Arifin, B. and Ibrahim, S. (2018) 'Struktur, Bioaktivitas Dan Antioksidan Flavonoid', *Jurnal Zarah*, 6(1), pp. 21–29. Available at: https://doi.org/10.31629/zarah.v6i1.313.

Arnay del Arco, R., Castilla Rodríguez, I. and Cabrera Hernández, M.A. (2025) 'Improving clinical decision making by creating surrogate models from health technology assessment models: A case study on Type 1 Diabetes Melitus', *Computer Methods and Programs in Biomedicine*, 262(January), p. 108646. Available at: https://doi.org/10.1016/j.cmpb.2025.108646.

Artur, R.P. and Anna, P. (2025) 'Comparative profiling of phenolic compounds in callus cultures of Fagopyrum spp .: insights into F . esculentum , F . tataricum , and F .'

Aryana Nurisa, Alfinda Novi Kristanti, Y.S.W.M. (2023) 'Effect of sucrose, erythrose-4-phosphate and phenylalanine on biomassa and flavonoid content of callus culture from leaves of', *AIP Publishing*, (January), pp. 1–8. Available at: https://doi.org/10.1063/1.4995205.

Asmono, S.L., Setyoko, U. and Arifiana, N.B. (2026) 'Pengaruh Komposisi Media Kultur Terhadap Induksi Kalus Kopi Arabika Andungsari 1 (Coffea arabica L .)', *Jurnal Agro Indragiri*, 11(1), pp. 33–39. Available at: doi: https://doi.org/10.32520/jai.v4i1.

Asti Pratiwi, Ardita Febrianty Manurung, dan J.S. (2020) 'Penetapan Kadar

Vitamin C Pada Kulit Pisang (Musa paradisiaca) Dengan Metode Spektrofotometri Uv-Visible Abstract : Vitamin C is a vitamin that is water soluble qnd one vitamin that are needed', *Jurnal Farmasi,* 2(2), pp. 56–62.

Bagus Setiawan, Eny Fuskhah, dan K. (2020) 'The Sugarcane (Saccharum Officinarum L .) Bud Chip Growth on the Giving of Different NAA Concentrations and Nitrogen Fertilizer Doses', *Journal Tropical Crop Science And Technology*, 2, pp. 71–82.

Balilashaki, K., Vahedi, M. and Karimi, R. (2015) 'In vitro direct regeneration from node and leaf explants of Phalaenopsis cv. "Surabaya"', *Plant Tissue Culture and Biotechnology*, 25(2), pp. 193–205. Available at: https://doi.org/10.3329/ptcb.v25i2.26254.

Bano, A.S. *et al.* (2022) 'Callus Induction, Proliferation, Enhanced Secondary Metabolites Production and Antioxidants Activity of Salvia moorcroftiana L. as Influenced by Combinations of Auxin, Cytokinin and Melatonin', *Brazilian Archives of Biology and Technology*, 65, pp. 1–16. Available at: https://doi.org/10.1590/1678-4324-2022210200.

Barros, J. and Dixon, R.A. (2019) 'Plant Phenylalanine / Tyrosine Ammonia-lyases', *Trends in Plant Science*, pp. 1–14.

Bindu, P., S.D. and Udayan, P.S. (2018) 'Callus Induction and Organogenesis from Pueraria tuberosa (Roxb. ex Willd.) DC', *International Journal of Environment, Agriculture and Biotechnology*, 3(2), pp. 589–593. Available at: https://doi.org/10.22161/ijeab/3.2.37.

Biradar, S.R. (2018) *An introduction of Plant Tissue Culture*. Available at: https://www.researchgate.net/publication/361304964.

Boča, R., Štofko, J. and Imrich, R. (2023) 'Ab initio study of molecular properties of l-tyrosine', *Journal of Molecular Modeling*, 29(8), pp. 1–9. Available at: https://doi.org/10.1007/s00894-023-05648-8.

Cao, X. *et al.* (2020) 'The methods to crystallize anhydrous L-phenylalanine from methanol-water solution', *Crystals*, 10(2). Available at:

https://doi.org/10.3390/cryst10020060.

Carlos, J. *et al.* (2019) 'Cover article', (June), pp. 124–132.

Chagas-Paula, D.A. *et al.* (2015) 'A metabolomic approach to target compounds from the asteraceae family for dual COX and LOX inhibition', *Metabolites*, 5(3), pp. 404–430. Available at: https://doi.org/10.3390/metabo5030404.

Cheynier, V. *et al.* (2013) 'Plant phenolics: Recent advances on their biosynthesis, genetics, andecophysiology', *Plant Physiology and Biochemistry*, 72, pp. 1–20. Available at: https://doi.org/10.1016/j.plaphy.2013.05.009.

Chukwuka, K.S., Ogunyemi, S. and Fawole, I. (2007) 'Ecological distribution of Tithonia diversifolia (Hemsl). A. Gray-A new exotic weed in Nigeria', *Journal of Biological Sciences*, pp. 709–719. Available at: https://doi.org/10.3923/jbs.2007.709.719.

Chunudom, L. *et al.* (2019) 'Amelioration of oxidative stress and pathological alterations in alloxan-induced diabetes mice by Tithonia diversifolia leaves extract', *Chiang Mai Journal of Science*, 46(6), pp. 1096–1106.

Conner, A.J. and Jacobs, J.M.E. (2025) 'Defining the use of MS medium in plant science research', *Plant Cell, Tissue and Organ Culture*, 162(3), pp. 4–6. Available at: https://doi.org/10.1007/s11240-025-03210-3.

Deng, Y. and Lu, S. (2017) 'Biosynthesis and Regulation of Phenylpropanoids in Plants', *Critical Reviews in Plant Sciences*, 36(4), pp. 257–290. Available at: https://doi.org/10.1080/07352689.2017.1402852.

Desa, S.M. *et al.* (2010) 'Effect of Culture Conditions on L-Dopa Accumulation in Callus Culture Of Mucuna pruriens', *Journal of Chemical and Pharmaceutical Research*, 2(4), pp. 134–146.

Dias, R. *et al.* (2021) 'Recent advances in extracting phenolic compounds from food and their use in disease prevention and as cosmetics', *Critical Reviews in Food Science and Nutrition*, 61(7), pp. 1130–1151. Available at: https://doi.org/10.1080/10408398.2020.1754162.

Douglas, K. and Jeruto, J. (2016) 'Phytochemistry and Antimicrobial Activity of Extracts from Medicinal Plants Tithonia diversifolia and Olea africana', *British Journal of Pharmaceutical Research*, 12(3), pp. 1–7. Available at: https://doi.org/10.9734/bjpr/2016/26566.

Duke, J.C. La (1982) 'Revision Of Tithonia', 84(840), pp. 453–522.

Duran, R.E. (2024) 'Salvia officinalis L.'in İn Vitro Kallus Kültürü ve Bazı Amino Asitlerin Rosmarinik Asit Birikimi Üzerine Etkisi', *Journal of The Institute of Science and Technology*, 7(5), pp. 1970–1981.

Duri, R.D. *et al.* (2024) 'Identifikasi Kalus Embriogenik pada Tanaman Kakao (*Theobroma cacao* L.) Klon Sulawesi 01', *Vegetalika*, 13(4), p. 391. Available at: https://doi.org/10.22146/veg.95832.

Dwi Kusuma Wahyuni, Putri Andriani, Arif Nur Muhammad Ansori, Edy Setiti Utami, W. (2017) 'Callus Induction of Gendarussa (Justicia gendarussa) by Various Concentration of 2,4-D, IBA, and BAP', *Journal of Biology & Biology Education*, 9(4), pp. 402–408. Available at: https://doi.org/10.15294/biosaintifika.v9i3.11347.

Eddijanto, I., Restiani, R. and Aditiyarini, D. (2022) 'Elisitasi Flavonoid menggunakan Kitosan pada Kultur Kalus Ginseng Jawa (Talinum paniculatum Gaertn.)', *Sciscitatio*, 3(2), pp. 90–99. Available at: https://doi.org/10.21460/sciscitatio.2022.32.94.

Effendi, S., Maryam, S. and Azura, D.N. (2024) 'Analisis Kandungan Flavonoid Dan Fenolik Total Dari Esktrak Dan Fraksi Tanaman Batang Tebu Telur (Saccharum Edule Hasskarl)', 7(3), pp. 58–70.

Emilia, Lia Destiarti, A. (2021) 'Indonesian Journal of Pure and Applied Chemistry (Determination Of Manganese In Peat Water Using Uv-Vis Spectrophotometer : Comparation Of Calibration Of Curve And Standard Addition Method)', *Indonesian Journal of Pure and Applied Chemistry*, 4(1), pp. 1–10.

Ermavitalini, P.N.I.D. (2013) 'nduksi Kalus Daun Nyamplung (Calophyllum

inophyllum Linn.) pada Beberapa Kombinasi Konsentrasi 6-Benzylaminopurine (BAP) dan 2,4-Dichlorophenoxyacetic Acid (2,4-D)', *Jurnal Sains Dan Seni Pomits*, 2(1), pp. 1–6.

Ermi, A. *et al.* (2024) 'Analisis Hasil Penentuan Struktur Kimia Senyawa Asam Askorbat Dengan Metode Spektrofotometri UV-VIS Sebagai Bahan Ajar Kimia Analitik', *Jurnal Ilmiah Wahana Pendidikan*, 10(11), pp. 134–138. Available at: https://doi.org/10.5281/zenodo.12563929.

Erni Suminar1*, Syariful Mubarok1, Rahmat Budiarto1, Fiky Yulianto1, Anne Nuraini1, Anni Yuniarti2, V. and Kusumadewi3, Rika Meliansyah3, Dikdik Kurnia4, S.J. (2025) 'Phenylalanine-Induced Modulation Of Callus Characteristics And Secondary Metabolite Accumulation In Ocimum Basilicum L. Under In Vitro Conditions', 13(3), pp. 612–623.

Fajri, N. *et al.* (2024) 'Validasi Metode Analisis Konsentrasi Larutan Kopi berdasarkan Spektroskopi Absorpsi Cahaya', *JIPFRI (Jurnal Inovasi Pendidikan Fisika dan Riset Ilmiah)*, 8(1), pp. 51–59. Available at: https://doi.org/10.30599/jipfri.v8i1.2101.

Fan, L. *et al.* (2024) 'Blended nexus molecules promote CO2 to l-tyrosine conversion', *Science Advances*, 10(36), pp. 1–11. Available at: https://doi.org/10.1126/sciadv.ado1352.

Fatima, T. *et al.* (2024) 'Indirect Organogenesis of Calendula officinalis L. and Comparative Phytochemical Studies of Field-Grown and In Vitro-Regenerated Tissues', *Agronomy*, 14(8), pp. 1–17. Available at: https://doi.org/10.3390/agronomy14081743.

Fauziyah, Y. *et al.* (2024) 'Potensi Daun Tithonia Diversifolia sebagai Antihiperglikemia pada Diabetes Mellitus : Systematic Review', *Jurnal Implementa Husada*, 5(2), pp. 105–112.

Firgiyanto, R. *et al.* (2023) 'Effect of modified murashige and skoog medium on chrysanthemum tissue culture', *IOP Conference Series: Earth and Environmental Science*, 1168(1). Available at: https://doi.org/10.1088/1755-1315/1168/1/012008.

Fiya Firdiyani, Tri Winarni Agustini, W.F.M. (2015) 'Extraction of Bioactive Compounds as Natural Antioxidants from Fresh Spirulina platensis using Different Solvents', *Jurnal Pengolahan Hasil Perikanan Indonesia (JPHPI)*, 18(1), pp. 28–37. Available at: https://doi.org/10.17844/jphpi.2015.18.1.28.

Galindo, V. *et al.* (2017) 'Facilitation by pioneer shrubs for the ecological restoration of riparian forests in the Central Andes of Colombia', *Restoration Ecology*, 25(5), pp. 731–737. Available at: https://doi.org/10.1111/rec.12490.

Ganeshpurkar, A. and Saluja, A.K. (2017) 'The Pharmacological Potential of Rutin', *Saudi Pharmaceutical Journal*, 25(2), pp. 149–164. Available at: https://doi.org/10.1016/j.jsps.2016.04.025.

Ghorbani, A. (2017) 'Mechanisms of antidiabetic effects of flavonoid rutin', *Biomedicine and Pharmacotherapy*, 96(September), pp. 305–312. Available at: https://doi.org/10.1016/j.biopha.2017.10.001.

Giacomo, C. Di *et al.* (2015) 'Effects of Tithonia diversifolia (Hemsl.) A. Gray extract on adipocyte differentiation of human mesenchymal stem cells', *PLoS ONE*, 10(4), pp. 1–15. Available at: https://doi.org/10.1371/journal.pone.0122320.

Greenwell, Z.L.I. and Ruter, J.M. (2018) 'Effect of glutamine and arginine on growth of', *Scientific Article*, 24, No.1(1), pp. 393–399.

Guo, F. *et al.* (2023) 'Initiation of scutellum-derived callus is regulated by an embryo-like developmental pathway in rice', *Communications Biology*, 6(1), pp. 1–10. Available at: https://doi.org/10.1038/s42003-023-04835-w.

H. Al Mamari, H. (2022) 'Phenolic Compounds: Classification, Chemistry, and Updated Techniques of Analysis and Synthesis', pp. 1–22. Available at: https://doi.org/10.5772/intechopen.98958.

Handayani, Y., Susiloningrum, D. and Ismah, K. (2024) 'Penetapan Kadar Fenol Total Daun Temu Kunci (Boesenbergia rotunda (L .) Mansf) Dengan

Metode Ekstraksi Ultrasound Assisted Extraction Menggunakan', *Cendekia Journal of Pharmacy*, 8(2), pp. 182–189.

Haryanto Haryanto *et al.* (2025) 'Analisis Kandungan Kadar Paracetamol pada Jamu Pegal Linu Menggunakan Spektrofotometri UV VIS', *Jurnal Mahasiswa Ilmu Kesehatan*, 3(1), pp. 104–110. Available at: https://doi.org/10.59841/jumkes.v3i1.2237.

Hegazi, G.A. *et al.* (2016) 'Benzyl isothiocyanate production from Salvadorapersica L . callus cultures', *Journal of Biotechnology and Biochemistry*, 2(2), pp. 19–25.

Hyun, M.W. *et al.* (2011) 'Fungal and plant phenylalanine ammonia-lyase', *Mycobiology*, 39(4), pp. 257–265. Available at: https://doi.org/10.5941/MYCO.2011.39.4.257.

Ikeuchi, M., Sugimoto, K. and Iwase, A. (2013) 'Plant callus: Mechanisms of induction and repression', *Plant Cell*, 25(9), pp. 3159–3173. Available at: https://doi.org/10.1105/tpc.113.116053.

Irchhaiya, R. *et al.* (2015) 'Metabolites in Plants and Its Classification', *World Journal of Pharmacy and Pharmaceutical Sciences*, 4(1), pp. 287–305.

Isah, T. *et al.* (2018) 'Secondary metabolism of pharmaceuticals in the plant in vitro cultures: strategies, approaches, and limitations to achieving higher yield', *Plant Cell, Tissue and Organ Culture*, 132(2), pp. 239–265. Available at: https://doi.org/10.1007/s11240-017-1332-2.

Isalar, C.E. (2020) 'Comparative Evaluation of Auxins and Cytokinins on Callus Morphology and Biomass Accumulation', *International Journal of Scientific Research in Science and Technology*, 7(4), pp. 504–522.

Isda, M.S. dan M.N. (2021) 'Respon Pembentukan Kalus Daun Tacca Chantrieri dengan Berbagai Konsentrasi 2,4 D dan BAP Secara In Vitro', *Jurnal Biologi Universitas Andalas*, 9(1), pp. 8–17. Available at: https://doi.org/10.25077/jbioua.9.1.8-17.2021.

Ismawati Nur Jamiah, Diding Latipudin, A.H. (2025) 'Pengaruh Lama Maserasi

Terhadap Rendemen, Ph, Dan Profil Fitokimia Ekstrak Etil Asetat Pollard (Triticum aestivum L.) Sebagai Sumber Betain', *Wahana Peternakan*, 9(3), pp. 657–666.

Jadhav, V.R. *et al.* (2019) 'Mathematical Treatment to Understanding the Concentration Terms', *International Journal of Research & Review (www.ijrrjournal.com)*, 6(1), pp. 172–175.

Jagiełło-Kubiec, K. *et al.* (2021) 'Acclimation to ex vitro conditions in ninebark', *Agronomy*, 11(4). Available at: https://doi.org/10.3390/agronomy11040612.

Jama, B. *et al.* (2000) 'Tithonia diversifolia as a green manure for soil fertility improvement in western Kenya: A review', *Agroforestry Systems*, 49(2), pp. 201–221. Available at: https://doi.org/10.1023/A:1006339025728.

Jannah, K.P.A., Prihantoro, I. and Karti, P. dewi manu hara (2023) 'Optimasi Level Benzyl Amino Purin (BAP) terhadap Pertumbuhan Tanaman Kembang Telang (Clitoria ternatea) melalui Teknik Kultur Jaringan', *Jurnal Ilmu Nutrisi dan Teknologi Pakan*, 21(2), pp. 100–106. Available at: https://doi.org/10.29244/jintp.21.2.100-106.

Jialal, I. and Singh, R. (2019) 'Oral pharmacotherapy as alternative treatment fortype 2 diabetes mellitus in a 61 year old ethnic Filipino man with insulin allergies', *Lab Medicine*, 50(1), pp. 93–95. Available at: https://doi.org/10.1093/labmed/lmy049.

John-Dewole, J.-D. (2013) 'Phytochemical and Antimicrobial Studies of Extracts from the Leaves of Tithonia Diversifolia for Pharmaceutical Importance', *IOSR Journal of Pharmacy and Biological Sciences*, 6(4), pp. 21–25. Available at: https://doi.org/10.9790/3008-0642125.

Kareem, A.J. and Alwash, B.M. (2022) 'Enhancement phenolic content in callus of Taraxacum officinale plant by using phenylalanine precursors', *Biochemical and Cellular Archives*, 22(1), pp. 3545–3552. Available at: https://doi.org/10.51470/bca.2022.22.2.3545.

Kaur, M. *et al.* (2015) 'Effect of growth regulators on micropropagation of potato cultivars', *African Journal of Crop Science*, 3(5), pp. 162–164. Available at: www.internationalscholarsjournals.org.

Kaushik, S. *et al.* (2020) 'A review on effect of IBA and NAA and their combination on the rooting of stem cuttings of different ornamental crops', *~ 1881 ~ Journal of Pharmacognosy and Phytochemistry*, 9(3), pp. 1881–1885. Available at: www.phytojournal.com.

Khalifa, A.M. *et al.* (2022) 'Influence of gamma radiation and phenylalanine on secondary metabolites in callus cultures of milk thistle (Silybum marianum L .)', *Journal of Genetic Engineering and Biotechnology*, 2(20), pp. 1–12. Available at: https://doi.org/10.1186/s43141-022-00424-2.

Khan, T. *et al.* (2018) 'Carbohydrate-induced biomass accumulation and elicitation of secondary metabolites in callus cultures of Fagonia indica', *Industrial Crops and Products*, 126(October), pp. 168–176. Available at: https://doi.org/10.1016/j.indcrop.2018.10.023.

Kherasani, I. *et al.* (2017) 'Pertumbuhan Kalus Eksplan Rimpang Jahe Merah (Zingiber officinale Rosc.) pada Berbagai Konsentrasi Sukrosa Secara In Vitro', 2.

Khoirunnisa1, R., Susanti2, R. and Nera Umilia Purwanti (2019) 'Penetapan Kadar Total Flavonoid Dan Fenol Fraksi Etil Asetat Dari Ekstrak Etanol Rimpang Acorus Sp.', *Jurnal Mahasiswa Farmasi Fakultas Kedokteran UNTAN*, 4(1).

Kim, M.H. *et al.* (2025) 'Structural Diversity and Anti-Diabetic Potential of Flavonoids and Phenolic Compounds in Eriobotrya japonica Leaves', *Molecules*, 30(3). Available at: https://doi.org/10.3390/molecules30030736.

Kong, J. (2015) 'Phenylalanine ammonia-lyase, a key component used for phenylpropanoids production by metabolic engineering', *RSC Advances*, 5, pp. 62587–62603. Available at: https://doi.org/10.1039/C5RA08196C.

Kumar, N. and Reddy, M.P. (2011) 'In vitro Plant Propagation', *Journal of Forest Science*, 27(2), pp. 3–6. Available at: https://koreascience.kr/article/JAKO201122350102027.page.

Kurnianingrum, I. and Rosya, A. (2024) 'Optimalisasi Pemberian Zat Pengatur Tumbuh Alami Untuk Perlakuan Benih Tomat (Solanum Esculentum) Dengan Variasi Konsentrasi Guna Peningkatan Viabilitas Benih', *Jurnal Ilmiah Hijau Cendekia*, 9(1), p. 65. Available at: https://doi.org/10.32503/hijau.v9i1.4912.

Kurniasari, R., Suzery, M. and Cahyono, B. (2024) 'Analysis of Total Phenolics, Flavonoids, and Antioxidant Activity of Cashew Leaf Extract (Anacardium occidentale L.) with Varying Ethanol Concentrations', *Jurnal Riset Kimia*, 15(2), pp. 116–130. Available at: https://doi.org/10.25077/jrk.v15i2.735.

Larkin, P.J. and Scowcroft, W.R. (1981) 'Somaclonal variation - a novel source of variability from cell cultures for plant improvement', *Theoretical and Applied Genetics*, 60(4), pp. 197–214. Available at: https://doi.org/10.1007/BF02342540.

Lengkong, E.F., Mantiri, H. and Pinaria, A.G. (2023) 'Growth Of Potato Seeds (Solanum Tuberesum L.) On Ms Media Substituted With Coconut Water', *Jurnal Agroekoteknologi Terapan*, 4(2), pp. 361–369. Available at: https://doi.org/10.35791/jat.v4i2.50675.

Lestari, S.A.D. (2016) 'Pemanfaatan paitan sebagai pupuk organik pada tanaman kedelai', *Iptek Tanaman Pangan*, 11(1), pp. 49–56.

Li-Beisson, et al (2024) 'eXtra Botany Plant metabolomics', *Journal of Experimental Botany,* 75(6), pp. 1651–1653.

Li, G. *et al.* (2023) 'Functional and kinetics of two efficient phenylalanine ammonia lyase from Pyrus bretschneideri', *BMC Plant Biology*, 23(1), pp. 1–14. Available at: https://doi.org/10.1186/s12870-023-04586-0.

Lin, D. *et al.* (2016) 'An overview of plant phenolic compounds and their importance in human nutrition and management of type 2 diabetes',

Molecules, 21(10), pp. 1–19. Available at: https://doi.org/10.3390/molecules21101374.

Liu, C.Z. *et al.* (1998) 'Production of artemisinin by shoot cultures of Artemisia annua L. in a modified inner-loop mist bioreactor', *Plant Science*, 135(2), pp. 211–217. Available at: https://doi.org/10.1016/S0168-9452(98)00086-7.

Liu, W. *et al.* (2021) 'The Flavonoid Biosynthesis Network in Plants', *Molecular Sciences*, 22(12824), pp. 1–18.

LPMQ (2011) *Tumbuhan Dalam Prespektif Al-Qur'an Dan Sains*, *Angewandte Chemie International Edition, 6(11), 951–952.*

Ma'ruf, N.Y.L. dan S.H. (2020) 'Penetapan Kadar Total Flavonoid Ekstrak Etanol Kacang Merah (Phaseolus vulgaris L .) Dengan Metode Kompleks Kolorimetri Secara Spektrofotometri', *Jurnal Ilmiah Manuntung*, 6(1), pp. 83–91.

Mabou Tagne, A., Marino, F. and Cosentino, M. (2018) 'Tithonia diversifolia (Hemsl.) A. Gray as a medicinal plant: A comprehensive review of its ethnopharmacology, phytochemistry, pharmacotoxicology and clinical relevance', *Journal of Ethnopharmacology*, 220, pp. 94–116. Available at: https://doi.org/10.1016/j.jep.2018.03.025.

Maeda, H. and Dudareva, N. (2012) 'The shikimate pathway and aromatic amino acid biosynthesis in plants', *Annual Review of Plant Biology*, 63, pp. 73–105. Available at: https://doi.org/10.1146/annurev-arplant-042811-105439.

Maeda, H.A. *et al.* (2018) 'Tyrosine Biosynthesis , Metabolism , and Catabolism in Plants', *Phytochemistry*, 149, pp. 82–102. Available at: 10.1016/j.phytochem.2018.02.003.

Mahdalena, Ali Rakhman Hakim, P.V.D. (2022) 'Penetapan Kadar Flavonoid Total Fraksi N-Butanol Dengan Metode Spektrofotometri Uv-Vis Terhadap Ekstrak Daun Sukun (Artocarpus altilis)', *Sains Media*, 1(1), pp. 1–8. Available at: https://wpcpublisher.com/jurnal/index.php/sainsmedisina .

Majeed, M. *et al.* (2021) 'A randomized, double-blind clinical trial of a herbal formulation (GlycaCare-II) for the management of type 2 diabetes in comparison with metformin', *Diabetology and Metabolic Syndrome*, 13(1), pp. 1–12. Available at: https://doi.org/10.1186/s13098-021-00746-0.

Maqfirah, Z. *et al.* (2023) 'No Title', *Journal Of Pharmaceutical And Sciences*, 6(4), pp. 1534–1543.

Maria Ulva, Yulita Nurchayati, Erma Prihastanti, N.S. (2019) 'Pertumbuhan Kalus Tomat (Lycopersicon esculentum Mill.) Varietas Permata F1 dari Jenis Eksplan dan Konsentrasi Sukrosa yang Berbeda secara In Vitro', *Life Science*, 8(2), pp. 160–169.

Marlina Agustina Sitinjak, Mayta Novaliza Isda, S.F. (2015) 'Induksi Kalus Dari Eksplan Daun In Vitro Keladi Tikus (Typhonium sp.) Dengan Perlakuan 2,4-D Dan Kinetin', *Jurnal Biologi*, 8(April), pp. 32–39.

Martinez, M.E. *et al.* (2021) 'Effect of the carbon source and plant growth regulators (Pgrs) in the induction and maintenance of an in vitro callus culture of taraxacum officinale (l) weber ex f.h. wigg', *Agronomy*, 11(6). Available at: https://doi.org/10.3390/agronomy11061181.

Mata-Ramírez, D., Serna-Saldívar, S.O. and Antunes-Ricardo, M. (2019) 'Enhancement of anti-inflammatory and antioxidant metabolites in soybean (Glycine max) calluses subjected to selenium or UV-light stresses', *Scientia Horticulturae*, 257(January), p. 108669. Available at: https://doi.org/10.1016/j.scienta.2019.108669.

Miceli, N. *et al.* (2023) 'Improvement in the Biosynthesis of Antioxidant-Active Metabolites in In Vitro Cultures of Isatis tinctoria (Brassicaceae) by Biotechnological Methods/Elicitation and Precursor Feeding', *Antioxidants*, 12(5). Available at: https://doi.org/10.3390/antiox12051111.

Mohan, V. *et al.* (2023) 'Are Unhealthy Diets Contributing to the Rapid Rise of Type 2 Diabetes in India?', *Journal of Nutrition*, 153(4), pp. 940–948. Available at: https://doi.org/10.1016/j.tjnut.2023.02.028.

Muldianah, D. *et al.* (2021) 'Teknik Isolasi dan Identifikasi Senyawa Glikosida dari Berbagai Tanaman', *PharmaCine : Journal of Pharmacy, Medical and Health Science*, 2(1), pp. 11–21. Available at: https://doi.org/10.35706/pc.v2i1.5577.

Muniroh, L., Mahmudah and Solfaine, R. (2022) 'Effect of Tithonia diversifolia Leaf Extract on Leptin, Adiponectin, and Insulin Receptor Levels in Diabetic Rats', *Preventive Nutrition and Food Science*, 27(1), pp. 63–69. Available at: https://doi.org/10.3746/pnf.2022.27.1.63.

Musbah, H.M., Ibrahim, K.M. and Ibrahim, K. (2019) 'Effects of feeding tyrosine or phenylalanine on the accumulation of polyphenols in Coleus Blumei in Vivo and in Vitro .', *Journal of Biotechnology Research Center*, 13(1), pp. 35–43. Available at: https://doi.org/10.24126/jobrc.2019.13.1.566.

Muslimawati, N., Suketi, K. and D. Susila, A. (2015) 'Pertumbuhan Stek Batang Pohpohan (Pilea trinervia Wight.) pada Umur Tanaman, Bagian Batang, dan Media Tanam yang Berbeda', *Jurnal Hortikultura Indonesia*, 6(2), pp. 91–98. Available at: https://doi.org/10.29244/jhi.6.2.91-98.

Nabavi, S.M. *et al.* (2020) 'Flavonoid biosynthetic pathways in plants: Versatile targets for metabolic engineering', *Biotechnology Advances*, 38(October 2018), p. 107316. Available at: https://doi.org/10.1016/j.biotechadv.2018.11.005.

Nabila, A.Z., Rahmat, A. and Yulianty, N. (2024) 'Response of Pinus merkusii Jung . & Devr . Megagametophyte Explants Cultured on DCR Medium with Different 2 , 4-D and Kinetin Combination', 1(December), pp. 63–74.

Nadhira, R. and Cahyana, Y. (2023) 'Study of functional properties and amylographic properties of starch with the addition of phenolic compounds', *Indonesian J Food Res 3*, 3(1), pp. 14–19. Available at: https://doi.org/10.14710/jkm.v6i1.19866.

Nkonge, D.K. and Nkonge, T.N. (2023) 'Insulin Therapy for the Management of Diabetes Mellitus : A Narrative Review of Innovative Treatment Strategies', *Diabetes Therapy*, 14(11), pp. 1801–1831. Available at:

https://doi.org/10.1007/s13300-023-01468-4.

Noer, S. *et al.* (2018) 'Penetapan Kadar Senyawa Fitokimia (Tanin , Saponin Dan Flavonoid Sebagai Kuersetin) Pada Ekstrak Daun Inggu (Ruta angustifolia L .)', *Jurnal Eksakta,* 18(1), pp. 19–29. Available at: https://doi.org/10.20885/eksakta.vol18.iss1.art3.

Nofita, D., Sari, S.N. and Mardiah, H. (2020) 'Penentuan Fenolik Total dan Flavonoid Ekstrak Etanol Kulit Batang Matoa (Pometia pinnata J.R& G.Forst) secara Spektrofotometri', *Chimica et Natura Acta*, 8(1), p. 36. Available at: https://doi.org/10.24198/cna.v8.n1.26600.

Nurwijayanti, Kencanawaty, Sad Omega, Nurwijayanti1*, Sad Omega Kencanawaty2, L. (2025) 'Increasing Knowledge of Diabetes Mellitus Patients through Dietary Assistance at the Gurah Community Health Center ', 8(1), pp. 10–16.

O'donoghue, G. *et al.* (2021) 'Lifestyle interventions to improve glycemic control in adults with type 2 diabetes living in low-and-middle income countries: A systematic review and meta-analysis of randomized controlled trials (rcts)', *International Journal of Environmental Research and Public Health*, 18(12). Available at: https://doi.org/10.3390/ijerph18126273.

Obiakara, M.C. and Fourcade, Y. (2018) 'Climatic niche and potential distribution of Tithonia diversifolia (Hemsl.) A. Gray in Africa', *PLoS ONE*, 13(9), pp. 1–18. Available at: https://doi.org/10.1371/journal.pone.0202421.

Ochoa-Alejo, V.M.L.-V. and N. (2018) 'An Introduction to Plant Tissue Culture: Advances and Perspectives', *Plant Cell Culture Protocols, Methods in Molecular Biology,* 1815(July 2018), pp. 1–13. Available at: https://doi.org/10.1007/978-1-4939-8594-4.

Olayinka, B.U., Raiyemo, D.A. and Etereje, E.O. (2015) 'Phytochemical and proximate Compostition of Tithonia diversifoila (Hemsl .) Phytochemical And Proximate Composition Of Tithonia diversifolia (Hemls .) A . Gray , a perennial broad-leaved weed species reported ornamental plant (Akobundu and Agyakwa , Sc', *Annals Food Science and Technology*, 16(1).

Omolo, R.G. *et al.* (2012) 'Studies of Phytochemical Screening , Acute Toxicity and Anti-Diarrhoeal Effect of Aqueous Extract of Kenyan Tithonia diversifolia Leaves in Rats', *British Journal of Pharmacology and Toxicology*, 3(3), pp. 127–134.

Pagalla, D.B. (2023) '"INDUKSI KALUS"', (December 2022).

Pan, Y. *et al.* (2020) 'Callus growth kinetics and accumulation of secondary metabolites of Bletilla striata Rchb . f . using a callus suspension culture', *PLoS ONE*, 15(2), pp. 1–14. Available at: https://doi.org/10.1371/journal.pone.0220084 .

Panche, A.N., Diwan, A.D. and Chandra, S.R. (2016) 'Flavonoids: An overview', *Journal of Nutritional Science*, 5. Available at: https://doi.org/10.1017/jns.2016.41.

Pannucci, E. *et al.* (2023) 'Phenolic Compounds as Preventive and Therapeutic Agents in Diabetes-Related Oxidative Stress, Inflammation, Advanced Glycation End-Products Production and Insulin Sensitivity', *Discovery Medicine*, 35(178), p. 715. Available at: https://doi.org/10.24976/discov.med.202335178.68.

Park, J. *et al.* (2023) 'Uncovering transcriptional reprogramming during callus development in soybean : insights and implications', *Frontiers in Plant Science*, 14(1239917), pp. 1–19. Available at: https://doi.org/10.3389/fpls.2023.1239917.

Pasternak, T.P. and Steinmacher, D. (2024) 'Plant Growth Regulation in Cell and Tissue Culture In Vitro', *Plants*, 13(2), pp. 1–24. Available at: https://doi.org/10.3390/plants13020327.

Pavel Feduraev *, L.S. *et al.* (2020) 'Phenylalanine and Tyrosine as Exogenous Precursors of Wheat (Triticum aestivum L.) Secondary Metabolism through PAL-Associated Pathways', *plants*, 9(4), pp. 1–19. Available at: https://doi.org/10.1201/9781003084198-2.

Primahana, G. and Darmawan, A. (2017) 'A Flavonoid Glycoside Compound

Isolated from Macaranga gigantifolia Merr Leaves', *The Journal of Pure and Applied Chemistry Research*, 6(1), pp. 22–26. Available at: https://doi.org/10.21776/ub.jpacr.2017.006.01.298.

Purba, M.N.B., Meutia, R. and Karo, R.M.B. (2024) 'Efektivitas Gel Ekstrak Etanol Daun Insulin(Tithonia diversifolia) Hemsl) A.Gray) sebagai Penyembuh Luka pada Tikus Diabetes', *Jurnal Kesehatan Tambusai*, 5(3), pp. 9889–9898.

Puspaningtyas, I. *et al.* (2025) 'Effects of Combined 2 , 4-D and BAP Treatments on the Formation of Leaf-Derived Callus in Pogostemon cablin (Blanco) Benth .', *Caraka Tani: Journal of Sustainable Agriculture,* 40(2), pp. 295–306.

Rachmawan, A. and Dalimunthe, C.I. (2017) 'Prospek Pemanfaatan Metabolit Sekunder Tumbuhan Sebagai Pestisida Nabati Untuk Pengendalian Patogen Pada Tanaman Karet', *Warta Perkaretan*, 36(1), pp. 15–28. Available at: https://doi.org/10.22302/ppk.wp.v36i1.324.

Rachmawan, C.I.D. dan A. (2017) 'Prospek Pemanfaatan Metabolit Sekunder Tumbuhan Sebagai Pestisida Nabati Untuk Pengendalian Patogen Pada Tanaman Karet', *Warta Perkaretan*, 36(1), pp. 15–28.

Radol, A. *et al.* (2016) 'Cytotoxicity and Anti - Herpes Activity of Selected Medicinal Plants Cited for Management of HIV Conditions in Kakamega County – Kenya', *British Journal of Pharmaceutical Research*, 13(5), pp. 1–13. Available at: https://doi.org/10.9734/bjpr/2016/29317.

Ramadani, M.R.N. and Jadid, N. (2024) 'A comprehensive review of in vitro precursor feeding strategies for the overproduction of high-value plant secondary metabolites', *Arabian Journal of Chemistry*, 17(12), p. 106018. Available at: https://doi.org/10.1016/j.arabjc.2024.106018.

Rasud, Y. and Bustaman, B. (2020) 'In Vitro Callus Induction from Clove (Syzigium aromaticum L.) Leaves on Medium Containing Various Auxin Concentrations', *Jurnal Ilmu Pertanian Indonesia*, 25(1), pp. 67–72. Available at: https://doi.org/10.18343/jipi.25.1.67.

Rattan, S., Kumar, D. and Warghat, A.R. (2022) 'The influence of phenylalanine feeding on cell growth, antioxidant activity, phenylpropanoids content, and yield in cell suspension culture of Rhodiola imbricata (Edgew.)', *Plant Cell, Tissue and Organ Culture*, 151(2), pp. 347–359. Available at: https://doi.org/10.1007/s11240-022-02356-8.

Rohma, R.N. (2022) 'Pengaruh Pemberian Zat Pengatur Tumbuh (Zpt) Naa Dan Bap Terhadap Induksi Kalus Tanaman Insulin (Thitonia diversifolia (Hemsl)) SECARA IN VITRO', p. 80.

Roopa, M.S. *et al.* (2021) 'Tithonia diversifolia Scavenging Activity And Gc-Ms Analysis Of Leaf And Flower Extract Of', *International Journal of Pharmaceutical Sciences and Research*, 11(10), pp. 5081–5090. Available at: https://doi.org/10.13040/IJPSR.0975-8232.11(10).5081-90.

Rosita Husnun Fauziah, Florentina KusmiyatI, S.A. (2019) 'Lilium longiflorum Plant Growth with a combination of Naphthylacetic Acid (NAA) and 6 Benzylaminopurine (BAP) In Vitro', *Journal tropical crop science and technology*, 1, pp. 78–92.

Rosyidah, M., Ratnasari, E. and Rahayu, Y.S. (2014) 'Induksi Kalus Daun Melati (Jasminum sambac) dengan Penambahan Berbagai (BAP) pada Media MS secara in Vitro Leaf Callus Induction of Jasmine (Jasminum sambac) with Addition and 6-Benzylamino Purine (BAP) in Media MS in Vitro', *LenteraBio*, 3(2), pp. 147–153. Available at: http://ejournal.unesa.ac.id/index.php/lenterabio.

Roychowdhury, R. *et al.* (2012) 'Effect of gibberellic acid, Kinetin and indole 3-acetic acid on seed germination performance of Dianthus caryophyllus (Carnation)', *Agriculturae Conspectus Scientificus*, 77(3), pp. 157–160.

Rush, S.D. *et al.* (2015) 'Stability of glutamate-aspartate cardioplegia additive solution in polyolefin IV bags', *Hospital Pharmacy*, 50(6), pp. 522–525. Available at: https://doi.org/10.1310/hpj5006-522.

Sagharyan, M. *et al.* (2020) 'Optimization of callus induction with enhancing production of phenolic compounds production and antioxidants activity in

callus cultures of nepeta binaloudensis jamzad (Lamiaceae)', *Iranian Journal of Biotechnology*, 18(4), pp. 47–55. Available at: https://doi.org/10.30498/IJB.2020.2621.

Sanvee, S. *et al.* (2021) 'Antidiabetic activity of tannin fraction of Bridelia ferruginea (Benth) leaf extract on fructose-induced diabetic mice', *Journal of HerbMed Pharmacology*, 10(1), pp. 68–74. Available at: https://doi.org/10.34172/jhp.2021.06.

Saputri, A.D.S. and Sa'ad, M. (2023) 'Penetapan Kadar Fenolik Dan Flavonoid Fraksi Daun Insulin (Smallanthus sonchifolius) Secara Spektrofotometri Uv-Vis', *Jurnal Farmasi Medica/Pharmacy Medical Journal (PMJ)*, 6(1), pp. 51–58. Available at: https://doi.org/10.35799/pmj.v6i1.48197.

Šarlota Kaˇnuková, Marcela Gubišová, Lenka Klˇcová, Daniel Mihálik, A. (2022) 'Establishment of Stem Cell-like Cells of Sida hermaphrodita (L .) Rusby from Explants Containing Cambial Meristems', *International Journal of Molecular Sciences*, 23(7644), pp. 1–11. Available at: https://doi.org/10.3390/%0Aijms23147644.

Schenck, C.A. and Maeda, H.A. (2018) 'Tyrosine biosynthesis, metabolism, and catabolism in plants', *Phytochemistry*, 149, pp. 82–102. Available at: https://doi.org/10.1016/j.phytochem.2018.02.003.

Setiawan, A.A. (2013) 'Pengaruh Konsentrasi Ion Pb2+Terhadap Daya Serapkulit Kacang Tanah, Sekam Padi Dan Serbuk Gergaji', *Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam,* 10(1), pp. 51–58.

Setiawati, T., Ayalla, A. and Witri, A. (2019) 'Induksi Kalus Krisan (Chrysanthemum morifolium Ramat .) dengan Penambahan Berbagai Kombinasi Zat Pengatur Tumbuh (ZPT)', 3(2), pp. 119–132.

Shama, M.A.G. dan (2014) 'Phenolic Compounds', *Natural Products Chemistry*, (1), pp. 84–95. Available at: https://doi.org/10.1201/b17244-12.

Sharifi, Y. *et al.* (2019) 'Effect of salicylic acid on phenols and flavonoids content in callus culture of Iranian sodab (Ruta graveolens): A threatened medicinal

plant of north of Iran', *Original Article Tabari Biomed Stu Res J*, 1(3), pp. 32–36.

Sharma, M. *et al.* (2014) 'Phytochemical analysis of glycosides from leaves of Trigonella foenum graecum', *International Journal of Pharmaceutical Sciences Review and Research*, 29(1), pp. 146–152.

Shehta, A. and Abbas, F.A. (2022) 'Some Factors Affecting in Vitro Secondary Metabolites Production From Verbesina Encelioides Callus Cultures', *Egyptian Journal of Applied Science*, 37(11), pp. 80–94. Available at: https://doi.org/10.21608/ejas.2022.287925.

Shihab, M.Q. (2000) *TAFSIR AL-MISHBAH Pesan, Kesan dan Keserasian Al-Qur'an*.

Sihombing, J., Yunus, M. and Piska, F. (2026) 'Uji Aktivitas Antioksidan dan Profil Kandungan Fenol serta Flavonoid pada Ekstrak Daun Sirsak (Annona muricata L .)', *urnal Ilmiah Penelitian Mahasiswa (JIPM)*, 4(1).

Sijuade, A., Fadare, J. and Oseni, O. (2016) 'Evaluation of Anti-inflammatory and Analgesic Activities of Tithonia diversifolia in Experimental Animal Models', *British Journal of Medicine and Medical Research*, 15(3), pp. 1–8. Available at: https://doi.org/10.9734/bjmmr/2016/25267.

Simanjuntak, H.A. (2017) 'Potensi Famili Asteraceae Sebagai Obat Tradisional Di Masyarakat Etnis Simalungun Kabupaten Simalungun Provinsi Sumatera Utara', *BIOLINK (Jurnal Biologi Lingkungan Industri Kesehatan)*, 4(1), pp. 11–18. Available at: https://doi.org/10.31289/biolink.v4i1.961.

Sinaulan, J.S., Lengkong, E.F. and Tulung, S. (2019) 'Respon pembentukan kalus embrionik tanaman krisan kulo (Chysanthemun morifolium) terhadap pemberian zat pengatur tumbuh sitokinin', *Jurnal Unsrat*, 1(2), pp. 1–9.

Singh, P., Singh, A. and Choudhary, K.K. (2023) 'Revisiting the role of phenylpropanoids in plant defense against UV-B stress', *Plant Stress*, 7(November 2022), p. 100143. Available at: https://doi.org/10.1016/j.stress.2023.100143.

Sirait, J. and Simanihuruk, K. (2021) 'Utilization of Tithonia diversifolia as Ruminant Feed', *Indonesian Bulletin of Animal and Veterinary Sciences*, 31(3), p. 137. Available at: https://doi.org/10.14334/wartazoa.v31i3.2876.

Solfaine, R., Muniroh, L. and Mubarokah, W.W. (2019) 'Aktivitas Ekstrak Daun Tithonia Diversifolia Terhadap Regulasi Kadar Adiponektin pada Diabetes Melitus Tikus Putih Wistar', *Jurnal Sain Veteriner*, 37(2), p. 143. Available at: https://doi.org/10.22146/jsv.46837.

SopaPutriTanjung*, R.I.M.D.A.M.S. (2017) 'Potensi Terbentuknya Kalus Embriogenik pada Beberapa Varietas Kedelai (Glycine max(L.) Merill) ToleranterhadapKondisiHipoksiasecaraIn Vitro', *Jurnal Agroekoteknologi FP USU*, 5(3), pp. 1–23.

Su, Y., Liu, Y. and Zhang, X. (2011) 'Auxin – Cytokinin Interaction Regulates Meristem Development', *Molecular Plant*, 4(4), pp. 616–625. Available at: https://doi.org/10.1093/mp/ssr007.

Sulistyani, M. *et al.* (2023) 'Calibration of Microplate Uv-Vis Spectrophotometer for Quality Assurance Testing of Vitamin C using Calibration Curve Method', *Indonesian Journal of Chemical Science*, 12(2), pp. 208–215.

Szewczyk, A. *et al.* (2021) 'Phenylalanine increases the production of antioxidant phenolic acids in ginkgo biloba cell cultures', *Molecules*, 26(16). Available at: https://doi.org/10.3390/molecules26164965.

Tesalonika, L. *et al.* (2024) 'Potensi Aktivitas Serapan Uv Pada Berbagai Pelarut Ekstrak Kelakai Menggunakan Spektrofotometri Uv-Vis', *Jurnal Crystal : Publikasi Penelitian Kimia dan Terapannya*, 6(2), pp. 110–114. Available at: https://doi.org/10.36526/jc.v6i2.3835.

Thomas, L. (2005) 'Introduction to Plant Physiology', *Journal of Plant Physiology;*, 162(3), pp. 363–364.

Thongsom, M. *et al.* (2013) 'Antioxidant and hypoglycemic effects of Tithonia diversifolia aqueous leaves extract in alloxan-induced diabetic mice', *Advances in Environmental Biology*, 7(9), pp. 2116–2125.

Timburas, R.D., Pinaria, A.G. and Lengkong, E.F. (2023) 'The Effect Of Several Concentrations Of Growth Regulatory Substance (ZPT) Auxin NAA (Naphthalene Acetic Acid) On The Root Growth Of Vanila (Vanila planifolia Andrew) Cuttings', *Jurnal Agroekoteknologi Terapan*, 4(1), pp. 67–73. Available at: https://doi.org/10.35791/jat.v4i1.44100.

Tohge, T. *et al.* (2013) 'Shikimate and phenylalanine biosynthesis in the green lineage', *Plant Metabolism and Chemodiversity*, 4(March), pp. 1–13. Available at: https://doi.org/10.3389/fpls.2013.00062.

De Toledo, J.S. *et al.* (2014) 'In Vitro leishmanicidal activities of sesquiterpene lactones from Tithonia diversifolia against Leishmania braziliensis promastigotes and amastigotes', *Molecules*, 19(5), pp. 6070–6079. Available at: https://doi.org/10.3390/molecules19056070.

Valeria Gianguzzi 1, Giulio Barone 1, 2, E.D.G. 1, 3, F.S. and 1, and G.D. (2023) 'Micropropagation of Endemic Endangered Taxa of the Italian Case Study', *Plants*, 12(1530), pp. 1–15.

Veronenci Yuliarbi FarlisaDidik Pudji Restanto, Tri Handoyo, Kacung Hariyono, P.D. (2022) 'Induksi Somatic Embriogenesis dan Kultur Suspensi Sel Pada Tanaman Porang (Amorphophallus muelleri Blume)', *Agriprima : Journal of Applied Agricultural Sciences*, 6(2), pp. 111–123. Available at: https://doi.org/10.25047/agriprima.v6i2.448.

Vina Octavia Azzahra, St Mardiana, Suharyadi, Rini Juita Sianipar, D.S.R. (2025) 'Effect of Solvent Polarity on Extraction Yield , Phytochemical Composition , and Antioxidant Activity of Curcuma xanthorrhiza Roxb .', *Biology, Medicine, & Natural Product Chemistry*, 14(2), pp. 1273–1284. Available at: https://doi.org/10.14421/biomedich.2025.142.1273-1284.

Wafa, S.N. *et al.* (2016) 'Organogenesis and Ultrastructural Features of In Vitro Grown Canna indica L .', 2016. Available at: https://doi.org/10.1155/2016/2820454.

Wahyuni, A., Satria, B. and Zainal, A. (2020) 'Induksi Kalus Gaharu dengan NAA dan BAP Secara In Vitro Callus Induction of Agarwood Using NAA and

BAP In Vitro', *Jurnal Penelitian Agronomi*, 22(1), pp. 39–44.

Wahyuni, A.M. and Afthoni, M.H. (2022) 'PENGEMBANGAN DAN VALIDASI METODE ANALISIS SPEKTROFOTOMETRI UV-VIS DERIVATIF UNTUK DETEKSI KOMBINASI HIDROKORTISON', 3(1), pp. 1–8.

Walangadi, F.R. *et al.* (2025) 'Effect of BAP and NAA on Callus Emergence Time of Dumbaya Young Leaf Explants in Vitro', *Jurnal Biologi Tropis*, 25(2), pp. 1903–1911. Available at: https://doi.org/10.29303/jbt.v25i2.9045.

Wang, Z. *et al.* (2025) 'Unveiling insecticidal compounds from the invasive weed Tithonia diversifolia against Spodoptera litura and elucidating mechanisms via transcriptomic analysis', *Pesticide Biochemistry and Physiology*, 210(February), p. 106354. Available at: https://doi.org/10.1016/j.pestbp.2025.106354.

Wen, X. *et al.* (2025) 'Integrated Metabolomic and Transcriptomic Analyses Reveal the Potential Molecular Mechanism Underlying Callus Browning in Paeonia ostii', *plants*, 14(560), pp. 1–17.

Widwiastuti, H., Malang, P.K. and Ukuran, P. (2022) 'Pengaruh Ukuran Simplisia Dan Lama Kontak Pada Ekstraksi Senyawa Aktif Simplisia Kayu Jawa (Lannea Coromandelica) Menggunakan Metode Maserasi Effect Of Simplisia Size And Contact Time On The Extraction Of Active Compounds Of Kayu Jawa Simplisia (LANNEA', *Jurnal Kimia Mulawarman*, 19(2), pp. 1–5.

Wulandari, M., Abdullah and Netty (2022) 'Ketahanan Kalus Embrio Kedelai (*Glycine max* L.) terhadap Tekanan Salinitas (NaCl) secara In Vitro', *Journal Techno Eco Farming*, 2(1), pp. 8–21.

Wulandari, S. *et al.* (2022) 'Sterilisasi Peralatan dan Media Kultur Jaringan', *Agrotechnology Innovation (Agrinova)*, 4(2), p. 16. Available at: https://doi.org/10.22146/a.77010.

Wurlina, W. *et al.* (2025) 'Alkaloid fraction of Achyranthes aspera Linn triggers breast cancer apoptosis in mice (Mus musculus) model', 15, pp. 1279–

1288. Available at: https://doi.org/10.5455/OVJ.2025.v15.i3.19.

Xu, J.J. *et al.* (2020) 'General and specialized tyrosine metabolism pathways in plants', *aBIOTECH*, 1(2), pp. 97–105. Available at: https://doi.org/10.1007/s42994-019-00006-w.

Xuan, Y. *et al.* (2024) 'Effects of aromatic amino acids on callus growth and accumulation of secondary metabolites in amaranth', *Tropical Plants*, 3(1). Available at: https://doi.org/10.48130/tp-0024-0034.

Yin, R. *et al.* (2012) 'Feedback inhibition of the general phenylpropanoid and flavonol biosynthetic pathways upon a compromised flavonol-3- O -glycosylation', *Journal of Experimental Botany,* 63(7), pp. 2465–2478. Available at: https://doi.org/10.1093/jxb/err416.

Yupi Weliyanto, Ali Rakhman Hakim, N.H. (2025) 'Penetapan Kadar Flavonoid Total Berdasarkan Tingkat Fraksinasi Ekstrak Daun Sirsak (Annona muricata L .)', *Jurnal Surya Medika (JSM)*, 11(2), pp. 114–119. Available at: https://doi.org/10.33084/jsm.vxix.xxx. .

Zhang, M. *et al.* (2024) 'Recent Advances in Alkaloids from Papaveraceae in China: Structural Characteristics and Pharmacological Effects', *Molecules*, 29(16). Available at: https://doi.org/10.3390/molecules29163778.

Zhang, X. and Liu, C. (2015) 'Multifaceted Regulations of Gateway Enzyme Phenylalanine Ammonia-Lyase in the Biosynthesis of Phenylpropanoids', *Molecular Plant*, 8(1), pp. 17–27. Available at: https://doi.org/10.1016/j.molp.2014.11.001.

Živile Tarasevi˘cien˙ e, A.V. and A.P. (2021) 'Impact of Foliar Application of Amino Acids on Total Phenols , Phenolic Acids Content of Different Mints Varieties under the', *plants*, 10(599), pp. 1–6.