

DAFTAR PUSTAKA

- Abdel Hafez, S.M.N., Saber, E.A., Aziz, N.M., Aleem, M.M.A. El, Mohamed, M.S., Abdelhafez, E.M.N., Ibrahim, R.A., 2024. Possible protective effects of vanillin against stress-induced seminiferous tubule injury via modulation of Nrf2 and ZO1. *Naunyn Schmiedebergs Arch Pharmacol* 398, 1853–1870. <https://doi.org/10.1007/S00210-024-03355-6/TABLES/4>
- Adindu, C.B., Okeke, P.I., 2025. Computational screening of potential ulcer inhibitors from *Moringa oleifera* Lam. leaves. *world news of natural sciences* 61(2), 237–254.
- Afsar, M., Soleimanzadeh, A., Khaki, A., Ayen, E., 2024. Improvement of Post-Thaw Quality and In Vivo Fertility of Simmental Bull Spermatozoa Using Ferulic Acid. *Vet Med Sci* 10, e70064. <https://doi.org/10.1002/VMS3.70064>
- Agarwal, A., Mulgund, A., Hamada, A., Chyatte, M.R., 2015. A unique view on male infertility around the globe. *Reproductive Biology and Endocrinology* 13. <https://doi.org/10.1186/s12958-015-0032-1>
- Ajayi, A.F., Onaolapo, M.C., Omole, A.I., Adeyemi, W.J., Oluwole, D.T., 2023. Mechanism associated with changes in male reproductive functions during ageing process. *Exp Gerontol* 179, 112232. <https://doi.org/10.1016/J.EXGER.2023.112232>
- Akbari, B., Baghaei-Yazdi, N., Bahmaie, M., Mahdavi Abhari, F., 2022. The role of plant-derived natural antioxidants in reduction of oxidative stress. *BioFactors* 48, 611–633. <https://doi.org/10.1002/BIOF.1831>
- Alahmadi, B.A., 2020. Effect of Herbal Medicine on Fertility Potential in Experimental Animals-an Update Review. *Herbal Medicine on Fertility Potential in Experimental Animals-an Update Review* 32, 140–147. <https://doi.org/10.5455/msm.2020.32.140-147>
- Al-Faqeh, H.H., Imad AMM, M., 2019. *Eurycoma longifolia* Root Aqueous Extract Augments the Testosterone Level and Spermatogenesis in Adult Male Rats.
- Alias, N.N., Azizan, K.A., Basherudin, N., Hassan, N.H., Abdullah, N., 2020. LC-Based Metabolomics and Multivariate Analyses Reveal Metabolite Variations in Different Propagation Methods of *Eurycoma longifolia* Roots Harvested at Different Ages and Locations. <https://doi.org/10.1101/2020.02.27.967786>
- Alzahrani, H., 2012. Sister chromatid exchanges produced by antidepressant. *Eur Rev Med Pharmacol Sci* 16, 2154–2161.
- Anderson, D., Laforge, J., Ross, M.M., Vanlangendonck, R., Hasoon, J., Viswanath, O., Kaye, A.D., Urits, I., 2022. Male Sexual Dysfunction. *Health Psychol Res* 10. <https://doi.org/10.52965/001C.37533>
- Anggraeni, N.R., Maulina, D., 2023. Pola Persepan Obat Anti Depresan Pada

Pasien Rawat Jalan Di Poli Kejiwaan Rs X Periode Agustus - November 2022. *Indonesian Journal Of Health Science* 3, 2023.

- Asif, M., Vijay, A.S., Maheshwari, Fyzullah, S., Rani, U., Swathi, R., Damodara Gowda, K.M., 2023. Impact of chronological ageing on semen parameters in southern Indian men visiting infertility centre: A retrospective study. *Asian Pacific Journal of Reproduction* 12, 10–15. <https://doi.org/10.4103/2305-0500.365227>
- Attia, Y.A., El-Naggar, A.S., Abou-Shehema, B.M., Abdella, A.A., 2019. Effect of Supplementation with Trimethylglycine (Betaine) and/or Vitamins on Semen Quality, Fertility, Antioxidant Status, DNA Repair and Welfare of Roosters Exposed to Chronic Heat Stress. *Animals (Basel)* 9, 547. <https://doi.org/10.3390/ANI9080547>
- Ayala, M.E., Gonzáles, A., Olivarez, R.M., Aragón-Martínez, A., 2018. Fluoxetine treatment of prepubertal male rats uniformly diminishes sex hormone levels and, in a subpopulation of animals, negatively affects sperm quality. *Reprod Fertil Dev* 30, 1329–1341. <https://doi.org/10.1071/RD17384>
- Bakhtiari, A., Basirat, Z., Aghajani Mir, M.-R., 2015. Sexual dysfunction in men seeking infertility treatment: The prevalence and associations. *Caspian Journal of Reproductive Medicine* 1, 1–5.
- Balercia, G., Mancini, A., Paggi, F., Tiano, L., Pontecorvi, A., Boscaro, M., Lenzi, A., Littarru, G.P., 2009. Coenzyme Q10 and male infertility. *J Endocrinol Invest* 32, 626–632. <https://doi.org/10.1007/BF03346521>
- Banihani, S.A., 2024. Role of Lipoic Acid in Testosterone Production in Males. *World J Mens Health* 43, 41. <https://doi.org/10.5534/WJMH.230291>
- Beeder, L.A., Samplaski, M.K., 2020a. Effect of antidepressant medications on semen parameters and male fertility. *International Journal of Urology*. <https://doi.org/10.1111/iju.14111>
- Behairy, A., Hashem, M.M.M., Abo-EL-Sooud, K., Soliman, A.M., Mouneir, S.M., El-Metwally, A.E., Ismail, S.H., Hassan, B.A., Abd-Elhakim, Y.M., 2024. Influence of titanium dioxide nanoparticles and/or cadmium chloride oral exposure on testicular morphology, oxidative stress, and apoptosis in rats: Ameliorative role of co-enzyme Q10. *Heliyon* 10, e24049. <https://doi.org/10.1016/J.HELIYON.2024.E24049>
- Bhat, R., Karim, A.A., 2010. Tongkat Ali (*Eurycoma longifolia* Jack): A review on its ethnobotany and pharmacological importance. *Fitoterapia*. <https://doi.org/10.1016/j.fitote.2010.04.006>
- Blignaut, M., Loos, B., Botchway, S.W., Parker, A.W., Huisamen, B., 2019. Ataxia-Telangiectasia Mutated is located in cardiac mitochondria and impacts oxidative phosphorylation. *Sci Rep* 9, 4782. <https://doi.org/10.1038/S41598-019-41108-1>
- Bogar, B.C.A., Tendean, L., Turalaki, G.L.A., 2016. Pengaruh pemberian ekstrak pasak bumi (*Eurycoma longifolia* Jack) terhadap kualitas spermatozoa tikus

- wistar (*Rattus norvegicus*). eBiomedik 4.
<https://doi.org/10.35790/EBM.V4I1.10867>
- Boshtam, S., Shokrzadeh, M., Ghassemi-Barghi, N., Boshtam, S., Shokrzadeh, M., Ghassemi-Barghi, N., 2023. Fluoxetine induces oxidative stress-dependent DNA damage in human hepatoma cells. *AIMS Medical Science* 2023 1:69 10, 69–79. <https://doi.org/10.3934/MEDSCI.2023007>
- BPOM RI, 2022. Peraturan Badan Pengawas Obat dan Makanan tentang pedoman uji toksisitas praklinik secara in vivo., Badan Pengawas Obat Dan Makanan. Badan Pengawas Obat Dan Makanan, Republik Indonesia.
- Buhling, K., Schumacher, A., Eulenburg, C. zu, Laakmann, E., 2019. Influence of oral vitamin and mineral supplementation on male infertility: a meta-analysis and systematic review. *Reprod Biomed Online* 39, 269–279. <https://doi.org/10.1016/J.RBMO.2019.03.099>
- Chaingam, J., Juengwatanatrakul, T., Yusakul, G., Kanchanapoom, T., Putalun, W., 2021a. HPLC-UV-Based Simultaneous Determination of Canthin-6-One Alkaloids, Quassinoids, and Scopoletin: The Active Ingredients in *Eurycoma longifolia* Jack and *Eurycoma Harmandiana* Pierre, and Their Anti-Inflammatory Activities. *J AOAC Int* 104, 802–810. <https://doi.org/10.1093/JAOACINT/QSAA141>
- Chan, K.Q., Stewart, C., Chester, N., Hamzah, S.H., Yusof, A., 2021. The effect of *Eurycoma longifolia* on the regulation of reproductive hormones in young males. *Andrologia* 53, e14001. <https://doi.org/10.1111/AND.14001>
- Chen, L., Shi, G. rui, Huang, D. dan, Li, Y., Ma, C. chao, Shi, M., Su, B. xiao, Shi, G. jiang, 2019. Male sexual dysfunction: A review of literature on its pathological mechanisms, potential risk factors, and herbal drug intervention. *Biomed Pharmacother* 112. <https://doi.org/10.1016/J.BIOPHA.2019.01.046>
- Chokka, P.R., Hankey, J.R., 2018a. Assessment and management of sexual dysfunction in the context of depression. *Ther Adv Psychopharmacol*. <https://doi.org/10.1177/2045125317720642>
- Chung, W.J., Chan, K.L., Lee, C.Y., 2021a. Comparing the pharmacokinetics of 13 α ,21-dihydroeurycomanone and eurycomanone exclusively enriched in *Eurycoma longifolia* extracts and their spermatogenesis enhancement in andrographolide-induced oligospermia in rats. *Journal of Pharmacy and Pharmacology* 73, 161–168. <https://doi.org/10.1093/JPP/RGAA026>
- Dey, Dr.S.M., Das, S., 2024. Acceptability of infertility treatment among men and the issue of social stigma: Some reflections. *International Journal of Research in Medical Science* 6, 54–60. <https://doi.org/10.33545/26648733.2024.V6.I1A.58>
- Dhir, V., Madaan, R., Kumar, D., 2021. Emerging prospective of phytochemicals as antioxidants against chronic diseases. *SGS - Engineering & Sciences* 1.
- Dipak Lodha, S., Sherkar, M., Shirsath, D., Wamane, V., Jadhav, V., 2022. A Review on: Plant Based Antioxidant. *International Journal for*

Multidisciplinary Research (IJFMR).

- Dong, J., Ye, T., Dong, Y., Hui, J., Wang, X., 2024. Ursolic acid attenuates oligospermia in busulfan-induced mice by promoting motor proteins. *PeerJ* 12, e17691. <https://doi.org/10.7717/PEERJ.17691/SUPP-2>
- Eissa, M.A., Farag, M.A., Saleh, D.O., Shabana, M.E., Abou El-Ezz, R.F., El-Kersh, D.M., 2025. Metabolome classification of Tongkat Ali (*Eurycoma longifolia* jack) and its commercial products via UHPLC-QTOF-MS-MS and its protective effect against 5-flurouracil-Induced testicular toxicity in male rats. *J Ethnopharmacol* 337, 118904. <https://doi.org/10.1016/J.JEP.2024.118904>
- El-Ratel, I.T., Attia, K.A.H., El-Raghi, A.A., Fouda, S.F., 2020. Relief of the negative effects of heat stress on semen quality, reproductive efficiency and oxidative capacity of rabbit bucks using different natural antioxidants. *Anim Biosci* 34, 844. <https://doi.org/10.5713/AJAS.20.0258>
- Engwa, G.A., 2018. Free Radicals and the Role of Plant Phytochemicals as Antioxidants Against Oxidative Stress-Related Diseases, in: *Phytochemicals - Source of Antioxidants and Role in Disease Prevention*. InTech. <https://doi.org/10.5772/intechopen.76719>
- Fang, L., Yuanfang, Z., Peng, L., Jiamin, L., Siyu, L., Junjie, W., 2023. PLC-Q-TOF-MS/MS combined with network pharmacology for exploring anti-inflammatory mechanism of *Eurycoma longifolia*. *Journal of Southern Medical University* 43, 879. <https://doi.org/10.12122/J.ISSN.1673-4254.2023.06.02>
- Farag, M.A., Ajayi, A.O., Taleb, M., Wang, K., Ayoub, I.M., 2022. A Multifaceted Review of *Eurycoma longifolia* Nutraceutical Bioactives: Production, Extraction, and Analysis in Drugs and Biofluids. *ACS Omega* 8, 1838–1850. <https://doi.org/10.1021/ACSOMEGA.2C06340>
- Farombi, E.O., Adedara, I.A., Ajayi, B.O., Idowu, T.E., Eriomala, O.O., Akinbote, F.O., 2018. 6-Gingerol improves testicular function in mice model of chronic ulcerative colitis. *Hum Exp Toxicol* 37, 358–372. https://doi.org/10.1177/0960327117703689/Asset/8d9a50c7-046c-4600-9c6d-229a0567facf/Assets/Images/Large/10.1177_0960327117703689-Fig10.Jpg
- Fatmawati, D., Isradji, I., Yusuf, I., Suparmi, S., 2016. Kualitas Spermatozoa Mencit Balb /C Jantan Setelah Pemberian Ekstrak Buah Kepel (*Stelechocarpus Burahol*). *Majalah Kedokteran Bandung* 48, 155–159.
- Ferial, E.W., Asnady, M., Juniarti, A., 2020. Quality of Spermatozoid Preclinical Analysis on Male Mice *Mus Musculus* L. *Technology Reports of Kansai University* 62.
- Foster, N.G., 2023. Male infertility. *InnovAiT* 16, 589–595. <https://doi.org/10.1177/17557380231199056>
- Garcia-Marin, L.M., Mulcahy, A., Byrne, E.M., Medland, S.E., Wray, N.R.,

- Chafota, F., Lind, P.A., Martin, N.G., Hickie, I.B., Rentería, M.E., Campos, A.I., 2023. Discontinuation of antidepressant treatment: a retrospective cohort study on more than 20,000 participants. *Ann Gen Psychiatry* 22, 49. <https://doi.org/10.1186/S12991-023-00480-Z>
- Ghanbari, A., Jalili, C., Shahveisi, K., Akhshi, N., 2024. Harmine exhibits anti-apoptotic properties and reduces diabetes-induced testicular damage caused by streptozotocin in rats. *Clin Exp Reprod Med* 51, 324. <https://doi.org/10.5653/CERM.2023.06254>
- Gholami-Ahangaran, M., Karimi-Dehkordi, M., Akbari Javar, A., Haj Salehi, M., Ostadpoor, M., 2021. A systematic review on the effect of Ginger (*Zingiber officinale*) on improvement of biological and fertility indices of sperm in laboratory animals, poultry and humans. *Vet Med Sci* 7, 1959–1969. <https://doi.org/10.1002/VMS3.538;Pagegroup:String:Publication>
- Goswami, S.K., Gangadarappa, S.K., Vishwanath, M., Razdan, R., Jamwal, R., Bhadri, N., Inamdar, M.N., 2016. Antioxidant Potential and Ability of Phloroglucinol to Decrease Formation of Advanced Glycation End Products Increase Efficacy of Sildenafil in Diabetes-Induced Sexual Dysfunction of Rats. *Sex Med* 4, e106. <https://doi.org/10.1016/J.ESXM.2015.12.002>
- Gui, Y., Ma, X., Xiong, M., Wen, Y., Cao, C., Zhang, L., Wang, X., Liu, C., Zhang, H., Huang, X., Xiong, C., Pan, F., Yuan, S., 2024. Transcriptome analysis of meiotic and post-meiotic spermatogenic cells reveals the potential hub genes of aging on the decline of male fertility. *Gene* 893, 147883. <https://doi.org/10.1016/J.GENE.2023.147883>
- Guo, H., Ouyang, Y., Wang, J., Cui, H., Deng, H., Zhong, X., Jian, Z., Liu, H., Fang, J., Zuo, Z., Wang, X., Zhao, L., Geng, Y., Ouyang, P., Tang, H., 2021. Cu-induced spermatogenesis disease is related to oxidative stress-mediated germ cell apoptosis and DNA damage. *J Hazard Mater* 416, 125903. <https://doi.org/10.1016/J.JHAZMAT.2021.125903>
- Habibi, M., Abbasi, B., Zavareh, Z.F., Esmaeili, V., Shahverdi, A., Gilani, M.A.S., Tavalaei, M., Nasr-Esfahani, M.H., 2022. Alpha-Lipoic Acid Ameliorates Sperm DNA Damage and Chromatin Integrity in Men with High DNA Damage: A Triple Blind Randomized Clinical Trial. *Cell Journal (Yakhteh)* 24, 603. <https://doi.org/10.22074/CELLJ.2022.8273>
- Hadi, S., Anwar, K., Komari, N., Azhara, D.R., Rosanti, D.A., 2022. Screening of *Eurycoma longifolia* compounds against the cell cycle by docking through cyclin interaction. *Skrining senyawa Eurycoma longifolia terhadap siklus sel dengan metode docking melalui interaksi cyclin. Jurnal Ilmiah Farmasi (Scientific Journal of Pharmacy)* 18, 153–163.
- Haidl, G., Haidl, F., Allam, J.P., Schuppe, H.C., 2019. Therapeutic options in male genital tract inflammation. *Andrologia* 51, e13207. <https://doi.org/10.1111/AND.13207>
- Hayati, F., 2013. Uji Praktikum Dan Uji Klinik Fase I Ekstrak Air Akar Pasak Bumi (*Eurycoma Longifolia*, Jack) Terstandar Sebagai Afrodisiaka. Universitas

Gadjah Mada, Yogyakarta.

- Heijkoop, R., Huijgens, P.T., Snoeren, E.M.S., 2018. Assessment of sexual behavior in rats: The potentials and pitfalls. *Behavioural Brain Research* 352, 70–80. <https://doi.org/10.1016/J.BBR.2017.10.029>
- Higgins, A., Nash, M., Lynch, A.M., 2010. Antidepressant-associated sexual dysfunction: Impact, effects, and treatment. *Drug Healthc Patient Saf* 2, 141–150. <https://doi.org/10.2147/DHPS.S7634>
- Huang, B., Wang, Z., Kong, Y., Jin, M., Ma, L., 2023. Global, regional and national burden of male infertility in 204 countries and territories between 1990 and 2019: an analysis of global burden of disease study. *BMC Public Health* 23, 1–12. <https://doi.org/10.1186/S12889-023-16793-3/FIGURES/4>
- Hussein, S.A., Gatea, F.K., 2024. Impact of scutellarin on cyclophosphamide-induced testicular damage in Sprague Dawley male rats. *Journal of Advanced Biotechnology and Experimental Therapeutics* 7, 572–585. <https://doi.org/10.5455/JABET.2024.D49>
- Ingold, I., Aichler, M., Yefremova, E., Roveri, A., Buday, K., Doll, S., Tasdemir, A., Hoffard, N., Wurst, W., Walch, A., Ursini, F., Angeli, J.P.F., Conrad, M., 2015. Expression of a Catalytically Inactive Mutant Form of Glutathione Peroxidase 4 (Gpx4) Confers a Dominant-negative Effect in Male Fertility. *J Biol Chem* 290, 14668–14678. <https://doi.org/10.1074/JBC.M115.656363>
- Javed, A., TS, M., Saba, K., 2023. The relationship between oxidative stress and sperm physiology. *MOJ Anat Physiol Volume* 10, 32–33. <https://doi.org/10.15406/MOJAP.2023.10.00335>
- Jiménez-Trejo, F., Coronado-Mares, I., Arriaga-Canon, C., Herrera, L.A., Roque-Ramírez, B., Chávez-Saldaña, M., Rojas-Castañeda, J., Cerbón, M., Viguera-Villaseñor, R.M., 2021. Indolaminergic System in Adult Rat Testes: Evidence for a Local Serotonin System. *Front Neuroanat* 14. <https://doi.org/10.3389/fnana.2020.570058>
- Jiwandono, S., Noor, D.N., 2022. Gambaran Penggunaan Obat Antidepressant Terhadap Penderita Gangguan Depresi di Rumah Sakit Jiwa Dr. Soeharto Heerdjan Periode Januari-Juni 2017. *Yarsi Journal of Pharmacology* 3, 66–75.
- Johnson, A.R., Lao, S., Wang, T., Galanko, J.A., Zeisel, S.H., 2012a. Choline Dehydrogenase Polymorphism rs12676 Is a Functional Variation and Is Associated with Changes in Human Sperm Cell Function. *PLoS One* 7, e36047. <https://doi.org/10.1371/JOURNAL.PONE.0036047>
- Kaliaperumal, K., Salendra, L., Liu, Y., Ju, Z., Sahu, S.K., Elumalai, S., Subramanian, K., M. Alotaibi, N., Alshammari, N., Saeed, M., Karunakaran, R., 2023. Isolation of anticancer bioactive secondary metabolites from the sponge-derived endophytic fungi *Penicillium* sp. and in-silico computational docking approach. *Front Microbiol* 14, 1216928. <https://doi.org/10.3389/FMICB.2023.1216928/FULL>

- Kaltsas, A., Zikopoulos, A., Dimitriadis, F., Sheshi, D., Politis, M., Moustakli, E., Symeonidis, E.N., Chrisofos, M., Sofikitis, N., Zachariou, A., 2024a. Oxidative Stress and Erectile Dysfunction: Pathophysiology, Impacts, and Potential Treatments. *Curr Issues Mol Biol*. <https://doi.org/10.3390/cimb46080521>
- Kashif, S., Razdan, R., Illuri, R., 2019. Potential of phloroglucinol to improve erectile dysfunction associated with streptozotocin-induced diabetes in rats. *J Integr Med* 17, 282–287. <https://doi.org/10.1016/J.JOIM.2019.04.002>
- Khanijo, T., Jiraungkoorskul, W., Jiraungkoorskul, W., Jiraungkoorskul, W., 2016a. Review Ergogenic Effect of Long Jack, Eurycoma Longifolia. *Pharmacogn Rev* 10, 139–142. <https://doi.org/10.4103/0973-7847.194041>
- Khaw, S.C., Wong, Z.Z., Anderson, R.A., da Silva, S.M., 2020. l-carnitine and l-acetylcarnitine supplementation for idiopathic male infertility. *Reproduction & Fertility* 1, 67. <https://doi.org/10.1530/RAF-20-0037>
- Koedkanmark, T., Ratchamak, R., Authaida, S., Boonkum, W., Semaming, Y., Chankitisakul, V., 2024. Supplementation of sperm cooling medium with Eurycoma longifolia extract enhances native Thai chicken sperm quality and fertility potential. *Front Vet Sci* 11, 1474386. <https://doi.org/10.3389/FVETS.2024.1474386>
- Korshunov, M.N., Korshunova, E.S., Kastrikin, Y. V., Darenkov, S.P., 2021. Selective serotonin reuptake inhibitors and spermatogenesis. *Vestnik Urologii/Urology Herald* 9, 74–79. <https://doi.org/10.21886/2308-6424-2021-9-2-74-79>
- Koura, S.M., Salama, M., El-Hussiny, M., Khalil, M.E.S.A., Lotfy, A., Hassan, S.A., Elhak, S.A.G., Sobh, M.A., 2019a. Fluoxetine induces direct inhibitory effects on mesenchymal stem cell-derived osteoprogenitor cells independent of serotonin concentration. *Mol Med Rep* 19, 2611–2619. <https://doi.org/10.3892/mmr.2019.9924>
- La Basy, L., Hertiani, T., Murwanti, R., Damayanti, E., 2024. Investigation of Cox-2 inhibition of Laportea decumana (Roxb). Wedd extract to support its analgesic potential. *J Ethnopharmacol* 318. <https://doi.org/10.1016/j.jep.2023.116857>
- Lange, J., Pan, J., Cole, F., Thelen, M.P., Jasin, M., Keeney, S., 2011. ATM controls meiotic double-strand-break formation. *Nature* 479, 237–240. <https://doi.org/10.1038/nature10508>
- Lee, J.H., 2024. Oxidative stress and the multifaceted roles of ATM in maintaining cellular redox homeostasis. *Redox Biol* 75, 103269. <https://doi.org/10.1016/J.REDOX.2024.103269>
- Leisegang, K., Finelli, R., Sikka, S.C., Panner Selvam, M.K., 2022a. Eurycoma longifolia (Jack) Improves Serum Total Testosterone in Men: A Systematic Review and Meta-Analysis of Clinical Trials. *Medicina (B Aires)* 58. <https://doi.org/10.3390/MEDICINA58081047>

- Li, C., Liu, C., Chen, Y., Zhao, Y., Tan, M., He, B., 2024. Protective Effects of Betaine on Boar Sperm Quality during Liquid Storage and Transport. *Animals (Basel)* 14, 2711. <https://doi.org/10.3390/ANI14182711>
- Liao, H., Zhong, Y., Zhou, D., Xie, Q., Zhang, Z., Wu, Y., Liu, S., Guo, W., Cui, L., Wu, X., 2022. Quassinoids from *Eurycoma longifolia* and their bone formation evaluation in zebrafish, C3H10 cells and silico. *Chem Biol Interact* 367, 110140. <https://doi.org/10.1016/J.CBI.2022.110140>
- Lima, G.S., Lima, N.M., Roque, J. V., de Aguiar, D.V.A., Oliveira, J.V.A., dos Santos, G.F., Chaves, A.R., Vaz, B.G., 2022. LC-HRMS/MS-Based Metabolomics Approaches Applied to the Detection of Antifungal Compounds and a Metabolic Dynamic Assessment of Orchidaceae. *Molecules* 2022, Vol. 27, Page 7937 27, 7937. <https://doi.org/10.3390/MOLECULES27227937>
- Lin, Y., Li, Jiayi, Wang, K., Fang, Z., Che, L., Xu, S., Feng, B., Zhuo, Y., Li, Jian, Wu, D., 2022. Effects of dietary L-leucine supplementation on testicular development and semen quality in boars. *Front Vet Sci* 9, 904653. <https://doi.org/10.3389/FVETS.2022.904653/FULL>
- Linn, E., Ghanem, L., Bhakta, H., Greer, C., Avella, M., 2021a. Genes Regulating Spermatogenesis and Sperm Function Associated With Rare Disorders. *Front Cell Dev Biol*. <https://doi.org/10.3389/fcell.2021.634536>
- Liu, B., Ruz-Maldonado, I., Toczyska, K., Olaniru, O.E., Zariwala, M.G., Hopkins, D., Zhao, M., Persaud, S.J., 2022. The selective serotonin reuptake inhibitor fluoxetine has direct effects on beta cells, promoting insulin secretion and increasing beta-cell mass. *Diabetes Obes Metab* 24, 2038. <https://doi.org/10.1111/DOM.14791>
- Liu, X., Qi, Y., Zhu, T., Ding, X., Zhou, D., Han, C., 2025. Butyrate improves testicular spermatogenic dysfunction induced by a high-fat diet. *Transl Androl Urol* 14, 627–636. <https://doi.org/10.21037/TAU-2024-660/PRF>
- Liu, Y., Wan, Y., Jiang, Y., Zhang, L., Cheng, W., 2023. GPX4: The hub of lipid oxidation, ferroptosis, disease and treatment. *Biochim Biophys Acta Rev Cancer*. <https://doi.org/10.1016/j.bbcan.2023.188890>
- Low, B.S., Choi, S.B., Abdul Wahab, H., Kumar Das, P., Chan, K.L., 2013a. Eurycomanone, the major quassinoid in *Eurycoma longifolia* root extract increases spermatogenesis by inhibiting the activity of phosphodiesterase and aromatase in steroidogenesis. *J Ethnopharmacol* 149, 201–207. <https://doi.org/10.1016/J.JEP.2013.06.023>
- Ma, H.Q., Ebrahimi, F., Low, B.S., Khan, N.A.K., Chan, K.L., 2017. Polar Quassinoids in Standardized *Eurycoma longifolia* Extract Formulated into a Lipid-Based Solid Dispersion to Improve Rat Sperm Count. *Phytotherapy Research* 31, 1875–1882. <https://doi.org/10.1002/PTR.5930>
- Mazur, D.J., Lipshultz, L.I., 2018. Infertility in the Aging Male. *Curr Urol Rep* 19. <https://doi.org/10.1007/S11934-018-0802-3>

- Mohammadi, T., hosseinchi Gharehaghaj, M., Alaei Novin, A., 2024. Effects of apigenin and trans-ferulic acid on microscopic and oxidative stress parameters in the semen of water buffalo bulls during cryopreservation. *Cryobiology* 115, 104868. <https://doi.org/10.1016/J.CRYOBIOL.2024.104868>
- Moradi, M., Golmohammadi, R., Najafi, A., Moosazadeh Moghaddam, M., Fasihi-Ramandi, M., Mirnejad, R., 2022. A contemporary review on the important role of in silico approaches for managing different aspects of COVID-19 crisis. *Inform Med Unlocked* 28, 100862. <https://doi.org/10.1016/J.IMU.2022.100862>
- Mori, N., Ishihara, M., Tasaki, H., Sankai, T., Otsuki, J., 2022. The effect of betaine for mouse sperm cryopreservation. *Cryobiology* 106, 157–159. <https://doi.org/10.1016/J.CRYOBIOL.2022.03.006>
- Muhammad Ja'far Luthfi, -, Mahanem Mat Noor, 2015. Analisis Kualitas Sperma Tikus Percobaan (Jumlah, Motilitas, dan Morfologi).
- Muraro, C., Tiezza, M.D., Pavan, C., Ribaldo, G., Zagotto, G., Orian, L., 2019. Major Depressive Disorder and Oxidative Stress: In Silico Investigation of Fluoxetine Activity against ROS. *Applied Sciences* 2019, Vol. 9, Page 3631 9, 3631. <https://doi.org/10.3390/APP9173631>
- Mustofa, Purwono, S., Sholikhah, E.N., Pramantara, D.P., Hayati, F., 2014. Sediaan farmasi untuk mengatasi gangguan seksual pada pria. No IDP000035521.
- Nicol, A., Chung, E., 2023. Male sexual dysfunction: Clinical diagnosis and management strategies for common sexual problems. *Aust J Gen Pract* 52, 41–45. <https://doi.org/10.31128/AJGP-09-22-6559>
- Nirwati, H., Damayanti, E., Sholikhah, E.N., Mutofa, M., Widada, J., 2022. Soil-derived *Streptomyces* sp. GMR22 producing antibiofilm activity against *Candida albicans*: bioassay, untargeted LC-HRMS, and gene cluster analysis. *Heliyon* 8. <https://doi.org/10.1016/j.heliyon.2022.e09333>
- Notarte, K.I.R., Quimque, M.T.J., Macaranas, I.T., Khan, A., Pastrana, A.M., Villaflores, O.B., Arturo, H.C.P., Pilapil IV, D.Y.H., Tan, S.M.M., Wei, D.Q., Wenzel-Storjohann, A., Tasdemir, D., Yen, C.H., Ji, S.Y., Kim, G.Y., Choi, Y.H., Macabeo, A.P.G., 2023. Attenuation of Lipopolysaccharide-Induced Inflammatory Responses through Inhibition of the NF- κ B Pathway and the Increased NRF2 Level by a Flavonol-Enriched n-Butanol Fraction from *Uvaria alba*. *ACS Omega* 8, 5377–5392. https://doi.org/10.1021/ACSOMEGA.2C06451/SUPPL_FILE/AO2C06451_SI_001.PDF
- Obajimi, G.O., Afolabi, B.M., Obajimi, G.O., Afolabi, B.M., 2023. Male Infertility: Aetiology and Management in Contemporary Practice. *Recent Advances in Male Reproductive System*. <https://doi.org/10.5772/INTECHOPEN.1002530>
- Olivier, J.D.A., Olivier, B., 2019a. Antidepressants and Sexual Dysfunctions: a Translational Perspective. *Curr Sex Health Rep*.

<https://doi.org/10.1007/s11930-019-00205-y>

- Panjaitan, R.G.P., M, M., Z, Z., 2016. The Effect of Eurycoma longifolia Jack. Roots on Liver Damage of Pregnant Mice. *Jurnal Kedokteran Hewan - Indonesian Journal of Veterinary Sciences* 10.
- Patki, A., Shelatkar, R., Singh, M., Agarwal, S., Venugopal, M., Umbardand, S., Reddy, A., Kannan, P., Gorthi, S., Khastgir, G., Kulshreshtha, A., Ganu, G., 2023. Impact of antioxidants in improving semen parameters like count, motility and DNA fragmentation in sub-fertile males: a randomized, double-blind, placebo-controlled clinical trial. *Transl Clin Pharmacol* 31, 28–39. <https://doi.org/10.12793/TCP.2023.31.E6>
- Pires, I.Z., Gobbo, M.O. da S., Sudo, R.Y.U., Milbradt, T.L., Marquardt, N., Carvalhal, Tg.F., Da Ros, C.T., 2025. Efficacy of Alpha Lipoic Acid Supplementation in Sperm Parameters: A Systematic Review and Meta-Analysis of Randomized Trials. *Int Braz J Urol* 51. <https://doi.org/10.1590/S1677-5538.IBJU.2024.0614>
- Prasetio, N.F., Bodhi, W., Manampiring, A., Budiarmo, F., 2021. Molecular Docking terhadap Senyawa Isoeuletherin dan Isoeuletherol sebagai Penghambat Pertumbuhan SARS-CoV-2 9, 101–106. <https://doi.org/10.35790/ebm.9.1.2021.31809>
- Prasetyaningrum, E., Advistasari, Y.D., 2018. Kajian Obat Fluoxetin Dan Sertraline Pasien Depresi Berat Di Instalasi Rawat Inap Rsjd Dr. Amino Gondohutomo Provinsi Jawa Tengah Periode Juli-Desember 2016. *Cendekia Eksakta* 3. <https://doi.org/10.3194/Ce.V3i1.2142>
- Pratama, A., Rifai, Y., Marzuki, A., 2017. Docking Molekuler Senyawa 5,5'-Dibromometilsesamin. *Original Article MFF* 21, 67–69. <https://doi.org/10.20956/mff.v>
- Purwono, S., 2021. Pengembangan Kapsul ekstrak Pasak Bumi (Eurycoma longifolia) Terstandar Sebagai Agen Terapi Disfungsi Seksual. *SINTA - Science and Technology Index*.
- Purwono, S., 2015. Khasiat dan keamanan ekstrak air akar pasak bumi (Eurycoma longifolia Jack) terstandar pada pria dengan gangguan fungsi Seksual. (Disertasi).
- Puspitasari, A.W., Angeline, L., 2019. Analisis Potensi Interaksi Obat Golongan Antidepresan pada Pasien Skizofrenia di Rumah Sakit Jiwa Dr. Soeharto Heerdjan Tahun 2016 Analysis of Potential Antidepressant Drug Interactions in Schizophrenic Patients at Dr. Soeharto Heerdjan 2016. *Pharmaceutical Sciences and Research* 6, 13–20.
- Rama, N., Lescay, H., Raheem, O., 2023. Male Factor Infertility: What Every OB/GYN Should Know. *Obstet Gynecol Clin North Am* 50, 763–777. <https://doi.org/10.1016/J.OGC.2023.08.001>
- Rothmore, J., 2020. Antidepressant-induced sexual dysfunction. *Medical Journal of Australia*. <https://doi.org/10.5694/mja2.50522>

- Ruiz-Santiago, C., Rodríguez-Pinacho, C.V., Pérez-Sánchez, G., Acosta-Cruz, E., 2024. Effects of selective serotonin reuptake inhibitors on endocrine system (Review). *Biomed Rep*. <https://doi.org/10.3892/br.2024.1816>
- Rydzik, A.M., Chowdhury, R., Kochan, G.T., Williams, S.T., McDonough, M.A., Kawamura, A., Schofield, C.J., 2014. Modulating carnitine levels by targeting its biosynthesis pathway – selective inhibition of γ -butyrobetaine hydroxylase. *Chemical science (Royal Society of Chemistry : 2010)* 5, 1765. <https://doi.org/10.1039/C4SC00020J>
- Said, R.S., Mohamed, H.A., Kamal, M.M., 2019. Coenzyme Q10 mitigates ionizing radiation-induced testicular damage in rats through inhibition of oxidative stress and mitochondria-mediated apoptotic cell death. *Toxicol Appl Pharmacol* 383. <https://doi.org/10.1016/J.TAAP.2019.114780>
- Sakr HF, Abbas AM, Elsamanoudy AZ, Ghoneim FM, 2015. Effect Of Fluoxetine And Resveratrol On Testicular Functions And Oxidative Stress In A Rat Model Of Chronic Mild Stress-Induced Depression.
- Salau, V.F., Erukainure, O.L., Olofinsan, K.A., Islam, M.S., 2021. Vanillin exerts therapeutic effects against hyperglycemia-altered glucose metabolism and purinergic activities in testicular tissues of diabetic rats. *Reproductive Toxicology* 102, 24–34. <https://doi.org/10.1016/J.REPROTOX.2021.03.007>
- Salihu, M., Ajayi, B.O., Adedara, I.A., Farombi, E.O., 2017. 6-Gingerol-rich fraction prevents disruption of histomorphometry and marker enzymes of testicular function in carbendazim-treated rats. *Andrologia* 49, e12782. <https://doi.org/10.1111/AND.12782>
- Salvio, G., Cutini, M., Ciarloni, A., Giovannini, L., Perrone, M., Balercia, G., 2021. Coenzyme Q10 and Male Infertility: A Systematic Review. *Antioxidants* 10, 874. <https://doi.org/10.3390/ANTIOX10060874>
- Santiago, J., Simková, M., Silva, J. V., Santos, M.A.S., Vitku, J., Fardilha, M., 2024. Bisphenol A Negatively Impacts Human Sperm MicroRNA and Protein Profiles. *Exposure and Health* 2024 1–19. <https://doi.org/10.1007/S12403-024-00627-7>
- Schweitzer, I., Maguire, K., 2001. Stopping antidepressants. *Aust Prescr* 24, 13–15. <https://doi.org/10.18773/AUSTPRESCR.2001.008>
- Serag, A., Zayed, A., Mediani, A., Farag, M.A., 2023. Integrated comparative metabolite profiling via NMR and GC–MS analyses for tongkat ali (*Eurycoma longifolia*) fingerprinting and quality control analysis. *Sci Rep* 13, 2533. <https://doi.org/10.1038/S41598-023-28551-X>
- Serralde-Zuñiga, A.E., González-Garay, A.G., Rodríguez-Carmona, Y., Meléndez-Mier, G., 2022. Use of Fluoxetine to Reduce Weight in Adults with Overweight or Obesity: Abridged Republication of the Cochrane Systematic Review. *Obes Facts* 15, 473. <https://doi.org/10.1159/000524995>
- Setyaningrum, D.A.W., Anggraini, K., 2023. Overview of the Functions of Ginger Rhizome (*Zingiber officinale* Roscoe), Black Cumin (*Nigella sativa*), and

- Pasak Bumi (*Eurycoma longifolia* Jack) in Male Infertility. *The Avicenna Medical Journal* 4, 17–24.
- Shaikh, J., More, A., Anjankar, N., Nair, N., Mahajan, S.S., Nawale, N., 2025. Enhancing Male Fertility Through Nutrition: The Role of L-Carnitine in Asthenozoospermic Patients. *J Pharm Bioallied Sci* 17, S1019. https://doi.org/10.4103/JPBS.JPBS_94_25
- Shayakhmetova, G., Luhovskyi, S., Voronina, A., Ziółkowska, B., Karatsuba, T., Bondarenko, L., Munko, M., Blazhchuk, I., Kovalenko, V., Gołda, S., Hajto, J., Korostyński, M., Parkitna, J.R., 2025. The impact of fluoxetine treatment on reproductive organs in male rats following peripubertal PTSD-like stress exposure. *Reproductive Toxicology* 136, 108977. <https://doi.org/10.1016/J.REPROTOX.2025.108977>
- Shibata, A., Jeggo, P.A., 2021. ATM's Role in the Repair of DNA Double-Strand Breaks. *Genes (Basel)* 12. <https://doi.org/10.3390/GENES12091370>
- Shibata, A., Jeggo, P.A., 2014. DNA double-strand break repair in a cellular context. *Clin Oncol (R Coll Radiol)* 26, 243–249. <https://doi.org/10.1016/J.CLON.2014.02.004>
- Silalahi M, 2019. Hubungan Pemanfaatan Tumbuhan Pasak Bumi (*Eurycoma longifolia* Jack.) Sebagai Obat Tradisional Dan Bioaktivitasnya. *Jurnal Pendidikan Matematika Dan Ipa* 10, 271–283. <https://doi.org/10.26418/Jpmipa.V10i2.31025>
- Simanjuntak P, Kamal, A.S., Waruwu, N., Bustanussalam, B., Helawati, L., 2022. Potensi Multiherbal Daun Benalu Teh (*Scurrula oortiana*), Batang Pasak Bumi (*Eurycoma longifolia* Jack) dan Batang Pulai (*Alstonia scholaris*) Sebagai Antioksidan. *Warta Industri Hasil Pertanian* 39, 16. <https://doi.org/10.32765/wartaihp.v39i1.6947>
- Smith, S.J., Lopresti, A.L., Teo, S.Y.M., Fairchild, T.J., 2021. Examining the Effects of Herbs on Testosterone Concentrations in Men: A Systematic Review. *Advances in Nutrition* 12, 744. <https://doi.org/10.1093/ADVANCES/NMAA134>
- Spergel, D.J., 2019. Modulation of gonadotropin-releasing hormone neuron activity and secretion in mice by non-peptide neurotransmitters, gasotransmitters, and gliotransmitters. *Front Endocrinol (Lausanne)* 10, 459107. <https://doi.org/10.3389/FENDO.2019.00329/XML/NLM>
- Stracker, T.H., Roig, I., Knobel, P.A., Marjanović, M., 2013. The ATM signaling network in development and disease. *Front Genet* 4, 45573. <https://doi.org/10.3389/FGENE.2013.00037/XML/NLM>
- Straus, R., Kelder, T., bot, W.M., Chichester, C., Summer-Kutmon, M., Hanspers, K., Weitz, E., Willighagen, L., 2023. ATM signaling pathway.
- Subhawa, S., Arpornchayanon, W., Jaijoy, K., Chansakaow, S., Soonthornchareonnon, N., Sireeratawong, S., 2023. Anti-Inflammatory, Antinociceptive, Antipyretic, and Gastroprotective Effects of *Eurycoma*

longifolia Jack Ethanolic Extract. Life 13, 1465.
<https://doi.org/10.3390/LIFE13071465/S1>

Sukardiman, Mutiah, R., Handayani, R., 2025. Potential and mechanisms of indigenous Indonesian medicinal plants in treating sexual dysfunction: A systematic review and pharmacological network overview. *Heliyon* 11, e42501. <https://doi.org/10.1016/J.HELIYON.2025.E42501>

Sukoff Rizzo, S.J., Schechter, L.E., Rosenzweig-Lipson, S., 2008. A novel approach for predicting antidepressant-induced sexual dysfunction in rats. *Psychopharmacology (Berl)* 195, 459–467. <https://doi.org/10.1007/s00213-007-0924-7>

Surajmal G. Malpani, 2020. *Molecular Docking: A Novel Appliance for Structure Based Drug Discovery*.

Taechowisan, T., Chuen-Im, T., Prangwattanakul, A., Phutdhawong, W.S., 2024. Estimation of Antioxidant, Anticancer and Cytotoxic Properties of *Eurycoma longifolia* Jack. *Pakistan Journal of Biological Sciences* 27, 512–517. <https://doi.org/10.3923/pjbs.2024.512.517>

Ueno, S., Sudo, T., Hirasawa, A., 2022. ATM: Functions of ATM Kinase and Its Relevance to Hereditary Tumors. *International Journal of Molecular Sciences* 2022, Vol. 23, Page 523 23, 523. <https://doi.org/10.3390/IJMS23010523>

Wahyuningsih, M.S.H., Putri, S.U., Viktoria, V., Nugrahaningsih, D.A.A., Wicaksono, A.J., 2025a. Bioassay Guided Partition of Dandang Gendis (*Clinacanthus nutans* L.) Monitored by Glucose Consumption Assay on Myoblast Cells and GLUT4 Molecular Docking Analysis. *Tropical Journal of Natural Product Research (TJNPR)* 9, 1136–1143. <https://doi.org/10.26538/TJNPR/V9I3.31>

Wang, S., Wang, Q., Zeng, X., Min, L., Zeng, W., Adetunji, A.O., Zhu, Z., 2025. 5-Aminolevulinic acid improves boar semen quality by enhancing the sperm mitochondrial function. *Theriogenology* 239, 117389. <https://doi.org/10.1016/J.THERIOGENOLOGY.2025.117389>

Wang, W., Zhang, C., Fan, Y., Yue, S., Yang, Y., Liu, R., Zhang, L., Wang, T., Fu, F., 2021. Dopamine receptor agonist rotigotine-loaded microspheres ameliorates sexual function deteriorated by fluoxetine in depression rats. *ASN Neuro* 13. <https://doi.org/10.1177/17590914211052862>

Wanita, Y.P., Damayanti, E., Hatmi, R.U., Amri, A.F., Karim, M.A., Ushada, M., Sukartiko, A.C., 2024. Mycotoxin contamination profiling in coffee bean by targeted LC-HRMS, in: *IOP Conference Series: Earth and Environmental Science*. Institute of Physics. <https://doi.org/10.1088/1755-1315/1377/1/012027>

Wei, Y., Bao, R., Hu, L., Geng, Y., Chen, X., Wen, Y., Wang, Y., Qin, M., Zhang, Y., Liu, X., 2023. Ti3C2 (MXene) nanosheets disrupt spermatogenesis in male mice mediated by the ATM/p53 signaling pathway. *Biol Direct* 18, 30. <https://doi.org/10.1186/S13062-023-00382-W>

- WHO, 2023. World Health Organization (WHO) - Infertility prevalence estimates 1990-2021 1–98.
- WHO, 2010. WHO laboratory manual for the, 5th edition. ed. World Health Organization.
- Wijayanti, A.M., Nurwening, E.S., Mustofa, 2020. Antiplasmodial Activity And Mechanisms Of Action Of Eurycoma Longifolia Jack Root Isolated Compounds.
- Windarsih, A., Suratno, Warmiko, H.D., Indrianingsih, A.W., Rohman, A., Ulumuddin, Y.I., 2022. Untargeted metabolomics and proteomics approach using liquid chromatography-Orbitrap high resolution mass spectrometry to detect pork adulteration in Pangasius hypophthalmus meat. Food Chem 386, 132856. <https://doi.org/10.1016/J.FOODCHEM.2022.132856>
- Woolley, P.R., Wen, X., Conway, O.M., Ender, N.A., Lee, J.H., Paull, T.T., 2024. Regulation of transcription patterns, poly(ADP-ribose), and RNA-DNA hybrids by the ATM protein kinase. Cell Rep 43, 113896. <https://doi.org/10.1016/J.CELREP.2024.113896>
- Xavier da Silva, T.N., Friedmann Angeli, J.P., Ingold, I., 2022. GPX4: old lessons, new features. Biochem Soc Trans 50, 1205–1213. <https://doi.org/10.1042/BST20220682>
- Xu, G., Lu, M., Fang, L., Tian, F., Zhu, H., Zhou, L., Zhou, X., 2023. Quercetin Suppresses Ferroptosis in Chondrocytes via Activating the Nrf2/ GPX4 Signaling Pathway. Nat Prod Commun 18. <https://doi.org/10.1177/1934578X231194837>
- Xu, J., He, K., Zhou, Y., Zhao, L., Lin, Y., Huang, Z., Xie, N., Yue, J., Tang, Y., 2022. The effect of SSRIs on Semen quality: A systematic review and meta-analysis. Front Pharmacol. <https://doi.org/10.3389/fphar.2022.911489>
- Yang, H., Winnegrad, Z., Obiora, D., Seftel, A.D., 2024. Male sexual dysfunction. Penn Clinical Manual of Urology, Third Edition 760-797.e6. <https://doi.org/10.1016/B978-0-323-77575-5.00030-7>
- Yao, D.F., Mills, J.N., 2016. Male infertility: lifestyle factors and holistic, complementary, and alternative therapies. Asian J Androl 18, 410. <https://doi.org/10.4103/1008-682X.175779>
- Yunos, N.M., Al-Thiabat, M.G., Sallehudin, N.J., Wahab, H.A., 2024. Quassinoids from Eurycoma longifolia as Potential Dihydrofolate Reductase Inhibitors: A Computational Study . Curr Pharm Biotechnol 25, 2154–2165. <https://doi.org/10.2174/0113892010273336240221101506>,
- Yunos, N.M., Wahab, H.A., Al-Thiabat, M.G., Sallehudin, N.J., Jauri, M.H., 2023. In Vitro and In Silico Analysis of the Anticancer Effects of Eurycomanone and Eurycomalactone from Eurycoma longifolia. Plants 12, 2827. <https://doi.org/10.3390/PLANTS12152827/S1>
- Zhang, J., Zhang, X., Liu, Y., Su, Z., Dawar, F.U., Dan, H., He, Y., Gui, J.F., Mei, J., 2017. Leucine mediates autophagosome-lysosome fusion and improves

sperm motility by activating the PI3K/Akt pathway. *Oncotarget* 8, 111807.
<https://doi.org/10.18632/ONCOTARGET.22910>

Zhang, W., Liu, Y., Liao, Y., Zhu, C., Zou, Z., 2024. GPX4, ferroptosis, and diseases. *Biomed Pharmacother* 174.

Zhao, M., Wu, F., Tang, Z., Yang, X., Liu, Y., Wang, F., Chen, B., 2023. Anti-inflammatory and antioxidant activity of ursolic acid: a systematic review and meta-analysis. *Front Pharmacol* 14, 1256946.
<https://doi.org/10.3389/FPHAR.2023.1256946/FULL>