

## DAFTAR PUSTAKA

- Aao, O., & Oa, F. (2021). The Intriguing Extrapolations of Haemolysis Assay as Screening Criterion for Selecting Biosurfactant-Producing Microorganisms in Petroleum Industries Process-Conditions. *Journal of Petroleum & Environmental Biotechnology*, 12(8), 431.
- Abas, M. R., Jalil, A., Kader, A., Sahaid Khalil, M., Hamid, A. A., *et al.*, (2013). Production of Surfactin from *Bacillus subtilis* ATCC 21332 by Using Treated Palm Oil Mill Effluent (POME) as Fermentation Media. *International Proceedings of Chemical, Biological and Environmental Engineering*. <https://doi.org/10.7763/IPCBE>
- Abdelraof, M., Nooman, M. U., Hashem, A. H., & Al-kashef, A. S. (2024). Production and optimization of surfactin produced from locally isolated *Bacillus halotolerans* grown on agro-industrial wastes and its antimicrobial efficiency. *BMC Microbiology*, 24(1). <https://doi.org/10.1186/s12866-024-03338-w>
- Afshar, S., Bagheri Lotfabad, T., Roostaazad, R., Rouholamini Najafabadi, A., & Akbari Noghabi, K. (2008). Comparative approach for detection of biosurfactant-producing bacteria isolated from Ahvaz petroleum excavation areas in south of Iran. In *Annals of Microbiology* (Vol. 58, Number 3).
- Akintayo, S. O., Treinen, C., Vahidinasab, M., Pfannstiel, J., Bertsche, U., *et al.*, (2022). Exploration of surfactin production by newly isolated *Bacillus* and *Lysinibacillus* strains from food-related sources. *Letters in Applied Microbiology*, 75(2), 378–387. <https://doi.org/10.1111/lam.13731>
- Albasri, H. M., Almohammadi, A. A., Alhhazmi, A., Bukhari, D. A., Waznah, M. S., *et al.*, (2024). Production and characterization of rhamnolipid biosurfactant from thermophilic *Geobacillus stearothermophilus* bacterium isolated from Uhud mountain. *Frontiers in Microbiology*, 15. <https://doi.org/10.3389/fmicb.2024.1358175>
- Albuquerque, A. P. da C., Ferreira, H. de S., Silva, Y. A. da., Silva, R. R. da., Lima, C. V. A. de., *et al.*, (2025). Biosurfactant Produced by *Bacillus subtilis* UCP 1533 Isolated from the Brazilian Semiarid Region: Characterization and Antimicrobial Potential. *Microorganisms*, 13(7). <https://doi.org/10.3390/microorganisms13071548>
- Al-Dhabi, N. A., Esmail, G. A., & Arasu, M. V. (2020). Enhanced production of biosurfactant from *Bacillus subtilis* strain al-dhabi-130 under solid-state fermentation using date molasses from Saudi Arabia for bioremediation of crude-oil-contaminated soils. *International Journal of Environmental Research and Public Health*, 17(22), 1–20. <https://doi.org/10.3390/ijerph17228446>

- Al-Garadi, M., Qaid, M., Alqhtani, A., Alhaji, M., Al-abdullatif, A., *et al.*, (2023). In Vitro Antimicrobial Efficacy Assessment of Ethanolic and Aqueous Extracts of Cinnamon (*Cinnamomum Verum*) Bark against Selected Microbes. *Brazilian Journal of Poultry Science*, 25(1). <https://doi.org/10.1590/1806-9061-2022-1682>
- Allen, R. J., & Waclaw, B. (2019). Bacterial growth: a statistical physicist's guide. *Reports on Progress in Physics*, 82(1), 016601. <https://doi.org/10.1088/1361-6633/aae546>
- Alyousif, N. A., Luaibi, Y. Y. Y. A., & Hussein, W. (2020). Distribution and molecular characterization of biosurfactant-producing bacteria. *Biodiversitas*, 21(9), 4034–4040. <https://doi.org/10.13057/biodiv/d210914>
- Amani, H., & Kariminezhad, H. (2016). Study on emulsification of crude oil in water using emulsan biosurfactant for pipeline transportation. *Petroleum Science and Technology*, 34(3), 216–222. <https://doi.org/10.1080/10916466.2015.1118500>
- Amin, M. A., Shukor, H., Yin, L. S., Kasim, F. H., Shoparwe, N. F., *et al.*, (2022). Methane Biogas Production in Malaysia: Challenge and Future Plan. In *International Journal of Chemical Engineering* (Vol. 2022). Hindawi Limited. <https://doi.org/10.1155/2022/2278211>
- Anaukwu, C. G., Ekwealor, C. C., Anakwenze, V. N., Orji, C. C., Ogbukagu, C. M., *et al.*, (2024). Heavy metal application of response surface optimized-lipopeptide biosurfactant produced by *Pseudomonas aeruginosa* strain CGA-02 in low-cost substrate. *Discover Applied Sciences*, 6(5), 252. <https://doi.org/10.1007/s42452-024-05821-5>
- Andrews, J. M. (2001). Determination of minimum inhibitory concentrations. *Journal of Antimicrobial Chemotherapy*, 48(suppl\_1), 5–16. [https://doi.org/10.1093/jac/48.suppl\\_1.5](https://doi.org/10.1093/jac/48.suppl_1.5)
- Aqlinia, M., Astuti, R. I., Prastya, M. E., & Wahyudi, A. T. (2025). Antioxidant potential of melanin pigment from marine sponge-associated actinomycete *Micromonospora* sp. *Journal of Applied Pharmaceutical Science*, 15(4), 212–224. <https://doi.org/10.7324/JAPS.2025.201566>
- Araújo, S. C. da S., Silva-Portela, R. C. B., de Lima, D. C., da Fonsêca, M. M. B., Araújo, W. J., *et al.*, (2020). MBSP1: a biosurfactant protein derived from a metagenomic library with activity in oil degradation. *Scientific Reports*, 10(1). <https://doi.org/10.1038/s41598-020-58330-x>
- Atef, A., Abo Elsoud, M. M., Elkhouly, H. I., & Sidkey, N. M. (2023). Production, Properties and Application Trends of Iturin Biosurfactant Produced from *Bacillus altitudinis* AHMNAZ2. In *The Egyptian Journal of Hospital Medicine* (Vol. 93). <http://www.ncbi.nlm.nih.gov>

- Badan Pusat Statistik Indonesia. (2025). *Statistik Tanaman Perkebunan Tahunan Indonesia 2024*.
- Baihaqi, R. A., & Diski Pratama, W. (2023). Feasibility study of utilization of palm oil mill effluent (POME) as a source for microalgae nutrients. *Journal of Emerging Science and Engineering*, 2023(1), 1–5. <http://creativecommons.org/licenses/by/4.0/>
- Bala, J. D., Lalung, J., Al-Gheethi, A. A. S., Hossain, K., & Ismail, N. (2018). Microbiota of palm oil mill wastewater in Malaysia. *Tropical Life Sciences Research*, 29(2), 131–163. <https://doi.org/10.21315/tlsr2018.29.2.10>
- Balouiri, M., Sadiki, M., & Ibensouda, S. K. (2016). Methods for in vitro evaluating antimicrobial activity: A review. *Journal of Pharmaceutical Analysis*, 6(2), 71–79. <https://doi.org/10.1016/j.jpha.2015.11.005>
- Bär, J., Boumasoud, M., Kouyos, R. D., Zinkernagel, A. S., & Vulin, C. (2020). Efficient microbial colony growth dynamics quantification with ColTapp, an automated image analysis application. *Scientific Reports*, 10(1), 16084. <https://doi.org/10.1038/s41598-020-72979-4>
- Beal, J., Farny, N. G., Haddock-Angelli, T., Selvarajah, V., Baldwin, G. S., *et al.*, (2020). Robust estimation of bacterial cell count from optical density. *Communications Biology*, 3(1), 512. <https://doi.org/10.1038/s42003-020-01127-5>
- Bhagaskara, R. J., Ahmad, A. S., Prasetyawan, S. R., Amelia, D., Pratama, D. P., *et al.*, (2023). Antibiotic Susceptibility Test Of Pseudomonas Aeruginosa And Staphylococcus Aureus With Disk Diffusion And Dilution Method. *Journal of Research in Pharmacy and Pharmaceutical Sciences*, 2(1), 29–37. <https://doi.org/10.33533/jrpps.v2i1.7029>
- Bhardwaj, G., Cameotra, S. S., & Chopra, H. K. (2013). Utilization of oleo-chemical industry by-products for biosurfactant production. *Springer Open Journal*. <http://www.amb-express.com/content/3/1/68>
- Borozan, A., Popescu, S., Madosa, E., Ciulca, A., Moldovan, C., *et al.*, (2023). Comparative study on the antimicrobial activity of propolis, catechin, quercetin and gallic acid. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 51(2), 12826. <https://doi.org/10.15835/nbha51212826>
- Bruggeling, C. E., Garza, D. R., Achouiti, S., Mes, W., Dutilh, B. E., *et al.*, (2021). Optimized bacterial DNA isolation method for microbiome analysis of human tissues. *MicrobiologyOpen*, 10(3). <https://doi.org/10.1002/mbo3.1191>
- Bueno-Mancebo, J., Barrena, R., Artola, A., Gea, T., & Altmajer-Vaz, D. (2024). Surfactin as an ingredient in cosmetic industry: Benefits and trends. In *International Journal of Cosmetic Science* (Vol. 46, Number 5, pp. 702–716). John Wiley and Sons Inc. <https://doi.org/10.1111/ics.12957>

- Burbaud, S., Laval, F., Lemassu, A., Daffé, M., Guilhot, C., *et al.*, (2016). Trehalose Polyphosphates Are Produced by a Glycolipid Biosynthetic Pathway Conserved across Phylogenetically Distant Mycobacteria. *Cell Chemical Biology*, 23(2), 278–289. <https://doi.org/10.1016/j.chembiol.2015.11.013>
- Campos, J. M., Montenegro Stamford, T. L., Sarubbo, L. A., de Luna, J. M., Rufino, R. D., *et al.*, (2013). Microbial biosurfactants as additives for food industries. *Biotechnology Progress*, 29(5), 1097–1108. <https://doi.org/10.1002/btpr.1796>
- Cao, Y., & Lin, H. (2021). Characterization and function of membrane vesicles in Gram-positive bacteria. *Applied Microbiology and Biotechnology*, 105(5), 1795–1801. <https://doi.org/10.1007/s00253-021-11140-1>
- Carolin C, F., Kumar, P. S., & Ngueagni, P. T. (2021). A review on new aspects of lipopeptide biosurfactant: Types, production, properties and its application in the bioremediation process. *Journal of Hazardous Materials*, 407, 124827. <https://doi.org/10.1016/j.jhazmat.2020.124827>
- Carrillo, C., Teruel, J. A., Aranda, F. J., & Ortiz, A. (2003). Molecular mechanism of membrane permeabilization by the peptide antibiotic surfactin. *Biochimica et Biophysica Acta - Biomembranes*, 1611(1–2), 91–97. [https://doi.org/10.1016/S0005-2736\(03\)00029-4](https://doi.org/10.1016/S0005-2736(03)00029-4)
- Cavalcanti, A. P. B., de Araújo, G. P., Bezerra, K. G. de O., de Almeida, F. C. G., da Silva, M. da G. C., *et al.*, (2025). Production of a Biosurfactant for Application in the Cosmetics Industry. *Fermentation*, 11(8). <https://doi.org/10.3390/fermentation11080451>
- Chooklin, C. S., Phertmean, S., Cheirsilp, B., Maneerat, S., & Saimmai, A. (2013). Utilization of palm oil mill effluent as a novel and promising substrate for biosurfactant production by *Nevskia ramosa* NA3. *Journal of Science and Technology*, 35(2), 167–176.
- Chopra, I., & Roberts, M. (2001). Tetracycline antibiotics: mode of action, applications, molecular biology, and epidemiology of bacterial resistance. *Microbiology and Molecular Biology Reviews: MMBR*, 65(2), 232–60 ; second page, table of contents. <https://doi.org/10.1128/MMBR.65.2.232-260.2001>
- Chrzanowski, Ł., Ławniczak, Ł., & Czaczyk, K. (2012). Why do microorganisms produce rhamnolipids? In *World Journal of Microbiology and Biotechnology* (Vol. 28, Number 2, pp. 401–419). <https://doi.org/10.1007/s11274-011-0854-8>
- Church, D. L., Cerutti, L., Gürtler, A., Griener, T., Zelazny, A., *et al.*, (2020). Performance and Application of 16S rRNA Gene Cycle Sequencing for Routine Identification of Bacteria in the Clinical Microbiology Laboratory. *Clinical Microbiology Reviews*, 33(4). <https://doi.org/10.1128/CMR.00053-19>

- Cooper, D. G., & Goldenberg, B. G. (1987). Surface-Active Agents from Two Bacillus Species. *Applied and Environmental Microbiology*, 224–229. <https://journals.asm.org/journal/aem>
- Czerwińska-Główka, D., & Krukiewicz, K. (2021). Guidelines for a Morphometric Analysis of Prokaryotic and Eukaryotic Cells by Scanning Electron Microscopy. *Cells*, 10(12), 3304. <https://doi.org/10.3390/cells10123304>
- Damayana, H., Nurhasanah, Kiswando, A. A., Juliasih, N. L. G. R., & Bahri, S. (2024). Utilization POME as growth substrate for local indigenous bacteria Bacillus sp. ALP D1 in producing biosurfactant. *IOP Conference Series: Earth and Environmental Science*, 1312(1). <https://doi.org/10.1088/1755-1315/1312/1/012057>
- Datta, P., Tiwari, P., & Pandey, L. M. (2018). Isolation and characterization of biosurfactant producing and oil degrading Bacillus subtilis MG495086 from formation water of Assam oil reservoir and its suitability for enhanced oil recovery. *Bioresource Technology*, 270, 439–448. <https://doi.org/10.1016/J.BIORTECH.2018.09.047>
- de Medeiros, N. S., da Nóbrega, F. F., Lopes, P. S., de Assis, C. F., & Sousa Júnior, F. C. de. (2024). Biotechnological potential of Lacticaseibacillus paracasei Shirota for bioemulsifier, bacteriocin and lipase production. *Brazilian Journal of Microbiology*, 55(4), 3229–3238. <https://doi.org/10.1007/s42770-024-01534-4>
- Degang, L., Auricchio, G., De Oliveira Schmidt, V. K., Della-Flora, I. K., & De Andrade, C. J. (2023). Oil displacement properties of surfactin: A comparative study. *Tenside, Surfactants, Detergents*, 60(5), 414–419. <https://doi.org/10.1515/tsd-2023-2525>
- Dehghan-Noudeh, G., Housaindokht, M., & Bazzaz, B. S. F. (2005). Isolation, characterization, and investigation of surface and hemolytic activities of a lipopeptide biosurfactant produced by Bacillus subtilis ATCC 6633. *The Journal of Microbiology*.
- Dereeper, A., Guignon, V., Blanc, G., Audic, S., Buffet, S., et al., (2008). Phylogeny.fr: robust phylogenetic analysis for the non-specialist. *Nucleic Acids Research*, 36(Web Server), W465–W469. <https://doi.org/10.1093/nar/gkn180>
- Djafri-Dib, S., Yalaoui-Guellal, D. Y.-G., Amessis-Ouchemoukh, N., Madani, K., & Ouchemoukh, S. (2025). Biological Activities, Biosorption of Heavy Metals, and Stability of Lipopeptide Biosurfactant Produced by the Alcaligenes aquatilis Bacterium YGD-2906. *Current Bioactive Compounds*, 21(4). <https://doi.org/10.2174/0115734072291385240523100300>
- Eras-Muñoz, E., Farré, A., Sánchez, A., Font, X., & Gea, T. (2022). Microbial biosurfactants: a review of recent environmental applications. *Bioengineered*, 13(5), 12365–12391. <https://doi.org/10.1080/21655979.2022.2074621>

- Farias, C. B. B., Almeida, F. C. G., Silva, I. A., Souza, T. C., Meira, H. M., *et al.*, (2021). Production of green surfactants: Market prospects. *Electronic Journal of Biotechnology*, 51, 28–39. <https://doi.org/10.1016/j.ejbt.2021.02.002>
- Felsenstein, J. (1985). Confidence limits on phylogenies: An approach using the bootstrap. *Evolution*, 39(4), 783–791. <https://doi.org/10.1111/j.1558-5646.1985.tb00420.x>
- Fernando, J. S. R., Premaratne, M., Dinalankara, D. M. S. D., Perera, G. L. N. J., & Ariyadasa, T. U. (2021). Cultivation of microalgae in palm oil mill effluent (POME) for astaxanthin production and simultaneous phycoremediation. *Journal of Environmental Chemical Engineering*, 9(4), 105375. <https://doi.org/10.1016/J.JECE.2021.105375>
- Fisher, E. N., Melnikov, E. S., Gegeckori, V., Potoldykova, N. V., Enikeev, D. V., *et al.*, (2022). Development and Validation of an LC-MS/MS Method for Simultaneous Determination of Short Peptide-Based Drugs in Human Blood Plasma. *Molecules*, 27(22), 7831. <https://doi.org/10.3390/molecules27227831>
- Foster, T. (1996). *Staphylococcus*. S. Baron (Ed.), *Medical microbiology* (4th ed.). University of Texas Medical Branch at Galveston.
- Gayathiri, E., Prakash, P., Karmegam, N., Varjani, S., Awasthi, M. K., *et al.*, (2022). Biosurfactants: Potential and Eco-Friendly Material for Sustainable Agriculture and Environmental Safety—A Review. In *Agronomy* (Vol. 12, Number 3). MDPI. <https://doi.org/10.3390/agronomy12030662>
- Gharaie, S., Ohadi, M., Hassanshahian, M., Shakibaie, M., Shahriary, P., *et al.*, (2023). Glycolipopeptide biosurfactant from *Bacillus pumilus* SG: physicochemical characterization, optimization, antibiofilm and antimicrobial activity evaluation. *3 Biotech*, 13(10). <https://doi.org/10.1007/s13205-023-03728-3>
- Golding, C. G., Lamboo, L. L., Beniac, D. R., & Booth, T. F. (2016). The scanning electron microscope in microbiology and diagnosis of infectious disease. *Scientific Reports*, 6(1), 26516. <https://doi.org/10.1038/srep26516>
- Gonzalez, J. M., & Aranda, B. (2023). Microbial Growth under Limiting Conditions-Future Perspectives. *Microorganisms*, 11(7), 1641. <https://doi.org/10.3390/microorganisms11071641>
- Grossman, T. H. (2016). Tetracycline Antibiotics and Resistance. *Cold Spring Harbor Perspectives in Medicine*, 6(4), a025387. <https://doi.org/10.1101/cshperspect.a025387>
- Hackmann, T. J. (2025). Setting new boundaries of 16S rRNA gene identity for prokaryotic taxonomy. *International Journal of Systematic and Evolutionary Microbiology*, 75(4). <https://doi.org/10.1099/ijsem.0.006747>

- Hage-Hülsmann, J., Grünberger, A., Thies, S., Santiago-Schübel, B., Klein, A. S., *et al.*, (2018). Natural biocide cocktails: Combinatorial antibiotic effects of prodigiosin and biosurfactants. *PLOS ONE*, *13*(7), e0200940. <https://doi.org/10.1371/journal.pone.0200940>
- Hala. M. A., & N. H. Haider. (2024). The Antibacterial Activity Of Glycolipopeptide Produced From Lactococcus Lactis Hn21 Against Some Clinical Pathogens In Combined With Some Standard Antibiotics. *Iraqi Journal Of Agricultural Sciences*, *55*(Special), 12–24. <https://doi.org/10.36103/ijas.v55iSpecial.1881>
- Hamill, P. G., Stevenson, A., McMullan, P. E., Williams, J. P., Lewis, A. D. R., S, S., *et al.*, (2020). Microbial lag phase can be indicative of, or independent from, cellular stress. *Scientific Reports*, *10*(1), 5948. <https://doi.org/10.1038/s41598-020-62552-4>
- Han, L.-L., Shao, H.-H., Liu, Y.-C., Liu, G., Xie, C.-Y., *et al.*, (2017). Transcriptome profiling analysis reveals metabolic changes across various growth phases in *Bacillus pumilus* BA06. *BMC Microbiology*, *17*(1), 156. <https://doi.org/10.1186/s12866-017-1066-7>
- Haydar, K. (2020). Production And Characterization Of Biosurfactant (Glycolipid) From Lactobacillus Helviticus M5 And Evaluate Its Antimicrobial And Antiadhesive Activity. *IRAQI JOURNAL OF AGRICULTURAL SCIENCES*, *51*(6), 1543–1558. <https://doi.org/10.36103/ijas.v51i6.1182>
- Hosseini, S. E., & Wahid, M. A. (2015). Pollutant in palm oil production process. *Journal of the Air and Waste Management Association*, *65*(7), 773–781. <https://doi.org/10.1080/10962247.2013.873092>
- Hosseini, S., Sharifi, R., Habibi, A., & Ali, Q. (2024). Molecular identification of rhamnolipids produced by *Pseudomonas oryzihabitans* during biodegradation of crude oil. *Frontiers in Microbiology*, *15*. <https://doi.org/10.3389/fmicb.2024.1459112>
- Ighilahriz, K., Benchouk, A., Belkebir, Y., Seghir, N., & Yahi, L. (2024). Production of biosurfactant by *Bacillus megaterium* using agro-food wastes and its application in petroleum sludge oil recovery. In *Journal of Environmental Health Science and Engineering* (Vol. 22, Number 2, pp. 413–424). Springer Science and Business Media Deutschland GmbH. <https://doi.org/10.1007/s40201-024-00919-9>
- Inès, M., & Dhouha, G. (2015). Lipopeptide surfactants: Production, recovery and pore forming capacity. *Peptides*, *71*, 100–112. <https://doi.org/10.1016/J.PEPTIDES.2015.07.006>
- Iyamu, E., & Ekhaïse, F. O. (2024). Identification of Contact lens bacterial Isolates from Students of University of Benin, Nigeria, Using 16S rRNA Gene Sequence Analysis. *Journal of the Nigerian Optometric Association*, *26*(1), 26–34. <https://doi.org/10.4314/jnoa.v26i1.5>

- Jagadeesan, B., Baert, L., Wiedmann, M., & Orsi, R. H. (2019). Comparative Analysis of Tools and Approaches for Source Tracking *Listeria monocytogenes* in a Food Facility Using Whole-Genome Sequence Data. *Frontiers in Microbiology*, *10*. <https://doi.org/10.3389/fmicb.2019.00947>
- Janda, J. M., & Abbott, S. L. (2007). 16S rRNA gene sequencing for bacterial identification in the diagnostic laboratory: pluses, perils, and pitfalls. *Journal of Clinical Microbiology*, *45*(9), 2761–2764. <https://doi.org/10.1128/JCM.01228-07>
- Jiang, M., Wang, H., Liu, J., Hou, X., Zhang, Y., *et al.*, (2024). Isolation and Characterization of Biosurfactant-Producing Bacteria for Enhancing Oil Recovery. *Processes*, *12*(11). <https://doi.org/10.3390/pr12112575>
- Jimoh, A. A., Booyesen, E., van Zyl, L., & Trindade, M. (2023). Do biosurfactants as anti-biofilm agents have a future in industrial water systems? In *Frontiers in Bioengineering and Biotechnology* (Vol. 11). Frontiers Media SA. <https://doi.org/10.3389/fbioe.2023.1244595>
- Jin, D., Zhao, S., Zheng, N., Bu, D., Beckers, Y., *et al.*, (2017). Differences in Ureolytic Bacterial Composition between the Rumen Digesta and Rumen Wall Based on ureC Gene Classification. *Frontiers in Microbiology*, *8*. <https://doi.org/10.3389/fmicb.2017.00385>
- Joshi-Navare, K., & Prabhune, A. (2013). A biosurfactant-sophorolipid acts in synergy with antibiotics to enhance their efficiency. *BioMed Research International*, *2013*. <https://doi.org/10.1155/2013/512495>
- Joy, S., Rahman, P. K. S. M., & Sharma, S. (2017). Biosurfactant production and concomitant hydrocarbon degradation potentials of bacteria isolated from extreme and hydrocarbon contaminated environments. *Chemical Engineering Journal*, *317*, 232–241. <https://doi.org/10.1016/j.cej.2017.02.054>
- Juergensmeyer, M. A., Nelson, E. S., & Juergensmeyer, E. A. (2007). Shaking alone, without concurrent aeration, affects the growth characteristics of *Escherichia coli*. *Letters in Applied Microbiology*, *45*(2), 179–183. <https://doi.org/10.1111/j.1472-765X.2007.02172.x>
- Juma, A., Lemoine, P., Simpson, A. B. J., Murray, J., O'Hagan, B. M. G., *et al.*, (2020). Microscopic Investigation of the Combined Use of Antibiotics and Biosurfactants on Methicillin Resistant *Staphylococcus aureus*. *Frontiers in Microbiology*, *11*. <https://doi.org/10.3389/fmicb.2020.01477>
- Jumpathong, W., Intra, B., Euanorasetr, J., & Wanapaisan, P. (2022). Biosurfactant-Producing *Bacillus velezensis* PW192 as an Anti-Fungal Biocontrol Agent against *Colletotrichum gloeosporioides* and *Colletotrichum musae*. *Microorganisms*, *10*(5). <https://doi.org/10.3390/microorganisms10051017>
- Kaczorek, E., Pacholak, A., Zdarta, A., & Smulek, W. (2018). The impact of biosurfactants on microbial cell properties leading to hydrocarbon

- bioavailability increase. In *Colloids and Interfaces* (Vol. 2, Number 3). MDPI AG. <https://doi.org/10.3390/colloids2030035>
- Kadeřábková, N., Mahmood, A. J. S., & Mavridou, D. A. I. (2024). Antibiotic susceptibility testing using minimum inhibitory concentration (MIC) assays. *Npj Antimicrobials and Resistance*, 2(1), 37. <https://doi.org/10.1038/s44259-024-00051-6>
- Kamnev, A. A., Dyatlova, Y. A., Kenzhegulov, O. A., Fedonenko, Y. P., Evstigneeva, S. S., *et al.*, (2023). Fourier Transform Infrared (FTIR) Spectroscopic Study of Biofilms Formed by the Rhizobacterium *Azospirillum baldaniorum* Sp245: Aspects of Methodology and Matrix Composition. *Molecules*, 28(4), 1949. <https://doi.org/10.3390/molecules28041949>
- Karmainski, T., Dielentheis-Frenken, M. R. E., Lipa, M. K., Phan, A. N. T., Blank, L. M., *et al.*, (2023). High-quality physiology of *Alcanivorax borkumensis* SK2 producing glycolipids enables efficient stirred-tank bioreactor cultivation. *Frontiers in Bioengineering and Biotechnology*, 11. <https://doi.org/10.3389/fbioe.2023.1325019>
- Karnwal, A., Shrivastava, S., Al-Tawaha, A. R. M. S., Kumar, G., Singh, R., *et al.*, (2023). Microbial Biosurfactant as an Alternate to Chemical Surfactants for Application in Cosmetics Industries in Personal and Skin Care Products: A Critical Review. *BioMed Research International*, 2023. <https://doi.org/10.1155/2023/2375223>
- Kaundal, T., Sharma, A., & Batra, N. (2025). Isolation and screening of biosurfactants producing lactic acid bacteria strain from Bhatnagar, an Indian traditional fermented food. *Biotechnologia*, 106(3), 279–290. <https://doi.org/10.5114/bta/207713>
- Kementerian Energi dan Sumber Daya Mineral. (2018, January 24). *Limbah Sawit Di Indonesia Berpotensi Hasilkan Listrik 12.654 MW*. Kementerian ESDM Republik Indonesia.
- Kenzaka, T., & Tani, K. (2012). Scanning Electron Microscopy Imaging of Bacteria Based on Nucleic Acid Sequences. In *Scanning Electron Microscopy*. InTech. <https://doi.org/10.5772/36638>
- Khorvash, F., Abdi, F., Kashani, H. H., Naeini, F. F., & Narimani, T. (2012). Staphylococcus aureus in acne pathogenesis: A case-control study. *North American Journal of Medical Sciences*, 4(11), 573–576. <https://doi.org/10.4103/1947-2714.103317>
- Konopacki, M., Jabłońska, J., Dubrowska, K., Augustyniak, A., Grygorcewicz, B., *et al.*, (2022). The Influence of Hydrodynamic Conditions in a Laboratory-Scale Bioreactor on *Pseudomonas aeruginosa* Metabolite Production. *Microorganisms*, 11(1), 88. <https://doi.org/10.3390/microorganisms11010088>

- Lee, P. Y., Costumbrado, J., Hsu, C.-Y., & Kim, Y. H. (2012). Agarose Gel Electrophoresis for the Separation of DNA Fragments. *Journal of Visualized Experiments*, (62). <https://doi.org/10.3791/3923>
- Legiawati, L., Halim, P. A., Fitriani, M., Hikmahrachim, H. G., & Lim, H. W. (2023). Microbiomes in Acne Vulgaris and Their Susceptibility to Antibiotics in Indonesia: A Systematic Review and Meta-Analysis. In *Antibiotics* (Vol. 12, Number 1). MDPI. <https://doi.org/10.3390/antibiotics12010145>
- Li, H., Fang, C., Liu, X., Bao, K., Li, Y., & Bao, M. (2023). Quantitative analysis of biosurfactants in water samples by a modified oil spreading technique. *RSC Advances*, 13(15), 9933–9944. <https://doi.org/10.1039/d3ra00102d>
- Lin, Z. X., Steed, L. L., Marculescu, C. E., Slone, H. S., & Woolf, S. K. (2020). Cutibacterium acnes Infection in Orthopedics: Microbiology, Clinical Findings, Diagnostic Strategies, and Management. *Orthopedics*, 43(1), 52–61. <https://doi.org/10.3928/01477447-20191213-02>
- Lourenço, M., Duarte, N., & Ribeiro, I. A. C. (2024). Exploring Biosurfactants as Antimicrobial Approaches. In *Pharmaceuticals* (Vol. 17, Number 9). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/ph17091239>
- Low, S. S., Bong, K. X., Mubashir, M., Cheng, C. K., Lam, M. K., *et al.*, (2021). Microalgae cultivation in palm oil mill effluent (POME) treatment and biofuel production. In *Sustainability (Switzerland)* (Vol. 13, Number 6). MDPI. <https://doi.org/10.3390/su13063247>
- Luong, N., Hoa, H., Loan, L. Q., Eun-Ki, K., Ha, T. T., *et al.*, (2016). Production and characterization of sophorolipids produced by *Candida bombicola* using sugarcane molasses and coconut oil. <https://www.tc-thaijo.org/index.php/APST/index>
- Ma, X. J., Wang, T., Zhang, H. M., Shao, J. Q., Jiang, M., *et al.*, (2022). Comparison of inhibitory effects and mechanisms of lactonic sophorolipid on different pathogenic bacteria. *Frontiers in Microbiology*, 13. <https://doi.org/10.3389/fmicb.2022.929932>
- Madaki, K. A., & Rabi'u, H. M. (2025). Biosurfactant: Bacterial Production, Properties, Classification and Applications. *Dutse Journal of Pure and Applied Sciences*, 11(1b), 17–25. <https://doi.org/10.4314/dujopas.v11i1b.3>
- Madigan Michael T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2019). *Brock Biology of Microorganisms* (15th ed.).
- Malakar, C., Kashyap, B., Bhattacharjee, S., Chandra Kalita, M., Mukherjee, A. K., *et al.*, (2024). Antibiofilm and wound healing efficacy of rhamnolipid biosurfactant against pathogenic bacterium *Staphylococcus aureus*. *Microbial Pathogenesis*, 195, 106855. <https://doi.org/https://doi.org/10.1016/j.micpath.2024.106855>

- Mayslich, C., Grange, P. A., & Dupin, N. (2021). Cutibacterium acnes as an Opportunistic Pathogen: An Update of Its Virulence-Associated Factors. *Microorganisms*, 9(2), 303. <https://doi.org/10.3390/microorganisms9020303>
- Menon, S., Mishra, A., Krishnan, J., Ravindran, A. K., Sneha, P. U., *et al.*, (2025). Production and characterization of biosurfactant from novel strains isolated from environmental samples. *Journal of Applied Biology and Biotechnology*, 13(4), 136–145. <https://doi.org/10.7324/JABB.2025.221419>
- Miao, Y., To, M. H., Siddiqui, M. A., Wang, H., Lodens, S., *et al.*, (2024). Sustainable biosurfactant production from secondary feedstock—recent advances, process optimization and perspectives. In *Frontiers in Chemistry* (Vol. 12). Frontiers Media SA. <https://doi.org/10.3389/fchem.2024.1327113>
- Miguel, C. F., & Pereira, C. C. (2024). Evaluation of the feasibility for replacing sheep blood with human blood in culture media used in microbiological diagnostics. *Anais Da Academia Brasileira de Ciências*, 96(2). <https://doi.org/10.1590/0001-3765202420231168>
- Mohammad, S., Baidurah, S., Kobayashi, T., Ismail, N., & Leh, C. P. (2021). Palm oil mill effluent treatment processes—A review. In *Processes* (Vol. 9, Number 5). MDPI AG. <https://doi.org/10.3390/pr9050739>
- Murray, C. J., Ikuta, K. S., Sharara, F., Swetschinski, L., Robles Aguilar, G., *et al.*, (2022). Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *The Lancet*, 399(10325), 629–655. [https://doi.org/10.1016/S0140-6736\(21\)02724-0](https://doi.org/10.1016/S0140-6736(21)02724-0)
- Nagtode, V. S., Cardoza, C., Yasin, H. K. A., Mali, S. N., Tambe, S. M., *et al.*, (2023). Green Surfactants (Biosurfactants): A Petroleum-Free Substitute for Sustainability—Comparison, Applications, Market, and Future Prospects. In *ACS Omega* (Vol. 8, Number 13, pp. 11674–11699). American Chemical Society. <https://doi.org/10.1021/acsomega.3c00591>
- Nandiyanto, A. B. D., Ragadhita, R., & Fiandini, M. (2022). Interpretation of Fourier Transform Infrared Spectra (FTIR): A Practical Approach in the Polymer/Plastic Thermal Decomposition. *Indonesian Journal of Science and Technology*, 8(1), 113–126. <https://doi.org/10.17509/ijost.v8i1.53297>
- Nasir, M. S., Yahya, A. R. M., & Noh, N. A. M. (2024). Agro-Industrial Wastes as Potential Substrates for Rhamnolipid Production by *Pseudomonas aeruginosa* USM-AR2. *Tropical Life Sciences Research*, 35(1), 33–47. <https://doi.org/10.21315/tlsr2024.35.1.3>
- Nasser, M., Sharma, M., & Kaur, G. (2024). Advances in the production of biosurfactants as green ingredients in home and personal care products. In *Frontiers in Chemistry* (Vol. 12). Frontiers Media SA. <https://doi.org/10.3389/fchem.2024.1382547>

- Nayarisseri, A., Singh, P., & Singh, S. K. (2018). Screening, isolation and characterization of biosurfactant producing *Bacillus subtilis* strain ANSKLAB03. *Bioinformation*, *14*(06), 304–314. <https://doi.org/10.6026/97320630014304>
- Ndlovu, T., Rautenbach, M., Vosloo, J. A., Khan, S., & Khan, W. (2017). Characterisation and antimicrobial activity of biosurfactant extracts produced by *Bacillus amyloliquefaciens* and *Pseudomonas aeruginosa* isolated from a wastewater treatment plant. *AMB Express*, *7*(1), 108. <https://doi.org/10.1186/s13568-017-0363-8>
- Nguena-Dongue, B. N., Tchamgoue, J., Tchamgoue, Y. A. N., Lungu, P. K., Toghuo, K. R. M., *et al.*, (2023). Potentiation effect of mallotojaponin B on chloramphenicol and mode of action of combinations against Methicillin-resistant *Staphylococcus aureus*. *PLoS ONE*, *18*(3 March). <https://doi.org/10.1371/journal.pone.0282008>
- Niedźwiedź, I., Juzwa, W., Skrzypiec, K., Skrzypek, T., Waśko, A., *et al.*, (2020). Morphological and physiological changes in *Lentilactobacillus hilgardii* cells after cold plasma treatment. *Scientific Reports*, *10*(1). <https://doi.org/10.1038/s41598-020-76053-x>
- Niu, Y., Sun, Y., Yang, Y., Niu, B., Wang, Y., *et al.*, (2023). Antibacterial Mechanism of Rhamnolipids against *Bacillus cereus* and Its Application in Fresh Wet Noodles. *Molecules*, *28*(19). <https://doi.org/10.3390/molecules28196946>
- Odds, F. C. (2003). Synergy, antagonism, and what the chequerboard puts between them. *Journal of Antimicrobial Chemotherapy*, *52*(1), 1–1. <https://doi.org/10.1093/jac/dkg301>
- Panchariya, V., Bhati, V., Madhyastha, H., Madhyastha, R., Prasad, J., *et al.*, (2021). Chromatic intervention and biocompatibility assay for biosurfactant derived from *Balanites aegyptiaca* (L.) Del. *Scientific Reports*, *11*(1), 4186. <https://doi.org/10.1038/s41598-021-83573-7>
- Paray, A. A., Singh, M., & Amin Mir, M. (2023). Gram Staining: A Brief Review. *International Journal of Research and Review*, *10*(9), 336–341. <https://doi.org/10.52403/ijrr.20230934>
- Pardhi, D. S., Panchal, R. R., Raval, V. H., Joshi, R. G., Poczai, P., *et al.*, (2022). Microbial surfactants: A journey from fundamentals to recent advances. *Frontiers in Microbiology*, *13*. <https://doi.org/10.3389/fmicb.2022.982603>
- Patel, M., Siddiqui, A. J., Hamadou, W. S., Surti, M., Awadelkareem, A. M., *et al.*, (2021). Inhibition of bacterial adhesion and antibiofilm activities of a glycolipid biosurfactant from *Lactobacillus rhamnosus* with its physicochemical and functional properties. *Antibiotics*, *10*(12). <https://doi.org/10.3390/antibiotics10121546>

- Patiño, A. D., Montoya-Giraldo, M., Quintero, M., López-Parra, L. L., Blandón, L. M., *et al.*, (2021). Dereplication of antimicrobial biosurfactants from marine bacteria using molecular networking. *Scientific Reports*, *11*(1), 16286. <https://doi.org/10.1038/s41598-021-95788-9>
- Paul, B. (2023). Concatenated 16S rRNA sequence analysis improves bacterial taxonomy. *F1000Research*, *11*, 1530. <https://doi.org/10.12688/f1000research.128320.3>
- Petra de Oliveira Barros, V., Macedo Silva, J. R., Maciel Melo, V. M., Terceiro, P. S., Nunes de Oliveira, I., *et al.*, (2024). Biosurfactants production by marine yeasts isolated from zoanthids and characterization of an emulsifier produced by *Yarrowia lipolytica* LMS 24B. *Chemosphere*, *355*, 141807. <https://doi.org/10.1016/j.chemosphere.2024.141807>
- Pisithkul, T., Schroeder, J. W., Trujillo, E. A., Yeesin, P., Stevenson, D. M., *et al.*, (2019). Metabolic Remodeling during Biofilm Development of *Bacillus subtilis*. *MBio*, *10*(3). <https://doi.org/10.1128/mBio.00623-19>
- Planson, A.-G., Sauveplane, V., Dervyn, E., & Jules, M. (2020). Bacterial growth physiology and RNA metabolism. *Biochimica et Biophysica Acta (BBA) - Gene Regulatory Mechanisms*, *1863*(5), 194502. <https://doi.org/10.1016/j.bbagr.2020.194502>
- Platsidaki, E., & Dessinioti, C. (2018). Recent advances in understanding *Propionibacterium acnes* (*Cutibacterium acnes*) in acne. *F1000Research*, *7*, 1953. <https://doi.org/10.12688/f1000research.15659.1>
- Prastya, M. E., Simbolon, S., Priyanto, J. A., Hasidu, L. O. A. F., Permatasari, V., *et al.*, (2024). *Antibacterial and antibiofilm activities from soil Streptomyces spp. isolated from Muna Island, Indonesia against multidrug-resistant clinical isolates*. <https://doi.org/10.21203/rs.3.rs-3811919/v1>
- Prastya, M. E., Suprihadi, A., Kusdiyantini, E., & Biologi, 1 Jurusan. (2021). Eksplorasi Rhizobakteri Indigenus Tanaman Cabai Rawit (*Capsicum Frutescens* Linn.) Dari Pertanian Semi Organik Desa Batur Kabupaten Semarang Sebagai Agen Hayati Pengendali Pertumbuhan Jamur *Fusarium oxysporum* f.sp *capsici*. In *Berkala Bioteknologi* (Vol. 4, Number 2).
- Priyanto, J. A., Prastya, M. E., Astuti, R. I., & Kristiana, R. (2023). The Antibacterial and Antibiofilm Activities of the Endophytic Bacteria Associated with *Archidendron pauciflorum* against Multidrug-Resistant Strains. *Applied Biochemistry and Biotechnology*, *195*(11), 6653–6674. <https://doi.org/10.1007/s12010-023-04382-4>
- Priyanto, J. A., Prastya, M. E., Hening, E. N. W., Suryanti, E., & Kristiana, R. (2024). Two Strains of Endophytic *Bacillus velezensis* Carrying Antibiotic-Biosynthetic Genes Show Antibacterial and Antibiofilm Activities Against Methicillin-Resistant *Staphylococcus aureus* (MRSA). *Indian Journal of*

*Microbiology*, 64(4), 1884–1893. <https://doi.org/10.1007/s12088-024-01262-1>

- Puyol McKenna, P., Naughton, P. J., Dooley, J. S. G., Ternan, N. G., Lemoine, P., *et al.*, (2024). Microbial Biosurfactants: Antimicrobial Activity and Potential Biomedical and Therapeutic Exploits. In *Pharmaceuticals* (Vol. 17, Number 1). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/ph17010138>
- Qi, G.-N., Qin, W.-Q., Li, G.-J., Ma, T.-T., Liu, Y.-F., Zhou, L., Liu, J.-F., Gang, H.-Z., Yang, S.-Z., & Mu, B.-Z. (2025). A New Bacterial Strain Producing Both of the Surfactin and Fengycin Lipopeptide Biosurfactant with Strong Emulsifications on Crude Oil. *Applied Biochemistry and Biotechnology*, 197(2), 1192–1208. <https://doi.org/10.1007/s12010-024-05076-1>
- Quast, C., Pruesse, E., Yilmaz, P., Gerken, J., Schweer, T., *et al.*, (2012). The SILVA ribosomal RNA gene database project: improved data processing and web-based tools. *Nucleic Acids Research*, 41(D1), D590–D596. <https://doi.org/10.1093/nar/gks1219>
- Rappold, B. A. (2022). Review of the Use of Liquid Chromatography-Tandem Mass Spectrometry in Clinical Laboratories: Part II—Operations. *Annals of Laboratory Medicine*, 42(5), 531–557. <https://doi.org/10.3343/alm.2022.42.5.531>
- Rolfe, M. D., Rice, C. J., Lucchini, S., Pin, C., Thompson, A., *et al.*, (2012). Lag phase is a distinct growth phase that prepares bacteria for exponential growth and involves transient metal accumulation. *Journal of Bacteriology*, 194(3), 686–701. <https://doi.org/10.1128/JB.06112-11>
- Rossignol, G., Merieau, A., Guerillon, J., Veron, W., Lesouhaitier, O., *et al.*, (2008). Involvement of a phospholipase C in the hemolytic activity of a clinical strain of *Pseudomonas fluorescens*. *BMC Microbiology*, 8. <https://doi.org/10.1186/1471-2180-8-189>
- Roth, T., Zelinger, E., Kossovsky, T., & Borkow, G. (2024). Scanning Electron Microscopy Analysis of Biofilm-Encased Bacteria Exposed to Cuprous Oxide-Impregnated Wound Dressings. *Microbiology Research*, 15(4), 2358–2368. <https://doi.org/10.3390/microbiolres15040158>
- Ruden, S., Rieder, A., Chis Ster, I., Schwartz, T., Mikut, R., *et al.*, (2019). Synergy Pattern of Short Cationic Antimicrobial Peptides Against Multidrug-Resistant *Pseudomonas aeruginosa*. *Frontiers in Microbiology*, 10. <https://doi.org/10.3389/fmicb.2019.02740>
- Ruiz, B., Chávez, A., Forero, A., García-Huante, Y., Romero, A., *et al.*, (2010). Production of microbial secondary metabolites: Regulation by the carbon source. *Critical Reviews in Microbiology*, 36(2), 146–167. <https://doi.org/10.3109/10408410903489576>

- Ruparelia, J., Rabari, A., Mitra, D., Panneerselvam, P., Das-mohapatra, P. K., *et al.*, (2022). Efficient applications of bacterial secondary metabolites for management of biotic stress in plants. *Plant Stress*, 6, 100125. <https://doi.org/10.1016/j.stress.2022.100125>
- Russo, C. A. de M., & Selvatti, A. P. (2018). Bootstrap and Rogue Identification Tests for Phylogenetic Analyses. *Molecular Biology and Evolution*, 35(9), 2327–2333. <https://doi.org/10.1093/molbev/msy118>
- Sá, S., Fernandes, R., Gestoso, Á., Macedo, J. M., Martins-Mendes, D., *et al.*, (2023). Cutibacterium acnes Dysbiosis: Alternative Therapeutics for Clinical Application. *Applied Sciences*, 13(21), 12086. <https://doi.org/10.3390/app132112086>
- Sacco, M. A., Gualtieri, S., Santos, A., Mendes, B., Raffaele, R., *et al.*, (2025). Scanning Electron Microscopy Techniques in the Analysis of Gunshot Residues: A Literature Review. *Applied Sciences*, 15(5), 2634. <https://doi.org/10.3390/app15052634>
- Sachdev, D. P., & Cameotra, S. S. (2013). Biosurfactants in agriculture. In *Applied Microbiology and Biotechnology* (Vol. 97, Number 3, pp. 1005–1016). <https://doi.org/10.1007/s00253-012-4641-8>
- Sah, D., Rai, J. P. N., Ghosh, A., & Chakraborty, M. (2022). A review on biosurfactant producing bacteria for remediation of petroleum contaminated soils. In *3 Biotech* (Vol. 12, Number 9). Springer Science and Business Media Deutschland GmbH. <https://doi.org/10.1007/s13205-022-03277-1>
- Sambanthamoorthy, K., Feng, X., Patel, R., Patel, S., & Parnavitana, C. (2014). Antimicrobial and antibiofilm potential of biosurfactants isolated from lactobacilli against multi-drug-resistant pathogens. *BMC Microbiology*, 14(1). <https://doi.org/10.1186/1471-2180-14-197>
- Sana, S., Datta, S., Biswas, D., & Sengupta, D. (2018). Assessment of synergistic antibacterial activity of combined biosurfactants revealed by bacterial cell envelop damage. *Biochimica et Biophysica Acta (BBA) - Biomembranes*, 1860(2), 579–585. <https://doi.org/10.1016/j.bbamem.2017.09.027>
- Santos, D. K. F., Rufino, R. D., Luna, J. M., Santos, V. A., & Sarubbo, L. A. (2016). Biosurfactants: Multifunctional biomolecules of the 21st century. In *International Journal of Molecular Sciences* (Vol. 17, Number 3). MDPI AG. <https://doi.org/10.3390/ijms17030401>
- Santos, D., Rufino, R., Luna, J., Santos, V., & Sarubbo, L. (2016). Biosurfactants: Multifunctional Biomolecules of the 21st Century. *International Journal of Molecular Sciences*, 17(3), 401. <https://doi.org/10.3390/ijms17030401>
- Sari, C. N., Hertadi, R., Harahap, A. F. P., Ramadhan, M. Y. A., & Gozan, M. (2020). Process optimization of palm oil mill effluent-based biosurfactant of *Halomonas meridiana* BK-AB4 originated from bledug kuwu mud volcano in

- central java for microbial enhanced oil recovery. *Processes*, 8(6). <https://doi.org/10.3390/PR8060716>
- Sari, M., Afiati, F., & Wien, kusharyoto. (2015, March 1). *Potensi bakteri lumpur minyak sebagai penghasil biosurfaktan dan antimikroba*. <https://doi.org/10.13057/psnmbi/m010113>
- Sen, S., Borah, S. N., Bora, A., & Deka, S. (2017). Production, characterization, and antifungal activity of a biosurfactant produced by *Rhodotorula babjevae* YS3. *Microbial Cell Factories*, 16(1), 95. <https://doi.org/10.1186/s12934-017-0711-z>
- Sen, S., Borah, S. N., Bora, A., & Deka, S. (2020). Rhamnolipid exhibits anti-biofilm activity against the dermatophytic fungi *Trichophyton rubrum* and *Trichophyton mentagrophytes*. *Biotechnology Reports*, 27. <https://doi.org/10.1016/j.btre.2020.e00516>
- Shandookh, F. K. (2025). FTIR characterization of biosurfactants that produced from *Bacillus subtilis* isolated from wastewater samples contaminated with organic pollutants. *International Journal of Chemical and Biological Sciences*, 7(2), 102–105. <https://doi.org/10.33545/26646765.2025.v7.i2b.158>
- Sharma, N., Lavania, M., & Lal, B. (2023). Biosurfactant: an emerging tool for the petroleum industries. In *Frontiers in Microbiology* (Vol. 14). Frontiers Media SA. <https://doi.org/10.3389/fmicb.2023.1254557>
- Shoeb, E., Akhlaq, F., Badar, U., Akhter, J., & Imtiaz, S. (2013). *Classification And Industrial Applications Of Biosurfactants*. [www.savap.org.pk/www.journals.savap.org.pk](http://www.savap.org.pk/www.journals.savap.org.pk)
- Silva, I. A., Fortunato, J. G. L. A., Almeida, F. C. G., Alves, R. N., Cunha, M. C. C., *et al.*, (2024). Production and Application of a New Biosurfactant for Solubilisation and Mobilisation of Residual Oil from Sand and Seawater. *Processes*, 12(8). <https://doi.org/10.3390/pr12081605>
- Soberón-Chávez, G., González-Valdez, A., Soto-Aceves, M. P., & Cocotl-Yañez, M. (2021). Rhamnolipids produced by *Pseudomonas*: from molecular genetics to the market. In *Microbial Biotechnology* (Vol. 14, Number 1, pp. 136–146). John Wiley and Sons Ltd. <https://doi.org/10.1111/1751-7915.13700>
- Solyman, S. M., & Samak, M. (2025). Narrative Review of Bacterial DNA Extraction: Key Points and Challenges. In *SINAI International Scientific Journal (SISJ)* (Vol. 1, Number 3).
- Sorour, A., Zobair, N., Ghanem, K., & Khairy, H. (2025). Rhamnolipid from *Pseudomonas* sp. as a green surfactant for enhanced phytoremediation. *Scientific Reports*, 15(1). <https://doi.org/10.1038/s41598-025-14244-0>
- Sousa, A. M., Machado, I., Nicolau, A., & Pereira, M. O. (2013). Improvements on colony morphology identification towards bacterial profiling. *Journal of*

*Microbiological Methods*, 95(3), 327–335.  
<https://doi.org/10.1016/j.mimet.2013.09.020>

Stewart, E. J. (2012). Growing Unculturable Bacteria. *Journal of Bacteriology*, 194(16), 4151–4160. <https://doi.org/10.1128/JB.00345-12>

Suárez-Contreras, L. Y., & Yañez-Meneses, L. F. (2020). 16S rRNA as an applied tool in the molecular characterization of genera and species of bacteria. *Respuestas*, 25(1), 127–137. <https://doi.org/10.22463/0122820X.2430>

Sultana, S., Sultana, R., Al-Mansur, Md. A., Akbor, Md. A., Bhuiyan, N. A., *et al.*, (2024). An industrially potent rhamnolipid-like biosurfactant produced from a novel oil-degrading bacterium, *Bacillus velezensis* S2. *RSC Advances*, 14(34), 24516–24533. <https://doi.org/10.1039/D4RA02572E>

Sundaram, T., Govindarajan, R. K., Vinayagam, S., Krishnan, V., Nagarajan, S., *et al.*, (2024). Advancements in biosurfactant production using agro-industrial waste for industrial and environmental applications. In *Frontiers in Microbiology* (Vol. 15). Frontiers Media SA. <https://doi.org/10.3389/fmicb.2024.1357302>

Sze, M. A., & Schloss, P. D. (2019). The Impact of DNA Polymerase and Number of Rounds of Amplification in PCR on 16S rRNA Gene Sequence Data. *MSphere*, 4(3). <https://doi.org/10.1128/mSphere.00163-19>

Tamura, K., Stecher, G., & Kumar, S. (2021). MEGA11: Molecular Evolutionary Genetics Analysis Version 11. *Molecular Biology and Evolution*, 38(7), 3022–3027. <https://doi.org/10.1093/molbev/msab120>

Taylor, T. A., & Unakal, C. G. (2025). *Staphylococcus aureus Infection*.

Tchakouani, G. F. Y., Mouafo, H. T., Nguimbou, R. M., Nganou, N. D., & Mbawala, A. (2024). Antibacterial activity of bioemulsifiers/biosurfactants produced by *Levilactobacillus brevis* S4 and *Lactiplantibacillus plantarum* S5 and their utilization to enhance the stability of cold emulsions of milk chocolate drinks. *Food Science and Nutrition*, 12(1), 141–153. <https://doi.org/10.1002/fsn3.3740>

Thakur, B., Kaur, S., Dwibedi, V., Albadrani, G. M., Al-Ghadi, M. Q., *et al.*, (2024). Unveiling the antimicrobial and antibiofilm potential of biosurfactant produced by newly isolated *Lactiplantibacillus plantarum* strain 1625. *Frontiers in Microbiology*, 15. <https://doi.org/10.3389/fmicb.2024.1459388>

Thakur, P., Saini, N. K., Thakur, V. K., Gupta, V. K., Saini, R. V., *et al.*, (2021). Rhamnolipid the Glycolipid Biosurfactant: Emerging trends and promising strategies in the field of biotechnology and biomedicine. In *Microbial Cell Factories* (Vol. 20, Number 1). BioMed Central Ltd. <https://doi.org/10.1186/s12934-020-01497-9>

Trindade, M., Sithole, N., Kubicki, S., Thies, S., & Burger, A. (2021). *Screening Strategies for Biosurfactant Discovery*.

- Tripathi, N., Zubair, M., & Sapra, A. (2025). *Gram Staining*.
- Ughy, B., Nagyapati, S., Lajko, D. B., Letoha, T., Prohaszka, A., *et al.*, (2023). Reconsidering Dogmas about the Growth of Bacterial Populations. *Cells*, *12*(10), 1430. <https://doi.org/10.3390/cells12101430>
- Venkataraman, S., Rajendran, D. S., & Vaidyanathan, V. K. (2024). An insight into the utilization of microbial biosurfactants pertaining to their industrial applications in the food sector. In *Food Science and Biotechnology* (Vol. 33, Number 2, pp. 245–273). The Korean Society of Food Science and Technology. <https://doi.org/10.1007/s10068-023-01435-6>
- Wahyuningsih, N., & Zulaika, E. (2019). Perbandingan Pertumbuhan Bakteri Selulolitik pada Media Nutrient Broth dan Carboxy Methyl Cellulose. *Jurnal Sains Dan Seni ITS*, *7*(2). <https://doi.org/10.12962/j23373520.v7i2.36283>
- Walter, V., Syldatk, C., & Hausmann, R. (2013). *Screening Concepts for the Isolation of Biosurfactant Producing Microorganisms*.
- Wang, X., An, J., Cao, T., Guo, M., & Han, F. (2024). Application of Biosurfactants in Medical Sciences. In *Molecules* (Vol. 29, Number 11). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/molecules29112606>
- Weinstein, M. P. . (2019). *Performance standards for antimicrobial susceptibility testing*. Clinical and Laboratory Standards Institute.
- Yamasaki, R., Kawano, A., Yoshioka, Y., & Ariyoshi, W. (2020). Rhamnolipids and surfactin inhibit the growth or formation of oral bacterial biofilm. *BMC Microbiology*, *20*(1). <https://doi.org/10.1186/s12866-020-02034-9>
- Yarza, P., Yilmaz, P., Pruesse, E., Glöckner, F. O., Ludwig, W., *et al.*, (2014). Uniting the classification of cultured and uncultured bacteria and archaea using 16S rRNA gene sequences. *Nature Reviews Microbiology*, *12*(9), 635–645. <https://doi.org/10.1038/nrmicro3330>
- Yeh, E., Pinsky, B. A., Banaei, N., & Baron, E. J. (2009). Hair Sheep Blood, Citrated or Defibrinated, Fulfills All Requirements of Blood Agar for Diagnostic Microbiology Laboratory Tests. *PLoS ONE*, *4*(7), e6141. <https://doi.org/10.1371/journal.pone.0006141>
- Yonda Atwita, S., Malau, J., Permatasari, V., Primahana, G., Dewijanti, I. D., *et al.*, (n.d.). *The Antibacterial and Antioxidant Potential of Bioactive Metabolites from Soil-Derived Bacteria in Samarinda, East Kalimantan*. Retrieved <https://journal.ipb.ac.id/index.php/sumberdayahayati>
- Youssef, N. H., Duncan, K. E., Nagle, D. P., Savage, K. N., Knapp, R. M., *et al.*, (2004). Comparison of methods to detect biosurfactant production by diverse microorganisms. *Journal of Microbiological Methods*, *56*(3), 339–347. <https://doi.org/https://doi.org/10.1016/j.mimet.2003.11.001>

Yu, F., Du, Y., Deng, S., Jin, M., Zhang, D., *et al.*, (2023). Efficient preparation of extremely high-purity surfactin from fermentation broth by ethanol extraction. *Separation and Purification Technology*, 304. <https://doi.org/10.1016/j.seppur.2022.122278>

Zia, K., & Linda, T. M. (2023). Potensi *Bacillus* spp. Sebagai Penghasil Biosurfaktan untuk Pengolahan Limbah Minyak Pelumas. *Biota : Jurnal Ilmiah Ilmu-Ilmu Hayati*, 69–78. <https://doi.org/10.24002/biota.v8i2.6360>

