Preparation and Characterization of Mangrove Crude Extract and their Impact on the Survival Rate of Platy Fish (*Xiphophorus Maculatus*)

S. Padmalochini1 , Royaan venkat1,a)

1Padma Health Centre, Karur, Tamilnadu, India

**Corresponding Author:** a)[rfiza8740@gmail.com](mailto:rfiza8740@gmail.com)

**Abstract:** Mangrove ecosystems are essential for coastal stability, biodiversity preservation, and environmental sustainability. Among them, *Avicennia marina* stands out as a key mangrove species with significant ecological, genetic, and pharmacological relevance. This study examines the phytochemical profile, antibacterial activity, and potential toxicity of *A. marina* leaf extract using *Xiphophorus maculatus* (Platy fish) as a model organism. Ethanol-based crude extracts were prepared and analysed for bioactive compounds, confirming the presence of flavonoids, tannins, saponins, alkaloids, and terpenoids. Antibacterial efficacy was evaluated using the disc diffusion method against *Streptococcus mutans*, demonstrating a concentration-dependent inhibitory effect. FTIR identified key functional groups, such as amines, alkenes, and carboxyl groups, indicating a diverse phytochemical composition. Toxicity and survival assessments in *X. maculatus* revealed a dose-dependent reduction in survival, with the highest mortality observed at 200 µg/mL. These results highlight the pharmacological potential of *A. marina*, emphasizing its antimicrobial properties and prospective applications in drug development and phytoremediation while underscoring the importance of optimizing dosage for therapeutic efficacy and safety.

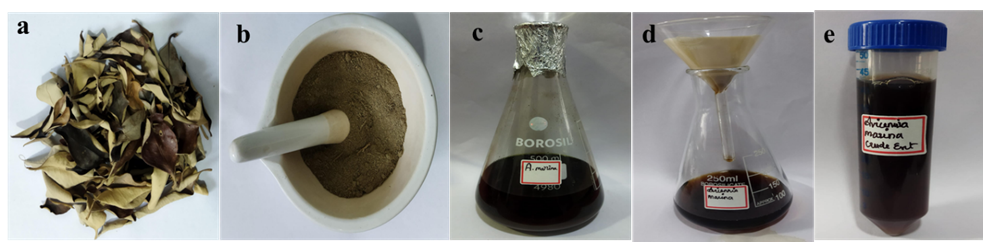
**Keywords:** *Avicennia marina,* Phytochemical, Antibacterial, FTIR, *Xiphophorus maculatus*

# Introduction

Mangroves are unique intertidal ecosystems found along tropical and subtropical coastlines, where they serve as critical buffers between land and sea. These forests provide essential ecological services, including coastal protection, carbon sequestration, sediment stabilization, and habitat for a wide range of marine organisms [(Sarkar et al. 2024)](https://paperpile.com/c/aNXQxg/dPhzU) . Mangrove species have evolved specialized adaptations to survive in saline, waterlogged, and oxygen-deficient environments. Among them, *Avicennia marina*, commonly known as the grey mangrove, is one of the most widely distributed and ecologically significant species, thriving in diverse coastal regions from Africa to the Indo-Pacific. It plays a crucial role in mangrove ecosystems by enhancing sediment accretion, supporting biodiversity, and contributing to nutrient cycling [(Cinco-Castro and Comín 2022)](https://paperpile.com/c/aNXQxg/RZxIR) . *Avicennia marina* exhibits remarkable physiological and genetic adaptations that enable it to survive in extreme environmental conditions, including high salinity, tidal inundation, and anaerobic soils [(Nizam et al. 2024)](https://paperpile.com/c/aNXQxg/r5Q3t). Mangrove species, including *Avicennia marina*, contain a diverse range of bioactive compounds such as alkaloids, flavonoids, terpenoids, saponins, and tannins which possess antioxidant, antimicrobial, anti-inflammatory, and anticancer properties [(Permatasari, Muliasari, and Rahman 2024)](https://paperpile.com/c/aNXQxg/QhB2) . These natural compounds make mangroves an important source of medicinal products with promising applications in human health [(Getzner and Islam 2020)](https://paperpile.com/c/aNXQxg/dySak). Studies show that *A. marina* seedlings regulate photosynthesis and activate antioxidants to counter oxidative stress from tidal submersion, improving survival in coastal environments [(Li et al. 2020)](https://paperpile.com/c/aNXQxg/HvXKG). *A. marina* can tolerate and accumulate cadmium, making it a key candidate for coastal phytoremediation [(Ramasubburayan et al. 2024)](https://paperpile.com/c/aNXQxg/pxyT). Leaf extracts of *A. marina* have shown potent anticancer properties by inducing apoptosis in human breast and liver cancer cells, with bioactive compounds playing a key role[(Huang et al. 2016)](https://paperpile.com/c/aNXQxg/rzWxg). *Avicennia marina* leaf extract has potential applications in the food industry, serving as a natural preservative while also enhancing nutritional content and sensory properties [(Sumartini, Ratrinia, and Andini 2021)](https://paperpile.com/c/aNXQxg/9dzW9) . *A. marina* is a focus of ecological, genetic, biotechnological, and pharmacological research due to its resilience, ecosystem benefits, and medical and environmental potential [(Sravya et al. 2025)](https://paperpile.com/c/aNXQxg/ANxYE) . Beyond its significance in aquaculture, *Xiphophorus maculatus* is widely recognized as a key model organism in scientific research, particularly in the study of melanoma and other genetic disorders. Research indicates that platy fish can naturally develop tumours or have them induced, making them valuable for exploring the genetic mechanisms underlying cancer [(Schartl and Lu 2024)](https://paperpile.com/c/aNXQxg/OQiHN). In addition to being a popular aquarium fish, *X. maculatus* plays a crucial role in advancing knowledge in genetics, ecology, and evolutionary biology.

# Materials and Methods

Fresh Mangrove *Avicennia marina* samples were collected from the Pichavaram coast, Chidambaram, Tamil Nadu, India, and identified by Dr. Pitchiah Sivaperumal. Voucher specimens (SIMATS/CMAR/SG/CS-01) were deposited at the Centre for Marine and Aquatic Research, SIMATS, Chennai. The samples were washed to remove impurities, air-dried, finely ground, and stored in sealed containers at room temperature for further analysis (Fig.1).



**Figure 1**. Mangrove Sample collection and pre-processing of the samples; a) *Avicennia marina plant*, b) Dried leaves, c) Extraction d) filtration process, e) filtrate crude

Crude extract preparation, 20 g of dried powder was mixed with 200 mL of 70% ethanol and shaken for 48 hours. The crude was filtered (Whatman No. 1), and the filtrate was concentrated at 60°C. The crude extract was stored in a desiccator(Saadh et al., 2024).Phytochemical analysis of ethanol extracts from mangrove samples was conducted to identify biologically active compounds(Almatrafi et al., 2024). The preliminary phytochemical screening of the extracts was performed following established standard protocols [(Uche et al. 2019)](https://paperpile.com/c/aNXQxg/VQbb0).Antibacterial activity was evaluated using a modified disc diffusion method 2014.[(Ravindran Nt and Mohamed Sadiq A 2019)](https://paperpile.com/c/aNXQxg/JcCHk). Nutrient agar plates (HIMEDIA-M001-500G) Pathogen were swabbed on agar plates, and sample-loaded Sterile discs (HIMEDIA-SDO67-1VL) with different concentrations were placed. After 12–24 hours of incubation, inhibition zones were measured.Fourier Transform Infrared Spectroscopy (FTIR) is a valuable technique for identifying functional groups in compounds based on their characteristic absorption wavelengths. Each chemical bond absorbs light at a specific wavelength, producing a unique spectrum that reflects molecular bonding. In this study, FTIR analysis was performed using dried powder samples from different solvent extracts of plant material.Red Platy fish were obtained from an aquarium shop in Kolathur, Chennai, and acclimated at the Marine Biomedical Laboratory, They were housed in a 10 L tank (1.2 g/L density) at 25 ± 2°C with a 12:12 h light-dark cycle and continuous aeration. Fish were fed commercial pellets, and health was monitored daily. Before spawning, males and females were separated for seven days and then introduced at a 1:2 ratio. Toxicity and survival were assessed based on hatching failure, morphological abnormalities, and mortality. Avicennia marina extract (50–200 µg/mL) was tested to ensure measurable biological responses. Each group was maintained in separate tanks with the respective extract concentration.

% Mortality = No. of deaths – No. of control deaths

No. fish x 100%

## Result and discussion

Mangrove plants possess biologically active compounds with significant medicinal value. However, the distribution of phytochemicals varies among different plant parts, such as leaves, stems, and roots. In this study, phytochemical screening was conducted using an ethanol extract of *Avicennia marina*. The analysis confirmed the presence of various bioactive compounds in the mangrove leaf extract, including saponins, tannins, steroids, flavonoids, terpenoids, alkaloids, and phenolic compounds (Table .1).

**Table 1.** Phytochemical screening of *Avicennia marina* mangrove extract

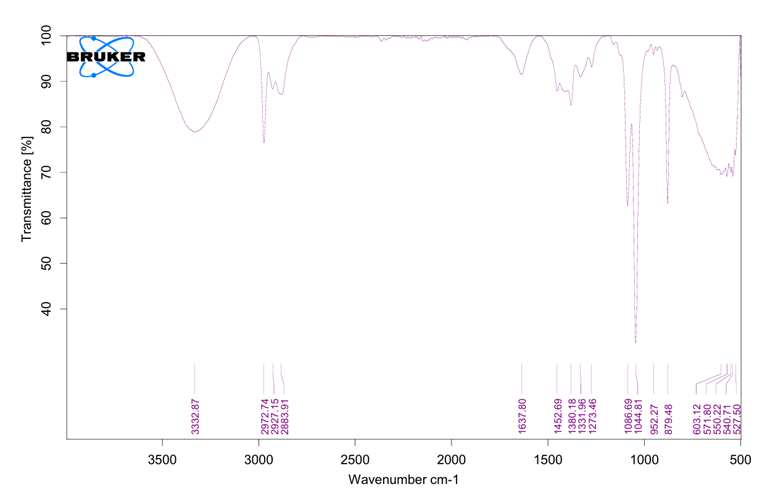
|  |  |  |
| --- | --- | --- |
| **S.no** | **TEST** | **RESULTS** |
| 1 | Saponins | + |
| 2 | Tannins | + |
| 3 | Steroids | + |
| 4 | Flavonoids | + |
| 5 | Terpenoids | + |
| 6 | Alkaloids | + |
| 7 | Phenolic compounds | + |

The antibacterial efficacy of *Avicennia marina* crude extract against *Streptococcus mutans* was measured using the disc diffusion assay. The results indicated a concentration-dependent inhibitory effect, with the 50 µg/mL extract showing a moderate zone of inhibition, while the 100 µg/mL extract exhibited a more pronounced antibacterial activity. The highest concentration (150 µg/mL) demonstrated the most significant inhibition zone, suggesting enhanced bacterial susceptibility at increased extract concentrations (Fig. 2).



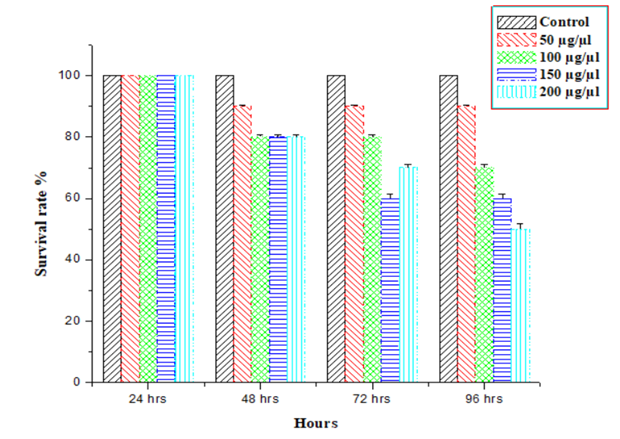
**Figure 2.** Antibacterial activity using *Avicennia marina* mangrove extract

The FTIR analysis of *Avicennia marina* crude extract identified key functional groups, indicating its diverse phytochemical composition. The absorption peak at 3328 cm⁻¹ corresponds to N-H stretching of aliphatic primary amines, while strong broad peaks at 2927 cm⁻¹ and 2853 cm⁻¹ indicate N-H stretching of amine salts. A strong band at 1637 cm⁻¹ represents C=C stretching of monosubstituted alkenes, suggesting the presence of unsaturated compounds (Fig.4). Peaks in the range of 1452–1046 cm⁻¹ are attributed to C-F stretching, indicating fluoro compounds.



**Figure 3.** FTIR analysis crude extract of *Avicennia marina*

These results confirm the presence of multiple functional groups, highlighting the complex biochemical nature of *A. marina* crude extract and its potential biological. Fish survival rates varied with different concentrations of *Avicennia marina* crude extract, showing a time- and dose-dependent decline. The control group exhibited 100% survival throughout the study (Fig. 4). At 50 µg/µL, survival remained above 80% even after 96 hours. However, higher concentrations (100, 150, and 200 µg/µL) led to a progressive decrease in survival, with the lowest rate observed at 200 µg/µL, indicating potential toxicity at elevated doses. Need for optimized concentrations to balance biological activity and safety.



**Figure 4:** Survival rates of platy fish larvae exposed to marine plant extracts to the control group

# Discussion

*Avicennia marina* seeds contain coumarins, glycosides, flavonoids, saponins, tannins, and carbohydrates, with minimal sugar content [(Khattaba and Temraz 2017)](https://paperpile.com/c/aNXQxg/vPjNp) . The presence of various bioactive compounds in *Rhizophora apiculata* leaf extract, including saponins, tannins, and terpenoids, as reported [(Syawal, Hakim, and Effendi, n.d.)](https://paperpile.com/c/aNXQxg/ytJM) . Earlier studies of Avicennia *marina* leaf extracts contain diverse bioactive compounds, highlighting their pharmacological potential and environmental influence [(Mitra, Naskar, and Chaudhuri 2021)](https://paperpile.com/c/aNXQxg/holZy) . *Avicennia corniculatum* leaf ethanol extract revealed a diverse range of bioactive compounds indicating its potential pharmacological significance (Debnath et al.2020) .Previous studies of the ethanolic extract of *Avicennia marina* leaves at concentrations of 2.5–10% effectively inhibited *Streptococcus mutans* [(Dharmautama et al. 2017)](https://paperpile.com/c/aNXQxg/jnj5). *Avicennia marina* exhibited broad-spectrum antimicrobial activity, with inhibition zones expanding as extract concentration increased, indicating a dose-dependent effect [(Sravya et al. 2025)](https://paperpile.com/c/aNXQxg/ANxYE) . The extract of *Cystoseira compressa* exhibited greater antibacterial activity against *E. coli*, forming a 14 mm inhibition zone, while *Padina pavonica* showed a smaller inhibition zone of 12 mm [(Čagalj et al. 2022)](https://paperpile.com/c/aNXQxg/qidHw) .Similarly, the absorption peaks at 2825–2855 cm⁻¹ correspond to C-H stretching, in *Excoecaria agallocha* leaf extract [(Raghavanpillai Sabu et al. 2022)](https://paperpile.com/c/aNXQxg/NoSp0). The FTIR spectrum identified key functional groups, including aromatics, alkanes, and carboxylic acids [(Kannappan et al. 2021)](https://paperpile.com/c/aNXQxg/B3bmO) . The ethanol leaf extract displayed characteristic absorption bands ranging from 721 to 3516 cm⁻¹, indicating the presence of carbon and hydrogen bond functional groups [(Das, and Tah 2022)](https://paperpile.com/c/aNXQxg/A5bWC) .The *Rhizophora mucronata* extract effectively cured *Vibrio harveyi* infection, increasing the survival rate of Nile Tilapia to 76.66% [(Mulyani et al. 2020; Protim et al. 2024)](https://paperpile.com/c/aNXQxg/rKDtU+TUS2). Dietary supplementation with *O. vulgare* significantly improved the survival rate compared to the control interval days post-infection with *A. hydrophila* [(Rashidian et al. 2021)](https://paperpile.com/c/aNXQxg/ATD1Y). The inclusion of red spinach leaf extract in feed at varying concentrations showed no significant impact on the survival rate of sword platy fish, with higher concentrations maintaining average survival [(Perdana, Maulida, and Indriani 2024)](https://paperpile.com/c/aNXQxg/DwWnE)

# Conclusion

*Avicennia marina*, a key mangrove species, exhibits significant ecological and pharmacological properties. This study examines its bioactive composition, antimicrobial potential, and toxicity using *Xiphophorus maculatus* as a model. Ethanol-based extracts revealed flavonoids, tannins, saponins, alkaloids, and terpenoids. Antibacterial assays against *Streptococcus mutans* showed concentration-dependent inhibition, while FTIR analysis confirmed diverse functional groups. Toxicity assessments indicated a dose-dependent decline in survival, with 200 µg/mL causing the highest mortality. These findings underscore its therapeutic potential and ecological applications, highlighting the need for optimized dosing to balance efficacy and safety.

# References

1. Almatrafi, T. A., Almohaimeed, H. M., Chakravarthi, S., Amin, A. H., Jafer, A., & Akhavan-Sigari, R. (2024). Reducing metastasis ability of gastric cancer cell line by targeting MMP16 using miR-193a-5p and 5-FU. Advances in Medical Sciences, 69(2), 463-473.
2. [Čagalj, Martina, Danijela Skroza, María Del Carmen Razola-Díaz, Vito Verardo, Daniela Bassi, Roberta Frleta, Ivana Generalić Mekinić, Giulia Tabanelli, and Vida Šimat. 2022. “Variations in the Composition, Antioxidant and Antimicrobial Activities of Cystoseira Compressa during Seasonal Growth.” *Marine Drugs* 20 (1): 64.](http://paperpile.com/b/aNXQxg/qidHw)
3. [Cinco-Castro, Siuling, Jorge Herrera-Silveira, and Francisco Comín. 2022. “Sedimentation as a Support Ecosystem Service in Different Ecological Types of Mangroves.” *Frontiers in Forests and Global Change* 5 (May). https://doi.org/](http://paperpile.com/b/aNXQxg/RZxIR)[10.3389/ffgc.2022.733820](http://dx.doi.org/10.3389/ffgc.2022.733820)[.](http://paperpile.com/b/aNXQxg/RZxIR)
4. [Das, Sudhir Chandra, Shreya Das, and Jagatpati Tah. 2022. “Mangrove Ecosystems and Their Services.” In *Mangroves: Biodiversity, Livelihoods and Conservation*, 139–52. Singapore: Springer Nature Singapore.](http://paperpile.com/b/aNXQxg/A5bWC)
5. [Dharmautama, Mohammad, Richard Tetelepta, Muhammad Ikbal, and Andi E. A. Warti. 2017. “Effect of Mangrove Leaves Extract (avicennia Marina) Concentration to Streptococcus Mutans and Candida Albicans Growth.” *Journal of Dentomaxillofacial Science* 2 (3): 155.](http://paperpile.com/b/aNXQxg/jnj5)
6. [Getzner, Michael, and Muhammad Shariful Islam. 2020. “Ecosystem Services of Mangrove Forests: Results of a Meta-Analysis of Economic Values.” *International Journal of Environmental Research and Public Health* 17 (16): 5830.](http://paperpile.com/b/aNXQxg/dySak)
7. [Huang, Cheng, Chung-Kuang Lu, Ming-Chin Tu, Jia-Hua Chang, Yen-Ju Chen, Yu-Hsuan Tu, and Hsiu-Chen Huang. 2016. “Polyphenol-Rich Avicennia Marina Leaf Extracts Induce Apoptosis in Human Breast and Liver Cancer Cells and in a Nude Mouse Xenograft Model.” *Oncotarget* 7 (24): 35874–93.](http://paperpile.com/b/aNXQxg/rzWxg)
8. [Kannappan, Sudalayandi, Krishnamoorthy Sivakumar, Karingalakkandy P. Jithendran, Balasubramaniam Sivamani, and Peter E. Praveena. 2021. “Effect of Asiatic Mangrove Plant (Rhizophora Mucronata) Extract on the Growth and Virulence of Vibrio Harveyi Causing Bioluminescence Disease in Penaeus Monodon Larviculture.” *Revista de Investigacion Agraria [Spanish Journal of Agricultural Research]* 19 (3): e0506.](http://paperpile.com/b/aNXQxg/B3bmO)
9. [Khattaba, Rafat, and Tarek Temraz. 2017. “Mangrove Avicennia Marina of Yanbu, Saudi Arabia: GC-MS Constituents and Mosquito Repellent Activities.” *Egyptian Journal of Aquatic Biology and Fisheries* 21 (3): 45–54.](http://paperpile.com/b/aNXQxg/vPjNp)
10. [Li, Huan, Zan Li, Zhi-Jun Shen, Mei-Rong Luo, Yi-Ling Liu, Ming-Yue Wei, Wen-Hua Wang, et al. 2020. “Physiological and Proteomic Responses of Mangrove Plant Avicennia Marina Seedlings to Simulated Periodical Inundation.” *Plant and Soil* 450 (1-2): 231–54.](http://paperpile.com/b/aNXQxg/HvXKG)
11. [Mitra, Sayantani, Nabanita Naskar, and Punarbasu Chaudhuri. 2021. “A Review on Potential Bioactive Phytochemicals for Novel Therapeutic Applications with Special Emphasis on Mangrove Species.” *Phytomedicine plus: International Journal of Phytotherapy and Phytopharmacology* 1 (4): 100107.](http://paperpile.com/b/aNXQxg/holZy)
12. [Mulyani, Yeni, Kiki Haetami, Lesta Krismawati Baeha, Sulastri Arsad, and Fiddy Semba Prasetiya. 2020. “In Vivo Test of Rhizophora Mucronata Mangrove Extract From Pangandaran Coast Towards Nile Tilapia Oreochromis Niloticus Infected by Vibrio Harveyi.” *Journal of Aquaculture and Fish Health* 9 (2): 131.](http://paperpile.com/b/aNXQxg/rKDtU)
13. [Nizam, Ashifa, Abdul Rawoof, Vivek Adot, Chithra Madhavan, Nirala Ramchiary, and Ajay Kumar. 2024. “Comparative Root Transcriptome Analysis of Kandelia Candel Druce and Rhizophora Mucronata Lam. Germinating Propagules under Salinity Gradients Reveal Their Tolerance Mechanisms and Ecological Adaptations.” *Plant Growth Regulation* 103 (3): 539–63.](http://paperpile.com/b/aNXQxg/r5Q3t)
14. [Perdana, Adli Waliul, Siti Maulida, and Rika Indriani. 2024. “Effect of Addition of Red Spinach Leaf Extract (*Amaranthus tricolor*L.) in Feed against the Level of Color Brightness of Sword Platy Fish (*Xiphophorus Helleri*).” *BIO Web of Conferences* 87:03012.](http://paperpile.com/b/aNXQxg/DwWnE)
15. [Permatasari, Lina, Handa Muliasari, and Fania Rahman. 2024. “Characterization of Isolated Crystals from Mangrove Leaves (Avicennia Marina and Sonneratia Alba) and Their Antibacterial Activity against Staphylococcus Aureus.” *International Journal of Applied Pharmaceutics*, October, 77–82.](http://paperpile.com/b/aNXQxg/QhB2)
16. [Protim, M., Klg Afeeza, S. Vasugi, and E. Dilipan. 2024. “Computational Analysis of a Marine-Derived Drug from Rhizophora Mucronata against the Capsid Protein of Rubella Virus.” *Cureus* 16 (8): e67352.](http://paperpile.com/b/aNXQxg/TUS2)
17. [Raghavanpillai Sabu, Kuzhunellil, Sujith Sugathan, Akbar Idhayadhulla, Melat Woldemariam, Addis Aklilu, Gelila Biresaw, Behailu Tsegaye, and Aseer Manilal. 2022. “Antibacterial, Antifungal, and Cytotoxic Activity of Excoecaria Agallocha Leaf Extract.” *Journal of Experimental Pharmacology* 14 (January):17–26.](http://paperpile.com/b/aNXQxg/NoSp0)
18. [Ramasubburayan, Ramasamy, Santhiyagu Prakash, Sivaperumal Pitchiah, and Ganapathy Dhanraj. 2024. “Antifouling Activity and Biodegradable Potential of the Bioactive Metabolites Isolated from Mangrove Avicennia Officinalis L.” *Natural Product Research* 38 (10): 1680–86.](http://paperpile.com/b/aNXQxg/pxyT)
19. [Rashidian, Ghasem, Javad Tahmasebi Boldaji, Simona Rainis, Marko D. Prokić, and Caterina Faggio. 2021. “Oregano (Origanum Vulgare) Extract Enhances Zebrafish (Danio Rerio) Growth Performance, Serum and Mucus Innate Immune Responses and Resistance against Aeromonas Hydrophila Challenge.” *Animals: An Open Access Journal from MDPI* 11 (2): 299.](http://paperpile.com/b/aNXQxg/ATD1Y)
20. [Ravindran Nt, and Mohamed Sadiq A. 2019. “Pharmacological Activity of Ulva Lactuca Polyphenols Fraction: Hepatoprotective and Antioxidant Activities against Paracetamol-Induced Liver Damage in Rats.” *Asian Journal of Pharmaceutical and Clinical Research*, February, 55–58.](http://paperpile.com/b/aNXQxg/JcCHk)
21. Saadh, M. J., Rasulova, I., Khalil, M., Farahim, F., Sârbu, I., Ciongradi, C. I. (2024). Natural killer cell-mediated immune surveillance in cancer: Role of tumor microenvironment. Pathology-Research and Practice, 254, 155120.
22. [Sarkar, Piyali, Saon Banerjee, Saroni Biswas, Sarathi Saha, Dolgobinda Pal, Manish Kumar Naskar, Sanjeev K. Srivastava, Dhananjay Barman, Gouranga Kar, and Sharif A. Mukul. 2024. “Contribution of Mangrove Ecosystem Services to Local Livelihoods in the Indian Sundarbans.” *Sustainability* 16 (16): 6804.](http://paperpile.com/b/aNXQxg/dPhzU)
23. [Schartl, Manfred, and Yuan Lu. 2024. “Validity of Xiphophorus Fish as Models for Human Disease.” *Disease Models & Mechanisms* 17 (1). https://doi.org/](http://paperpile.com/b/aNXQxg/OQiHN)[10.1242/dmm.050382](http://dx.doi.org/10.1242/dmm.050382)[.](http://paperpile.com/b/aNXQxg/OQiHN)
24. [Sravya, M. V. N., T. Rahul Sandeep, G. Beulah, N. S. Sampath Kumar, and G. Simhachalam. 2025. “Biopotency of Avicennia Marina Leaf Extracts against Pathogenic Bacteria in Carp Culture.” *AMB Express* 15 (1): 2.](http://paperpile.com/b/aNXQxg/ANxYE)
25. [Sumartini, Sumartini, Putri Wening Ratrinia, and Rekha Andini. 2021. “](http://paperpile.com/b/aNXQxg/9dzW9)Pengaruh penambahan maserat daun mangroave (avicennia marina) sebagai antibaakteri pada ikan layang benggol (decapterus russelli) selama penyimpanan.” *Aurelia journal* 2 (2): 171.
26. [Syawal, Henni, Luqman Hakim, and Irwan Effendi. n.d. “Phytochemical Analysis of Rhizophora Apiculata Leaf Extract and Its Inhibitory Action against Staphylococcus Aureus, Aeromonas Hydrophila and Pseudomonas Aeruginosa.” Accessed April 8, 2025.](http://paperpile.com/b/aNXQxg/ytJM) <http://www.bioflux.com.ro/docs/2020.2242-2249.pdf>[.](http://paperpile.com/b/aNXQxg/ytJM)
27. [Uche, Fidelia Ijeoma, Dickson Onuchukwu, Chidozie N. E. Ibezim, and Hanson Ige Ogbu. 2019. “Methanolic Extract of Caladium Bicolor Leaves against Selected Clinical Isolates.” *GSC Biological and Pharmaceutical Sciences* 6 (2): 098–107.](http://paperpile.com/b/aNXQxg/VQbb0)