JPPIPA 11(2) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Phytochemical Analysis, Physical Properties, and Chemical Compound Content White Teak Wood (*Gmelina Arborea Roxb*)

Ariyanti[1*], Mutmainnah[1], Asniati[1]

[1] Forestry Study Program, Faculty of Forestry, Universitas Tadulako, Palu, Indonesia.

Received: October 22, 2024
Revised: December 07, 2024
Accepted: February 25, 2025
Published: February 28, 2025

Corresponding Author:
Ariyanti
ariyantihamzari @gmail.com

DOI: 10.29303/jppipa.v11i2.9907

© 2025 The Authors. This open access article is distributed under a (CC-BY License)

Abstract: Indonesia is a country with a tropical climate. Rainfall in Indonesia is quite high and greatly affects the growth of mushrooms (fungi). The use of wood cannot be separated from the manufacture of traditional houses. These traditional houses made of wood are very susceptible to fungal attacks. Wood or wood rot fungi are fungi that live attached to decaying trees, but some types of wood fungi grow on living tree trunks and on dead trees. Wood rot fungi are heterotrophic, or do not produce their own food, This study aims to determine the resistance of white teak wood (*Gmelina arborea Roxb*) against wood-decay fungi. The research method used was a completely randomized factorial design consisting of two factors: factor I (wood) and factor II (fungi). The test samples used for the combination of the two factors measured 5x 2.50x1.50 cm, with a total of 9 test samples placed in culture jars separately. All samples from the base, middle, and tip tests were placed into a jar containing PSA media, and the inoculated mushroom culture was added to the jar. The observed parameters used an analysis of variance to determine whether the treatment had a significant effect on the decrease in teak wood weight. The Least Significant Difference (LSD) test was carried out to determine whether there were significant differences between treatments or not.

Keywords: Fitokimia; Schizophyllum commune; White teak wood; Wood fung

Introduction

Indonesia is a tropical country, referred to as a tropical country because of its geographical location, Indonesia is located on the equator and is crossed by 2 seasons, the dry season and the rainy season. The rainy season in Indonesia occurs for about 6 months each year, resulting in quite high rainfall each year. Rainfall in Indonesia has a high average, ranging from 2000-3000 mm per year. This high rainfall greatly affects the growth of both plants and fungi. Fungi are eukaryotic organisms that are multicellular or have many cells (Khadem et al., 2024; Roth et al., 2023). Fitriani et al. (2018) stated that fungi usually grow in shady environmental conditions and high humidity levels, wind currents, and lighting (Schumacher, 2017; Ding et al., 2022). Several other factors are the need for indirect sunlight, in these conditions, fungi can grow quickly, cool temperatures and air circulation, and lowland environmental conditions are very suitable for fungal life. The number of fungal diversitis in the world is estimated to reach 1.5 million species (Hyde, 2022; Gautam et al., 2022). Among the diversity of fungi, one type of fungus is wood rot or wood decay fungi.

Wood or wood rot fungi are fungi that live attached to decaying trees, but some types of wood fungi grow on living tree trunks and on dead trees. Wood rot fungi are heterotrophic, or do not produce their own food, therefore, wood fungi require a host to obtain their food (lignin, hemicellulose, and cellulose) as an energy source (Singh et al., 2022; Qi et al., 2023). Wood that has a low durability class is easily damaged and rots if used or

How to Cite:
Ariyanti, Mutmainnah, & Asniati. (2025). Phytochemical Analysis, Physical Properties, and Chemical Compound Content White Teak Wood (Gmelina Arborea Roxb). *Jurnal Penelitian Pendidikan IPA*, *11*(2), 57–63. https://doi.org/10.29303/jppipa.v11i2.9907

installed in an open place without shade, especially if it is in contact with damp soil because basically, wood is not resistant to changes in temperature, air, humidity, and water (Martín et al., 2023; Hill et al., 2022). Wood that has a high strength class is meaningless if its durability class is low because its service life will be short (low). Therefore, the resistance of wood to fungi is one of the important properties of wood. Wood resistance is the resistance of a type of wood to destructive organisms, including rotting fungi (Goodell et al., 2020; Ariyanti et al., 2024).

The use of wood is inseparable from the construction of traditional houses. Wood resistance to fungal attack is one of the important parameters in wood processing (Brischke et al., 2020; Aleinikovas et al., 2021). Due to the lack of information on the natural resistance of wood, in its use, low-quality and high-quality wood is often mixed for various purposes, especially for the wood, carpentry, housing, and building industries. In such conditions, if housing is damaged and needs repair, then the good housing wood is also dismantled along with the damaged wood that will be replaced, so that the use of wood becomes inefficient, which means a waste of natural resources. Damage to building wood by rotting fungi in several public housing projects can reach 67.10%. The increasing scarcity and cost of old wood or large-diameter wood from natural forests has increased the need for wood, so the role and contribution of teak wood will be increasingly important in meeting various needs (Pachas et al., 2019; Chayaporn et al., 2021).

Wood that has a high strength and durability class is considered to be durable in making furniture, both in meeting primary and secondary needs made of wood such as teak wood (*Gmelina arborea* Linn.f.) (Olaniran et al., 2022). Teak wood is considered suitable for testing whether it is resistant to wood rot fungi or not (Martha et al., 2024). The losses due to fungal attacks are very large every year, but there are still few studies or publications to find out how much loss occurs due to fungal attacks (Janbon et al., 2019; Bongomin et al., 2017). The formulation of the problem in this study is how is the resistance of teak wood (*Gmelina arborea* Linn.f) to wood rot fungi attacks based on the position on the trunk (*Schizophyllum commune*, *Pycnoporus sanguineus*, and Dacryopinax spathularia) after being tested for 3 months or 12 weeks in a jar (flask) containing fungal cultures? This study aimed to determine the resistance of teak wood (*Gmelina arborea* Linn.f.) to attacks by wood rot fungi based on the position of the trunk.

Method

Time and Place

This research was conducted in August - November 2024. Wood sampling was carried out in the Community Forest, Watatu Village, South Banawa District, Donggala Regency, Central Sulawesi Province, and wood durability testing was carried out in the Soil Science Laboratory, Faculty of Agriculture, Tadulako University.

Tools and Materials

The tools used in this study were a Chain Saw, meter, analytical balance, 40 mesh sieve, test tube, measuring cup (beaker glass), measuring cup spatula, stirring rod, Buchner filter, Erlenmeyer, vacuum rotary evaporator, spoon, Buchner funnel, dropper pipette, petri dish, glass bottle, aluminum foil, Bunsen spiritus, camera, oven, desiccator, and stationery. The materials used in this study were white teak wood sample test samples, 96% ethanol solvent, Dragendorf reagent, HCl, chloroform, H2So4, FeCl3, distilled water, Mg powder reducer, and filter paper.

Research Method

This study uses a completely randomized design method according to Mattjik et al. (2006).

$$Yijk = \mu + \lambda i + Bj\ (\lambda b)ij + \Sigma ijk \quad (1)$$

So, it is repeated 3 times so that there are 3 x 3 = 9 wood samples.

Research Procedure

The research procedure in this study is divided into several stages, namely:

Preparation of Wood Test Samples

The selected white teak tree (*Gmelina arborea Roxb*.) is 15 years old with a circumference of 71 cm, a height of 16 meters, and a diameter of 22.6 cm, cut down. The test samples, each of which has 3 repetitions with a total of 9 samples with a size of 5.0 cm x 2.5 cm x 1.5 cm. The physical test sample for testing water content and specific gravity with a size of 2 cm x 2 cm x 2 cm is based on (DIN 51283-77).

Testing of Wood Physical Properties

Water Content

Measurement of the water content of test samples using the gravimetric method, namely the test sample is weighed according to its initial weight (BA), then put into an oven at a temperature of (103)° C until its weight is constant (BKT). The water content value is calculated using the equation: (SNI-ISO-9427-2008).

$$KA\ (\%) = \frac{BB - BKT}{BKT}\ X\ 100 \quad (2)$$

$$KAKU\ (\%) = \frac{BB - BKT}{BKT}\ X\ 100 \quad (3)$$

Density

Density is the mass or weight of wood per unit volume of wood. Density is an important factor in determining the physical and mechanical properties of wood. The density value of wood is calculated using the following formula:

$$\mathbf{R} = BKT/V \quad (4)$$

Phytochemical Analysis

Identification of Chemical Compounds by GC-MS Method

White teak wood powder, carbonization process was carried out at a temperature of 400-4500 C. Lignocellulose biomass was analyzed using Gas Chromatography-Mass Spectrometry (GC-MS). This analysis was carried out at Pustarhut. The conditions for testing wood resistance to fungi must be made moist by first providing fungal cultures in sterile vessels. Non-sterile conditions will disrupt fungal growth so that it cannot cause normal attack power on wood. The test method uses PSA Media (Potatoes, Sucrose, Agar), the composition contained in PSA is potato juice, sucrose (sugar), and agar powder. PSA media can be made by mixing according to its composition, namely with potatoes, sucrose (sugar), and agar powder.

Schizophyllum commune fungus first made a pure culture to produce fungal hyphae before testing in a jar. Pure culture is made by mixing 50 grams of potatoes, 30 grams of sugar, and 7.5 grams of agar in 0.5 liters of distilled water for 3 petri dishes of each fungus. The test fungus is made separately so that there are 9 petri dishes from each fungal culture. The culture that has been made is then covered and isolated, then left for 4-5 days until the hyphae grow and spread. The hyphae that grow are then inoculated into the test jar. Media for testing is heated to boiling or until the mixture becomes ½ part. After boiling, the press is cooled and about 40 ml of the mixture is put into the test erlenmeyer, then covered and sterilized in an autoclave for 2 hours. After sterilization, the erlenmeyer is placed horizontally and ready to be put into the jar, test fungus is inoculated a few days later.

Testing of Test Samples

Sterile and weighted test samples are placed in test jars containing inoculated test fungus cultures. Contaminated fungal cultures must be replaced. Wood is placed in a culture jar containing S. commune wood rot fungus culture, for 3 months. The position of wood is placed in a culture jar (flask), where the culture jar is made separately based on different fungal cultures (SNI 01-7207-2006).

Observation and Calculation of Percentage of Weight Loss

After the feeding period is complete, the test sample is removed from the test bottle and cleaned of the mycelium attached to it, then dried in an oven. After the test sample is dried in the oven, it is then stored in a desiccator and weighed to determine its dry furnace weight. The magnitude of the rot fungus attack is obtained by calculating the percentage of weight loss, namely:

$$P = \frac{W1 - W2}{W1} \text{ x } 100\% \quad (5)$$

The calculation of the percentage of weight loss is carried out after the wood sample is dried in the oven until it reaches a constant weight and then weighed to obtain the final weight. The class of wood resistance to wood rot fungi can be seen in Table 1.

Table 1. Class of Wood Resistance to Fungus

Class	Durability	Decrease (%)
I	Very Durable	< 1
II	Durable	1-5
III	Somewhat Durable	5-10
IV	Not Durable	10-30
V	Very Durable	> 30

Source: SNI 01-7207-2006

Result and Discussion

Phytochemical Test Results

Table 2. The Results of the Phytochemical Test Analysis

Parameter	Jati Putih
Flavonoids	+
Saponins	-
Polyphenols and Tannins	+
Alkaloids	-
Steroids	-
Terpenoids	+
Carotenoids	+

Average Value of Air-Dry Moisture Content

The average value of dry air moisture content can be seen in Figure 2.

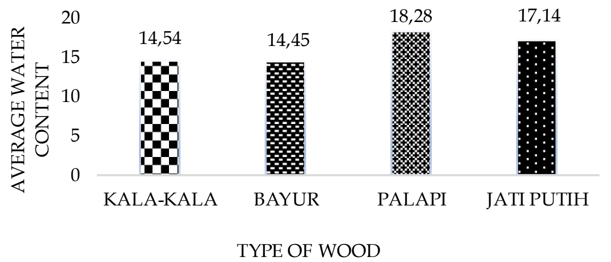

Figure 1. Dry air moisture content

White teak wood has an air-dry water content of 17.14% and has an average range.

Density

The density of white teak wood is 0.48 g/cm3, which is in the same range as Wibowo's research (2013), which is 0.72 g/cm^3. It is classified into strength class (KK) III, which has a density range between 0.62 and 0.75 g/cm^3.

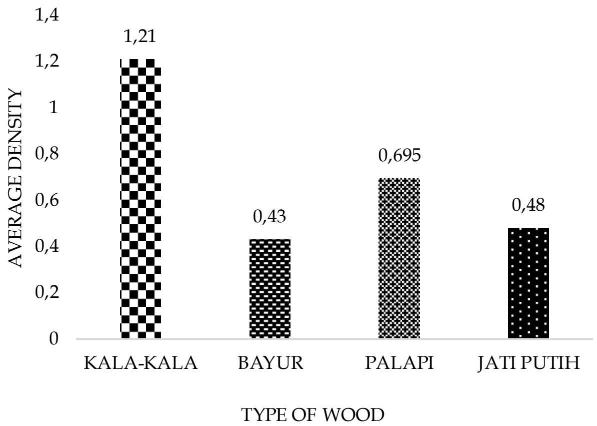

Figure 2. Density

GCMS Analysis of White Teak Wood

The results of the GCMS analysis of White Teak can be seen in Table 3. The average value water content of kala kala wood is 14.54%, the water content of bayur wood is 14.45%, the water content of palapi wood is 18.28%, and the water content of white teak wood is 17.14%; The average value of wood density: kalakala 1.21 g/cm^3, bayur 0.43 g/cm^3, palapi 0.69 g/cm^3 and white teak is 0.48 g/cm^3; The results of the phytochemical test analysis revealed that flavonoids, polyphenols, tannins, terpenoids, and carotenoids were present in wood from kalakala, palapi, bayur, and white teak in positive amounts. While saponins, alkaloids, steroids, gave negative results in kalakala, palapi, bayur and white teak wood; The chemical compounds found in white teak are 2-Propanol, 1-amino- (CAS) 1-Amino-2-propanol with a concentration of 14.64%, o-nitrobenzyl alcohol-.alpha.-d1 6.68% and Cyclohexanone, 5- methyl-2-(1-methylethyl)-, cis- (CAS) Isomenthone 6.12%.

The phytochemical analysis of White Teak Wood (*Gmelina arborea Roxb*) shows that it has a wide range of bioactive chemicals and interesting physical features. Researchers have thoroughly examined this tree, known for its therapeutic use, for its phytochemical components, which include flavonoids, alkaloids, tannins, and terpenoids. The subsequent sections elucidate the principal findings from the literature. The principal compounds of Gmelina arborea's phytochemical composition include flavonoids, alkaloids, tannins, and phenolic compounds, all of which contribute to its therapeutic properties (Idowu et al., 2024; Akhtar et al., 2018). The extracts demonstrate significant antioxidant activity, akin to ascorbic acid, suggesting possible health advantages (Shahidi & Zhong, 2015; Ravetti et al., 2019). The total ash value and acid-insoluble ash are essential for evaluating wood quality (Dhawle et al., 2021; Jerez-Timaure et al., 2021). The moisture content is crucial for assessing the wood's durability and applicability in several uses (Barański et al., 2021;(Rahman et al., 2024). Traditional medicinal applications of wood include its anti-inflammatory and antibacterial properties (Net-anong et al., 2023; Dechayont et al., 2020). Pharmacological Activities: Gmelina arborea is associated with multiple pharmacological actions, including antidiabetic and cardioprotective properties (Warrier et al., 2021; Wasana et al., 2021).

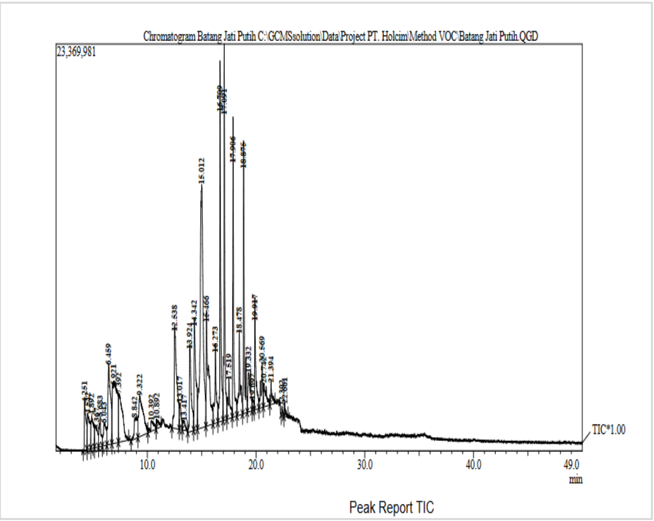

Figure 3. GCMS analysis of white teak wood

Researchers have discovered compounds like apigenin and luteolin derivatives, which are known for their antibacterial activities (Irinmwinuwa et al., 2023). These chemicals, found in both heartwood and sapwood, enhance the wood's longevity and pest resistance (Rosamah et al., 2020). These chemicals, identified via phytochemical screening, are associated with numerous health advantages (Hassan et al., 2020; Rodríguez-Negrete et al., 2024). Recognizes the potential therapeutic properties of protocatechuic acid and quinic acid derivatives. The lignin content fluctuates with the wood's age, affecting its mechanical qualities and decay resistance (Zhou et al., 2024; Gao et al., 2024). The presence of acetic acid and levoglucosan in wood increases its use in industries like perfumes and medicines (Mora et al., 2022; Almeida et al., 2024).

Table 3. Results of the GCMS Analysis of White Teak

Observation Time (Minutes)	Name	Concentration (%)
4.25	2-Benzyloxythylamine	1.73
4.54	Ethanol (CAS) Ethyl alcoho	1.90
4.89	6-(4-methylcarbonylbenzoate) 1,2-bis(pyrrole-2-carboxylate)-4,3-diacetate	1.57
5.36	RUTHENIUMDICHLORID, TETRAKIS(TRIMETHYLPHOSPHIT)	1.25
5.68	Methanamine, N-methyl- (CAS) Dimethylamine	1.05
6.04	Oxiranemethanol (CAS) Glycidol	1.33
6.45	2,2-DIDEUTEROPROPANE	4.18
6.92	Acetaldehyde (CAS) Ethanal	6.09
7.39	11,18-Diacetoxy-5,6,12,17-trinaphthylenetetrone	3.78
8.84	Carbamic acid, methyl ester (CAS) Methyl carbamate	1.40
9.32	1-DEUTEROBUTANE	3.62
10.39	NOREPINEPHRINE-PENTATMS	0.66
10.89	4-HYDROXYMETHYL-1,3-DIOXOLANE	0.39
12.53	1,4-Butanediamine (CAS) Putrescine	5.18
13.01	ZINC(II) BIS(N,N-DIPENTYLDITHIOCARBAMATE)	0.90
13.41	rac-Oxirane-2-carbonitrile	0.47
13.92	Thiophene, tetrahydrodimethyl-, 1,1-dioxide (CAS) DIMETHYL SULFOLANE	3.29
14.34	2-methyl-2-cyclohexenone	3.88
15.01	2-Propanol, 1-amino- (CAS) 1-Amino-2-propanol	14.64
15.46	Ethanone, 1-(4-methyl-1H-imidazol-2-yl)- (CAS) 2-ACETYL-5-METHYL-IMIDAZ	5.21
16.27	2,5-DIMETHYL-3-METHOXYPYRAZINE	2.45
16.70	O-NITROBENZYL ALCOHOL-.ALPHA.-D1	6.58
17.09	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, cis- (CAS) Isomenthone	6.12
17.51	Allyloxydicyclopentadiene	1.52
17.90	1,7-Octadiyne (CAS) OCTA-1,7-DIYNE	4.99
18.47	5-ALLYL-4-HYDROXY-2-MERCAPTO-6-METHYLPYRIMIDINE	2.56
18.87	3-Methylamino-2-nitropyridine	4.61
19.33	1,2,3,4-TETRAHYDROXYBUTANE	2.08
19.69	N-(GLYCYL)ALANINE	0.35
19.91	3-METHYL-4-NITRO-5-(1-PYRAZOLYL)PYRAZOLE	2.55
20.56	Benzenemethanol, 4-hydroxy-.alpha.-[(methylamino)methyl]- (CAS) 1-PARA-H	1.45
20.74	Benzene, 1,2-dimethoxy-4-nitro- (CAS) 3,4-Dimethoxynitrobenzene	1.22
21.39	1-Butanamine, N-methyl-N-nitroso- (CAS) Butylmethylnitrosamine	0.60
22.39	Benzenamine, 4-methyl-3-nitro- (CAS) 3-Nitro-p-toluidine	0.15
22.66	1,3,5-triazine-2,4,6(1H,3H,5H)-trione (CAS) s-Triazine-2,4,6(1H,3H,5H)-trione	0.25

Conclusion

The phytochemical examination of White Teak Wood (*Tectona grandis*) uncovers numerous bioactive components that enhance its medicinal and industrial value. Key ingredients found include flavonoids, tannins, alkaloids, and phenolic compounds, which are linked to a variety of medical effects and the ability to resist biodegradation. The subsequent sections elucidate these chemicals and their ramifications.

Acknowledgments
Thanks to all parties who have supported the implementation of this research. I hope this research can be useful.

Author Contributions
Conceptualization; A.; methodology.; M.; validation; A.; formal analysis; A.; investigation.; M.; resources; A.; data curation: A.; writing—original draft preparation. M.; writing—review and editing: A.; visualization: M. All authors have read and agreed to the published version of the manuscript.

Funding
Researchers independently funded this research.

Conflicts of Interest
The authors declare no conflict of interest.

References

Akhtar, N., Ihsan-ul-Haq, & Mirza, B. (2018). Phytochemical analysis and comprehensive evaluation of antimicrobial and antioxidant properties of 61 medicinal plant species. *Arabian Journal of Chemistry*, *11*(8), 1223–1235. https://doi.org/10.1016/j.arabjc.2015.01.013

Aleinikovas, M., Varnagirytė-Kabašinskienė, I., Povilaitienė, A., Šilinskas, B., Škėma, M., & Beniušienė, L. (2021). Resistance of Wood Treated with Iron Compounds against Wood-Destroying Decay and Mould Fungi. *Forests*, *12*(5), 645. https://doi.org/10.3390/f12050645

Almeida, M. C. P. D. S., Silva, J. E. D., Batista, W. G. D. S., Alves, J. L. F., Melo, D. M. D. A., Pimenta, A. S., & Braga, R. M. (2024). Valorization of Wood Residues from Vegetation Suppression during Wind Energy Plant Implementation and Its Potential for Renewable Phenolic Compounds through Flash Pyrolysis: A Case Study in Northeast Brazil's Semi-Arid Region. *Forests*, *15*(4), 621. https://doi.org/10.3390/f15040621

Ariyanti, A., Yusran, Y., Yusril, A., Erniwati, E., Hapid, A., Hamzari, H., Muthmainnah, M., & Rahmawati, R. (2024). Vertical Position-Based Resistance of Teak Wood (Tectona grandis Linn.f.) Against Wood-Decay Fungi. *International Journal of Design & Nature and Ecodynamics*, *19*(3), 753–759. https://doi.org/10.18280/ijdne.190305

Barański, J., Suchta, A., Barańska, S., Klement, I., Vilkovská, T., & Vilkovský, P. (2021). Wood Moisture-Content Measurement Accuracy of Impregnated and Nonimpregnated Wood. *Sensors*, *21*(21), 7033. https://doi.org/10.3390/s21217033

Bongomin, F., Gago, S., Oladele, R., & Denning, D. (2017). Global and Multi-National Prevalence of Fungal Diseases—Estimate Precision. *Journal of Fungi*, *3*(4), 57. https://doi.org/10.3390/jof3040057

Brischke, C., & Alfredsen, G. (2020). Wood-water relationships and their role for wood susceptibility to fungal decay. *Applied Microbiology and Biotechnology*, *104*(9), 3781–3795. https://doi.org/10.1007/s00253-020-10479-1

Chayaporn, P., Sasaki, N., Venkatappa, M., & Abe, I. (2021). Assessment of the overall carbon storage in a teak plantation in Kanchanaburi province, Thailand – Implications for carbon-based incentives. *Cleaner Environmental Systems*, *2*, 100023. https://doi.org/10.1016/j.cesys.2021.100023

Dechayont, B., Phuaklee, P., Chunthorng-Orn, J., Poomirat, S., Juckmeta, T., Phumlek, K., Mokmued, K., & Ouncharoen, K. (2020). Antimicrobial, Anti-inflammatory, and Antioxidant Activities of the Wood of *Myristica fragrans*. *Journal of Herbs, Spices & Medicinal Plants*, *26*(1), 49–60. https://doi.org/10.1080/10496475.2019.1676861

Dhawle, K., Dhuldhaj, U., & Mulani, R. (2021). Pharmacognostic studies and anatomical peculiarities in medicinal plant Enicostemma axillare. *Asian Journal of Ethnobiology*, *4*(1). https://doi.org/10.13057/asianjethnobiol/y040102

Ding, N., Liu, F., Ding, X., Yan, L., & Meng, X. (2022). Effect of Lighting Environment on the CO2 Concentration Reduction Efficiency of Plants by a Model Experiment. *Buildings*, *12*(11), 1848. https://doi.org/10.3390/buildings12111848

Gao, C., Cui, X., & Matsumura, J. (2024). Multidimensional Exploration of Wood Extractives: A Review of Compositional Analysis, Decay Resistance, Light Stability, and Staining Applications. *Forests*, *15*(10), 1782. https://doi.org/10.3390/f15101782

Gautam, A. K., Verma, R. K., Avasthi, S., Sushma, Bohra, Y., Devadatha, B., Niranjan, M., & Suwannarach, N. (2022). Current Insight into Traditional and Modern Methods in Fungal Diversity Estimates. *Journal of Fungi*, *8*(3), 226. https://doi.org/10.3390/jof8030226

Goodell, B., Winandy, J. E., & Morrell, J. J. (2020). Fungal Degradation of Wood: Emerging Data, New Insights and Changing Perceptions. *Coatings*, *10*(12), 1210. https://doi.org/10.3390/coatings10121210

Hassan, A., Akmal, Z., & Khan, N. (2020). The Phytochemical Screening and Antioxidants Potential of Schoenoplectus triqueter L. Palla. *Journal of Chemistry*, 1–8. https://doi.org/10.1155/2020/3865139

Hill, C., Kymäläinen, M., & Rautkari, L. (2022). Review of the use of solid wood as an external cladding material in the built environment. *Journal of Materials Science*, *57*(20), 9031–9076. https://doi.org/10.1007/s10853-022-07211-x

Hyde, K. D. (2022). The numbers of fungi. *Fungal Diversity*, *114*(1), 1–1. https://doi.org/10.1007/s13225-022-00507-y

Idowu, P. A., Ashiru, A. O., Idowu, D. O., Olaiya, C. O., & Karigidi, K. (2024). Phytochemical, antioxidant and antibacterial studies of extracts and chromatographic fractions of *Gmelina arborea* Roxb (Lamiaceae). *Journal of Pharmacy & Bioresources*, *21*(3), 144–155. https://doi.org/10.4314/jpb.v21i3.6

Irinmwinuwa, E. O., Cherechi, N. C., Oyate, G. B., Ifeyinwa, O. C., Chinedu, J. O., & John-Iganga, A. A. (2023). A comprehensive review of phytochemistry and antibacterial action of Tectona grandis. *International Journal of Science and Research Archive*, *9*(2), 133–143. https://doi.org/10.30574/ijsra.2023.9.2.0527

Janbon, G., Quintin, J., Lanternier, F., & d'Enfert, C. (2019). Studying fungal pathogens of humans and fungal infections: Fungal diversity and diversity of approaches. *Microbes and Infection*, *21*(5–6), 237–245. https://doi.org/10.1016/j.micinf.2019.06.011

Jerez-Timaure, N., Sánchez-Hidalgo, M., Pulido, R., & Mendoza, J. (2021). Effect of Dietary Brown Seaweed (Macrocystis pyrifera) Additive on Meat Quality and Nutrient Composition of Fattening Pigs. *Foods*, *10*(8), 1720. https://doi.org/10.3390/foods10081720

Khadem, S., Berry, D., & Al-khlifeh, E. (2024). Climate influences the gut eukaryome of wild rodents in the Great Rift Valley of Jordan. *Parasites & Vectors*, *17*(1), 358. https://doi.org/10.1186/s13071-024-06451-x

Martha, R., Candelier, K., Thévenon, M.-F., George, B., Rahayu, I. S., Darmawan, W., & Gérardin, P. (2024). Non biocide treatments for the protection of short rotation teak wood against subterranean termites. *Construction and Building Materials*, *450*, 138638. https://doi.org/10.1016/j.conbuildmat.2024.138638

Martín, J. A., & López, R. (2023). Biological Deterioration and Natural Durability of Wood in Europe. *Forests*, *14*(2), 283. https://doi.org/10.3390/f14020283

Mora, M., Fàbregas, E., Céspedes, F., Bartrolí, J., & Puy, N. (2022). Production and separation of value-added compounds from pine wood using pyrolysis and biorefinery techniques. *Fuel Processing Technology*, *238*, 107509. https://doi.org/10.1016/j.fuproc.2022.107509

Net-anong, S., Prommee, N., Dechayont, B., Prajuabjinda, O., Yangthaworn, K., Chunthorng-Orn, J., Phuaklee, P., Dawson, P. W. J., & Juckmeta, T. (2023). Calamus caesius (Rattan) wood: Chemical constituents, biological activities' relative medicinal properties from Thai medicinal scriptures, and in silico antioxidant activity. *Arabian Journal of Chemistry*, *16*(8), 104990. https://doi.org/10.1016/j.arabjc.2023.104990

Olaniran, S. O., Löning, S., Buschalsky, A., & Militz, H. (2022). Impregnation Properties of Nigerian-Grown Gmelina arborea Roxb. Wood. *Forests*, *13*(12), 2036. https://doi.org/10.3390/f13122036

Pachas, A. N. A., Sakanphet, S., Midgley, S., & Dieters, M. (2019). Teak (*Tectona grandis*) silviculture and research: Applications for smallholders in Lao PDR. *Australian Forestry*, *82*(sup1), 94–105. https://doi.org/10.1080/00049158.2019.1610215

Qi, J., Li, F., Jia, L., Zhang, X., Deng, S., Luo, B., Zhou, Y., Fan, M., & Xia, Y. (2023). Fungal Selectivity and Biodegradation Effects by White and Brown Rot Fungi for Wood Biomass Pretreatment. *Polymers*, *15*(8), 1957. https://doi.org/10.3390/polym15081957

Rahman, A., Marufuzzaman, M., Street, J., Wooten, J., Gude, V. G., Buchanan, R., & Wang, H. (2024). A comprehensive review on wood chip moisture content assessment and prediction. *Renewable and Sustainable Energy Reviews*, *189*, 113843. https://doi.org/10.1016/j.rser.2023.113843

Ravetti, S., Clemente, C., Brignone, S., Hergert, L., Allemandi, D., & Palma, S. (2019). Ascorbic Acid in Skin Health. *Cosmetics*, *6*(4), 58. https://doi.org/10.3390/cosmetics6040058

Rodríguez-Negrete, E. V., Morales-González, Á., Madrigal-Santillán, E. O., Sánchez-Reyes, K., Álvarez-González, I., Madrigal-Bujaidar, E., Valadez-Vega, C., Chamorro-Cevallos, G., Garcia-Melo, L. F., & Morales-González, J. A. (2024). Phytochemicals and Their Usefulness in the Maintenance of Health. *Plants*, *13*(4), 523. https://doi.org/10.3390/plants13040523

Rosamah, E., Ferliyanti, F., Kuspradini, H., Dungani, R., & Aditiawati, P. (2020). Chemical content in Two Teak Woods (Tectona grandis Linn.F.) that has been used for 2 years and 60 years. *3BIO: Journal of Biological Science, Technology and Management*, 2(1), 15. https://doi.org/10.5614/3bio.2020.2.1.3

Roth, M. G., Westrick, N. M., & Baldwin, T. T. (2023). Fungal biotechnology: From yesterday to tomorrow. *Frontiers in Fungal Biology*, *4*, 1135263. https://doi.org/10.3389/ffunb.2023.1135263

Schumacher, J. (2017). How light affects the life of Botrytis. *Fungal Genetics and Biology*, *106*, 26–41. https://doi.org/10.1016/j.fgb.2017.06.002

Shahidi, F., & Zhong, Y. (2015). Measurement of antioxidant activity. *Journal of Functional Foods*, *18*, 757–781. https://doi.org/10.1016/j.jff.2015.01.047

Singh, C., & Vyas, D. (2022). Biodegradation by Fungi for Humans and Plants Nutrition. In *Biodegradation Technology of Organic and Inorganic Pollutants*. IntechOpen. https://doi.org/10.5772/intechopen.99002

Warrier, R. R., Priya, S. M., & Kalaiselvi, R. (2021). Gmelina arborea– an indigenous timber species of India with high medicinal value: A review on its pharmacology, pharmacognosy and phytochemistry. *Journal of Ethnopharmacology*, *267*, 113593. https://doi.org/10.1016/j.jep.2020.113593

Wasana, K. G. P., Attanayake, A. P., Jayatilaka, K. A. P. W., & Weerarathna, T. P. (2021). Antidiabetic Activity of Widely Used Medicinal Plants in the Sri Lankan Traditional Healthcare System: New Insight to Medicinal Flora in Sri Lanka. *Evidence-Based Complementary and Alternative Medicine*, *2021*, 1–12. https://doi.org/10.1155/2021/6644004

Zhou, J., Tian, Q., Nie, J., Cao, P., & Tan, Z. (2024). Mechanical properties and damage mechanisms of woods under extreme environmental conditions. *Case Studies in Construction Materials*, *20*, e03146. https://doi.org/10.1016/j.cscm.2024.e03146