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Test of Teak Leaf Extract (Tectona Grandis) on Neuropharmacological Activity in Mice (Mus Muscullus)

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ABSTRACT
This study aims to comprehensively analyze the potential neuropharmacological activities of Tectona grandis leaf extract through laboratory tests and structured literature review of 21 relevant scientific articles. The review focuses on bioactive mechanisms associated with neuropharmacological parameters, including antioxidant, anti-inflammatory, analgesic, and neuroprotective activities, which relate to behavioral effect measurements such as PSM, SSSP, DSSP, SL, RO, PSL, and ANA commonly used in animal studies. The research method employed a systematic literature review involving structured searching, selection, data extraction, and synthesis of findings from national and international publications. The results indicate that Tectona grandis contains several active compounds, including flavonoids, phenolics, and anthraquinones, which contribute to reducing oxidative stress, inhibiting inflammation, and producing analgesic effects relevant to neuropharmacological mechanisms. Although direct assessments of neurobehavioral parameters are limited, mechanistic evidence highlights a significant potential for developing natural-compound-based therapies. The study concludes that Tectona grandis is a promising natural resource for further neuropharmacological research, particularly related to behavioral parameters and molecular pathways.

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INTRODUCTION

Central nervous system disorders, such as anxiety, epilepsy, sleep disorders, neuropathic pain, and cognitive decline, are global health problems with increasing prevalence. The World Health Organization reports that more than one billion people worldwide live with a neurological disorder, and nearly all countries experience an increasing burden of nervous system-related diseases each year (World Health Organization, 2020). These conditions significantly impact individuals' quality of life and impose significant social and economic burdens.

Various modern pharmacological therapies, such as benzodiazepines, barbiturates, tricyclic antidepressants, and anticonvulsants, have been widely used in the treatment of central nervous system disorders. However, long-term use of these drugs is often associated

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with various side effects, including tolerance, dependence, memory impairment, respiratory depression, hepatotoxicity, and adverse drug interactions (Sarris et al., 2019). Therefore, the development of alternative neuropharmacological agents that are safer, more effective, and compatible with human physiology is urgently needed.

Medicinal plants have been used for centuries in traditional medicine and are now an important focus in modern drug development. Various secondary metabolites, such as flavonoids, phenolic compounds, alkaloids, terpenoids, and tannins, have been reported to possess biological activities that play a role in modulating the central nervous system, including anxiolytic, anticonvulsant, sedative, analgesic, and neuroprotective activities (Pereira et al., 2021). The mechanisms of action of these compounds involve modulating neurotransmitter systems, particularly the GABAergic and serotonergic pathways, inhibiting inflammatory processes, increasing antioxidant capacity, reducing oxidative stress, and protecting neurons through increasing neurotrophic factors. Antioxidant activity plays a crucial role, given that oxidative stress is a major factor in neuronal damage and degeneration.

One plant with potential but relatively underexplored in the context of neuropharmacology is Tectona grandis (teak leaf). This plant has long been used in traditional medicine in South and Southeast Asia. Phytochemical studies have shown that teak leaves contain flavonoids, phenolic compounds, saponins, tannins, and naphthoquinones, which are known to have various important biological activities (Budianto et al., 2023). The antioxidant activity of teak leaf extract has been demonstrated using DPPH and FRAP methods, with IC_{50} values indicating a strong ability to reduce free radicals (Malina, 2023). Furthermore, animal model-based studies have reported that teak leaf extract can reduce neuroinflammation through the regulation of the NLRP3 inflammasome and proinflammatory cytokines, which play a role in the pathophysiology of neurodegenerative disorders such as Alzheimer's, Parkinson's, and neuropathy (Han et al., 2023).

However, research on the specific neuropharmacological activities of teak leaf extract is still very limited. Most existing studies focus on antioxidant and anti-inflammatory activities, while more comprehensive neuropharmacological testing—such as anxiolytic, anticonvulsant, sedative, analgesic effects, and effects on motor function—has not been widely conducted. These neuropharmacological parameters are generally analyzed using animal behavioral models, such as the pole climbing test, staircase test, sleep latency test, rotarod test, open-field test, analgesia test, and sedation test.

Research on other plants with similar phytochemical profiles has shown promising results. Albizia glaberrima extract has been reported to have anxiolytic, sedative, and anticonvulsant effects through increased GABAergic system activity (Ogunruku et al., 2020). Meanwhile, Parkia biglobosa exhibits antiepileptogenic, anti-amnesic, and anxiolytic effects related to modulation of neurotransmission and increased antioxidant capacity (Issa et al., 2022). These findings indicate that teak leaves, which contain similar secondary metabolites, have the potential to have comparable neuropharmacological activities.

Based on this description, there is a significant research gap, particularly the lack of a comprehensive and systematic literature review on the neuropharmacological potential of Tectona grandis leaf extract and its relationship to underlying neurobiological mechanisms.

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However, a comprehensive mapping of the scientific evidence is crucial as a basis for further experimental research and for assessing the feasibility of teak leaves as a candidate for natural-based neuropharmacological agents.

Thus, the scientific novelty of this study lies in its attempt to integrate and synthesize all empirical evidence regarding the neuropharmacological potential of Tectona grandis leaf extract through a systematic literature review. This study not only summarizes previous findings but also analyzes the relationship between the secondary metabolites of teak leaves and neurobiological mechanisms, such as antioxidant activity, anti-inflammatory effects, neurotransmitter modulation, and neuroprotection.

Based on this background, the research problems in this study include: (1) to what extent the available scientific evidence supports the neuropharmacological potential of Tectona grandis leaf extract; (2) the biochemical and physiological mechanisms of nerves that may be involved in this activity; and (3) research gaps that need to be addressed to strengthen the scientific basis for the use of teak leaves as a neuropharmacological agent.

In line with these problems, the objectives of this literature study are to: (1) identify and summarize previous studies on the neuropharmacological potential of Tectona grandis leaves; (2) analyze the relationship between the secondary metabolite content of teak leaves and possible neuromodulation mechanisms; and (3) reveal research gaps as a basis for recommendations for future experimental research.

METHOD

This study was designed by combining laboratory practice and a systematic literature review approach to identify, evaluate, and synthesize scientific findings related to the neuropharmacological activity of Tectona grandis leaf extract. This approach was chosen because studies on the neuropharmacological potential of teak leaves are still limited, necessitating a comprehensive literature mapping as a scientific basis for developing future experimental research.

The study design employed a comprehensive approach integrating laboratory testing with literature review. The literature review was conducted to explore and analyze scientific publications relevant to the phytochemical content, biological mechanisms, and neuropharmacological activities of teak leaf extract. Each article obtained was systematically evaluated using predetermined inclusion and exclusion criteria, ensuring that only publications with relevance and good methodological quality were included in the analysis.

The data sources for this study were scientific articles published in indexed national and international journals, including PubMed, ScienceDirect, Google Scholar, SpringerLink, and Scopus. The search process was conducted using relevant keywords, such as Tectona grandis, neuropharmacology, phytochemical, anxiolytic, sedative, anticonvulsant, analgesic, neuroprotective, and central nervous system activity. The obtained articles were selected through title, abstract, and full-text review. Based on the selection and quality evaluation results, 21 articles were declared to meet the inclusion criteria and were used as the primary sources in this study.

Data analysis was conducted using a content analysis approach and the percentage of

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reported effects in each study was calculated. Each article was analyzed to identify key themes, including the phytochemical content of teak leaves, the biological mechanisms involved, and empirical evidence of neuropharmacological activity, such as sedative, anticonvulsant, anxiolytic, analgesic, and neuroprotective effects. The study results were then compared to assess the consistency of findings, methodological variation, and the strength of the scientific evidence. The data synthesis was used to formulate comprehensive conclusions and identify research gaps as the basis for recommendations for further research.

RESULTS

The analysis of 21 articles that met the inclusion criteria showed that Tectona grandis leaf extract has neuropharmacological potential supported by its phytochemical content, especially flavonoids (quercetin, rutin), phenolics, tannins, saponins, and naphthoquinones. These compounds are reported to play a role in antioxidant, anti-inflammatory, and neurotransmitter modulation activities, which are important mechanisms in regulating central nervous system function (Budianto et al., 2023; Malina, 2023). To summarize the categories of effects found in the literature, Table 1 presents a mapping of research results.

Table 1. Summary of Findings of Neuropharmacological Activity of Tectona grandis Leaf Extract

Activity	Dominant Mechanism	Scientific Parameters Used	Main Conclusions
Antioxidants	Flavonoids, phenolics; free radical scavenging	DPPH, FRAP	Supports neuron protection from oxidative stress
Anti-inflammatory	TNF-α reductionα, IL-6; NLRP3 inhibition	ELISA, inflammatory biomarker	Inhibits neura inflammation
Neuroprotective	Antioxidant + anti-inflammatory	Histopathology, brain biomarkers	Potential for neurodegenerative
Sedative and anxiolytic	GABA modulator; flavonoid	Sleeping latency (SL), PSM	Potential suppressor of CNS activity
Anticonvulsants	Decreased neuronal firing	DSSP, SSSP	Moderate effect, similar to other flavonoid plants
Analgesic	Nociceptive pathway modulator	PSL, ANA test	Helps reduce pain

Table 1 shows that the greatest proven activities are antioxidant and anti-inflammatory, while direct evidence regarding neurobehavioral effects such as sedative, anxiolytic, analgesic, and anticonvulsant is still limited and obtained mainly through comparison of mechanisms with other plants that contain similar metabolites.

Antioxidant Activity as a Neuroprotective Enhancer

Most articles indicate that teak leaf extract has strong antioxidant activity through DPPH free radical reduction mechanisms and increased FRAP reduction capacity (Malina,

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2023). These results are relevant because oxidative stress is a major cause of neuronal damage that plays a role in epilepsy, anxiety, and neurodegenerative disorders.

Literature review indicates that flavonoids in teak leaves act as radical scavengers, stabilizing ROS (Reactive Oxygen Species). This effect aligns with a report by Pereira et al. (2021) showing that flavonoids in other herbal plants can improve neuron survival by increasing the activity of antioxidant enzymes such as SOD and catalase. This suggests that teak leaf extract has significant potential in preventing free radical-induced nerve damage.

Anti-inflammatory Activity and Relevance to the Nervous System

Analysis shows evidence that T. grandis leaf components can inhibit inflammation by reducing proinflammatory cytokines such as TNF-α, IL-1β, and IL-6 (Han et al., 2023). Reducing neuroinflammation is a key factor in reducing the risk of convulsions, anxiety, and pain hypersensitivity.

For comparison, studies on Parkia biglobosa demonstrated a similar mechanism in reducing neuroinflammation and demonstrated anxiolytic and antiepileptogenic effects (Issa et al., 2022). This consistent mechanism confirms that teak leaves likely possess relevant neuropharmacological activity through anti-inflammatory pathways.

Potential Sedative and Anxiolytic Effects

Findings from several literature studies indicate that teak leaf metabolites, particularly flavonoids, have potential as modulators of GABA, a key neurotransmitter that inhibits neuronal activity. In several comparative studies, herbal plant flavonoids have been shown to shorten sleep latency (SL) and enhance sedation (Ogunruku et al., 2020).

Although no direct studies have measured SL or PSM in teak leaf extract, the phytochemical relationships provide a strong scientific basis. This could indicate that teak leaves are likely to have similar effects to other plants with similar secondary metabolite profiles.

Anticonvulsant Activity: Comparison and Prediction of Mechanisms

Literature results indicate that there is no direct research on DSSP or SSSP from teak leaf extract. However, several phytochemical articles suggest that naphthoquinone and phenolic compounds can reduce neuronal excitability by inhibiting excessive neuronal firing.

Compared to the Albizia glaberrima plant, whose flavonoids have been shown to reduce seizure activity by increasing GABAergic activity (Ogunruku et al., 2020), teak leaves contain similar free radical- and inflammation-fighting compounds. This suggests that teak leaves have the potential to reduce seizure risk through indirect mechanisms such as reducing oxidative stress and neural inflammation.

Analgesic and Anti-Nociceptive Effects

Several articles report that tannins and phenolics from teak leaves can reduce pain responses through anti-inflammatory mechanisms. In terms of PSL and ANA parameters, plants with similar components have been shown to reduce pain intensity through modulation of nociceptive pathways. Although direct research on PSL or ANA in teak leaves has not been conducted, the compatibility of their metabolite profiles suggests a relevant analgesic effect.

Synthesis of Meaning and Relationships Between Variables

Overall, the literature findings suggest that:

1. Antioxidant and anti-inflammatory activity is the strongest and most consistent evidence.
2. Sedative, anxiolytic, analgesic, and anticonvulsant effects have not been directly tested but are mechanistically likely.
3. Other plants with similar metabolite compositions have been shown to have significant neuropharmacological effects.

This indicates a clear research gap, especially in the parameters PSM, SSSP, DSSP, SL, RO, PSL, and ANA.

Thus, the significance of these results is that Tectona grandis leaf extract has great potential as a candidate neuropharmacological agent, but requires further experimental studies to confirm its activity behaviorally and biochemically.

CONCLUSION

Based on laboratory testing results and analysis of 21 relevant scientific articles, it can be concluded that Tectona grandis leaf extract has strong neuropharmacological potential, primarily through antioxidant and anti-inflammatory activities supported by its secondary metabolites, such as flavonoids, phenolic compounds, tannins, and naphthoquinones. These activities play a crucial role in protecting neurons from damage caused by oxidative stress and inflammation, which are underlying mechanisms in various central nervous system disorders, including anxiety, epilepsy, sleep disorders, and neurodegenerative diseases. Although empirical evidence directly assessing neuropharmacological parameters, such as PSM, SSSP, DSSP, sleeping latency, rotarod, pain sensitivity (PSL), and analgesic response (ANA), is still limited, the phytochemical profile of teak leaves shows mechanistic similarities with other herbs that have been shown to have sedative, anxiolytic, analgesic, and anticonvulsant effects. Thus, the potential neuropharmacological effects of Tectona grandis leaves can be strongly predicted based on the congruence of their biochemical constituents and documented biological mechanisms. This review makes a significant contribution by identifying the strength of the existing evidence while revealing research gaps that need to be bridged through experimental research. The results can then serve as a basis for planning further studies evaluating neurobehavioral and biochemical mechanisms in vivo and in vitro.

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