Borneo Journal of Pharmacy
Vol 7 Issue 3 August 2024
Pages 306 – 314

https://journal.umpr.ac.id/index.php/bjop/article/view/7272
DOI: https://doi.org/10.33084/bjop.v7i3.7272
e-ISSN: 2621-4814

Research Article

Ethnomedicine Study of Medicinal Plants for Therapy of Elderly Sleep Disorders in Tengger Tribe

Devanus Lahardo [1]

Wiwied Ekasari [2,3]

Aty Widyawaruyanti [2,3*]

[1] Master Program of Pharmaceutical Science, Universitas Airlangga, Surabaya, East Java, Indonesia
[2] Center for Research and Development of Natural Medicines, Institute of Tropical Diseases, Universitas Airlangga, Surabaya, East Java, Indonesia
[3] Department of Pharmaceutical Science, Universitas Airlangga, Surabaya, East Java, Indonesia

*email: aty-w@ff.unair.ac.id; phone: +628113404171

Keywords:
Elderly
Plants
Sickness
Tengger

Abstract

Ethnomedicine offers valuable insights into plant-based therapies, potentially leading to the discovery of novel drugs. Sleep disturbances, including difficulty falling asleep, maintaining sleep, and early morning awakening, are prevalent among the elderly population and can significantly worsen Alzheimer's disease progression. This study explores the medicinal plants utilized by the Tengger tribe's elderly population for treating sleep disorders. Employing a mixed-methods approach, the study involved qualitative data collection through snowball sampling and in-depth interviews with 99 elderly participants and three traditional healers of the Tengger tribe. Quantitative data was obtained through questionnaires administered during field surveys. Participants were selected based on specific criteria: elderly individuals over 60 years of age, native Tengger tribe members with a history of using medicinal plants for sleep disorders; traditional healers were required to be native Tengger tribe members with knowledge passed down through generations. The study identified a total of 11 medicinal plants used for sleep disorders. Five plant species emerged as the most dominant based on the highest citation value (FC) analysis: kale (*Ipomoea reptans*), agarwood (*Aquilaria malaccensis*), sintok (*Cinnamomum sintoc*), Broadleaf plantain (*Plantago major*), and soursop (*Annona muricata*). The most commonly used plant parts were leaves, bark, and roots. Traditional preparation methods included boiling and burning the plant materials. Notably, knowledge of these medicinal plants is primarily transmitted orally within the community. Our findings highlight five medicinal plants employed by the Tengger elderly to manage sleep disorders, with limited documented evidence of their efficacy.

Received: June 3rd, 2024
1st Revised: June 27th, 2024
Accepted: July 21st, 2024
Published: August 30th, 2024

INTRODUCTION

Indonesia's rich cultural diversity, shaped by its archipelago status and diverse ethnic groups, presents a unique advantage. Each ethnic group possesses distinct traditional knowledge rooted in their culture and heritage. This includes unique perspectives on health, illness, and the use of plant species in traditional medicine. These practices, often passed down through generations, reflect a deep-rooted cultural understanding of health and healing[1,2].

Ethnomedicine, the traditional use of plants for medicinal purposes, offers a valuable resource for discovering novel drug candidates[3]. However, many indigenous communities and healers maintain secrecy around their traditional knowledge, believing that sharing it may diminish their healing abilities. This has led to a significant portion of traditional medicinal knowledge remaining undocumented and at risk of being lost due to oral transmission practices[4]. Habitat degradation, loss

How to cite: Lahardo D, Ekasari W, Widyawaruyanti A. Ethnomedicine Study of Medicinal Plants for Therapy of Elderly Sleep Disorders in Tengger Tribe. Borneo J Pharm. 2024;7(3):306-14. doi:10.33084/bjop.v7i3.7272

of plant ecosystems, and cultural erosion further threaten the sustainability of these practices[5,6]. A systematic exploration of traditional medicine is therefore crucial to identify potential alternative treatments for sleep disorders.

Sleep disorders, including difficulty falling asleep (sleep onset insomnia), early morning awakening, and disrupted deep sleep (deep maintenance insomnia), are prevalent among the elderly[7]. Over 80% of individuals aged 60 and older report sleep disturbances, which can contribute to the early stages of neurodegenerative diseases like Alzheimer's and Parkinson's dementia[8]. Sleep disorders, characterized by insomnia, inadequate sleep duration, and frequent awakenings, can significantly impact overall health and contribute to the development of various neurological and non-neurological conditions.

In the elderly population, sleep disturbances occur in approximately 50-70% of individuals aged 65 and older[Error! Reference source not found.]. Globally, the incidence of sleep disorders in this age group is estimated to be between 13% and 47%[10]. In Indonesia, around 67% of senior citizens experience sleep difficulties[Error! Reference source not found.]. Three villages in the Poncokusumo District, namely Ngadas, Gubuk Klakah, and Pandansari, have a notably high proportion of elderly residents. According to medical records from the General Poly Poncokusumo Health Center on 2019, as many as 40.7% of these elderly individuals reported sleep disorders and other physical ailments.

Disordered sleep is recognized as one of the symptoms of a condition known as *kancilan/kancilen* within the ethnomedicine framework of the Tengger tribe. The Tengger tribe, residing in Poncokusumo District, Malang Regency, Indonesia, has a rich tradition of utilizing medicinal plants for various ailments[Error! Reference source not found.]. Given the significant elderly population and the long-standing use of traditional medicine within this community, there is a compelling need to investigate the ethnomedical knowledge related to sleep quality disorders. This study aims to document the traditional medicinal herbs employed by the elderly Tengger tribe to address sleep disturbances. Specifically, we will explore the application and preparation methods of these plants for treating sleep disorders. This research endeavors to preserve valuable traditional knowledge that might otherwise be lost over time[12].

MATERIALS AND METHODS

Materials

This ethnobotanical study was conducted in the Tenggerese villages of Ngadas, Gubuk Klakah, and Pandansari, located within the Poncokusumo District of Malang Regency, East Java, Indonesia. The region is characterized by a consistent climate and topography, situated between 112.1330° to 122.5455° East Longitude and 7.5890° to 8.6813° South Latitude as shown in **Figure 1**. Data collection spanned from September 2023 to January 2024, encompassing the following stages:

1. Participant Selection: Participants were recruited from the three selected villages.
2. Data Collection: Interviews and direct observations were conducted to gather information on plant usage for sleep disorders.
3. Plant Sample Collection: Plant samples were collected for identification and subsequent analysis.
4. Literature Review: Existing literature was reviewed to verify plant identities and scientific names.

The study methodology encompassed both qualitative and quantitative approaches. Qualitative data collection involved interviews and direct observations to understand the traditional knowledge and practices related to plant usage. Quantitative data was gathered through plant sample collection and subsequent literature reviews to verify plant identities and scientific names. This research was approved by the Health Research Ethics Committee of Universitas Airlangga (certificate No. 1140/HRECC.FODM/X/2023) prior to commencement.

Methods

Selection of informants

Purposive and snowball sampling techniques were employed to identify suitable informants for this study[14]. Inclusion criteria for the elderly community included being native Tengger tribesmen or descendants over the age of 60, having used medicinal plants for at least five years to address sleep disorders, possessing strong communication skills, and being willing to participate as research informants. Exclusion criteria for the elderly community were not being residents of Ngadas, Gubuk Klakah, or Pandansari villages and lacking knowledge of medicinal plants within a traditional medicine context.

Traditional healers were also included in the study. Inclusion criteria for traditional healers comprised being native Tengger tribesmen with a generational knowledge of traditional medicine and being recognized as trusted healers by the surrounding community for at least five years. Exclusion criteria for traditional healers mirrored those of the elderly community, specifically excluding individuals not residing in the designated villages and those lacking knowledge of medicinal plants within a traditional medicine context.

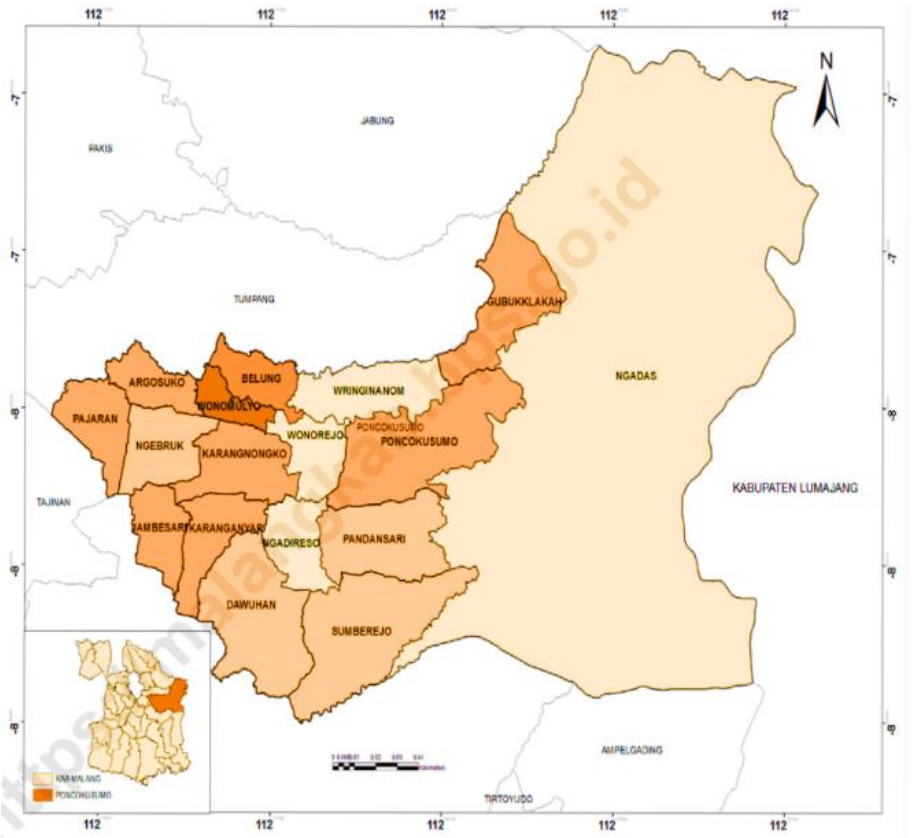

Figure 1. Ethnomedicine research location in the Tengger tribe, Poncokusumo District, Malang Regency (source: https://malangkab.bps.go.id/id).

Data collection

Data collection involved semi-structured interviews and observations to gather information about participants' demographics, knowledge of medicinal plants, processing methods, and the use of plants for treating sleep disorders. The questionnaire focused on eliciting details about the participants' health status, their understanding of sleep quality disorders, and their specific experiences with medicinal plants used to address these issues.

Data analysis

Data collected through field notes, interviews, questionnaires, and observations were systematically analyzed to identify medicinal plants used for treating sleep disorders, associated processing methods, and traditional practices for their application. To assess the prevalence of these medicinal plants in treating elderly patients' sleep problems, a quantitative analysis was conducted by calculating the citation frequency of each plant within our dataset.

RESULTS AND DISCUSSION

A total of 102 informants participated in the study, comprising 99 elderly community members and three traditional healers. Demographic characteristics are summarized in **Table I**. The majority of informants were female (86%), with the most common age group being 61-70 years old (68%). In terms of education, 49% of informants had a junior high school education or equivalent. The most prevalent religious backgrounds were Hinduism (45%), Islam (44%), and Buddhism (11%). The three traditional healers included in the study were all male (100%) with a majority having an elementary/middle school

education (67%). Additionally, 67% of the traditional healers identified as Hindu. The analysis of interview and questionnaire data yielded a comprehensive list of medicinal plants utilized by the community, along with their reported benefits and commonly used plant parts. This information is presented in **Table II** and **Figure 2**.

Table I. Demographic profile of informants (n=102).

Demographic profile	Group	Number of informants (elderly/healer)	
		N	%
Gender	Male	14/3	14/100
	Female	85/0	86/0
Age (years)	61-70	67/0	68/0
	71-80	26/2	26/67
	81-90	6/1	6/33
Education	Elementary school	24/2	24/67
	Secondary school	49/1	49/33
	High school	26/0	27/0
Routine activities	Workers	72/3	73/100
	Chicken farm worker	2/0	2/0
	Housewife	25/0	25/0
Religion	Islam	45/1	45/33
	Hindu	44/2	44/67
	Buddha	10/0	11/0

Table II. Medicinal plants based on plant parts used and processing methods.

Medicinal plant	Local name	Scientific name	Parts used	Processing method	Citation frequency (%)
Kale	*Kangkung*	*Ipomoea reptans*	Root	3-7 bunches of roots boiled	27
Agarwood and sintok	*Gaharu* and *sintok*	*Aquilaria malaccensis* and *Cinnamomum sintoc*	Stem bark	1 g of agarwood and 0.5 g of sintok barks for 1 inch of stem for burning	26
Broadleaf plantain	*Suri pandak*	*Plantago major*	Leaf	7-9 leaves boiled	18
Soursop	*Sirsak*	*Annona muricata*	Leaf	3, 5, or 7 leaves boiled	18
Pangotan	*Pangotan*	*Microsorum buergerianum*	Root	1-3 bunches of roots boiled	7
Tamarind perch	*Asam tengger*	*Radicula armoracia*	Shoots leaf	3, 5, or 7 leaves boiled	6
Mountain amethyst	*Kecubung gunung*	*Brugmansia candida*	Leaf	1-3 leaves boiled	8
Slender grape	*Ketirem/Tiyu*	*Cayratia clematidea*	Leaf	7 leaves boiled	5
Black nightshade	*Ranti*	*Solanum nigrum*	Leaf	3-5 leaves boiled	10
Garlic	*Bawang putih*	*Allium sativum*	Bulbs	1-3 cloves burned	3

a **b** **c** **d** **e**

Figure 2. Kale root (**a**), Broadleaf plantain leaf (**b**), soursop leaf (**c**), agarwood bark powder (**d**), and sintok bark (**e**).

Our ethnobotanical survey identified 11 medicinal plants used by the elderly Tengger community to address sleep disorders. These plants belonged to 10 distinct families, with *Convovulaceae*, *Malvaceae*, and *Lauraceae* being the most commonly represented (20% each). Other families included *Plantaginaceae* (15%), *Annonaceae* and *Solanaceae* (14% each), *Polypodiaceae* (6%), *Brassicaceae* (5%), *Vitaceae* (4%), and *Liliaceae* (2%) (**Figure 3**). Tengger elders demonstrated a nuanced understanding of medicinal plant usage, utilizing various plant parts, including leaves, bark, roots, leaf shoots, and bulbs. Consistent with previous ethnomedicinal studies, leaves emerged as the most commonly utilized plant part in traditional medicine practices among the elderly Tengger community with 40% (**Figure 4**)[12]. This preference is likely attributed to the relative ease of processing leaves through methods like boiling or pounding, making them readily accessible and adaptable for various medicinal applications[15]. Plant classification at the family level is a crucial factor in understanding the potential

medicinal value of plant species within local communities[5]. By examining the family-level classification of the identified medicinal plants, researchers can gain valuable insights into their pharmacological properties and potential therapeutic applications[16].

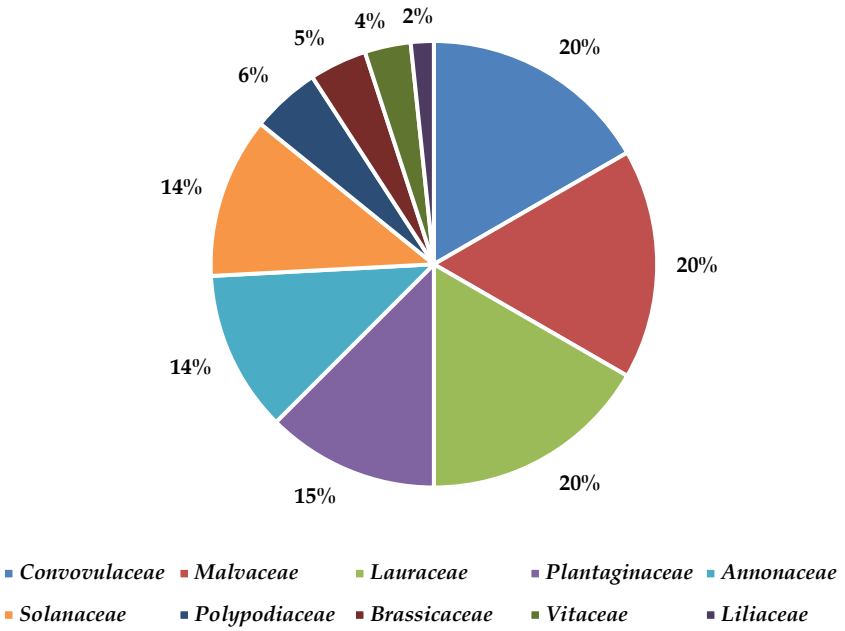

Figure 3. Families of medicinal plants used for therapy of elderly sleep disorders in Tengger Tribe.

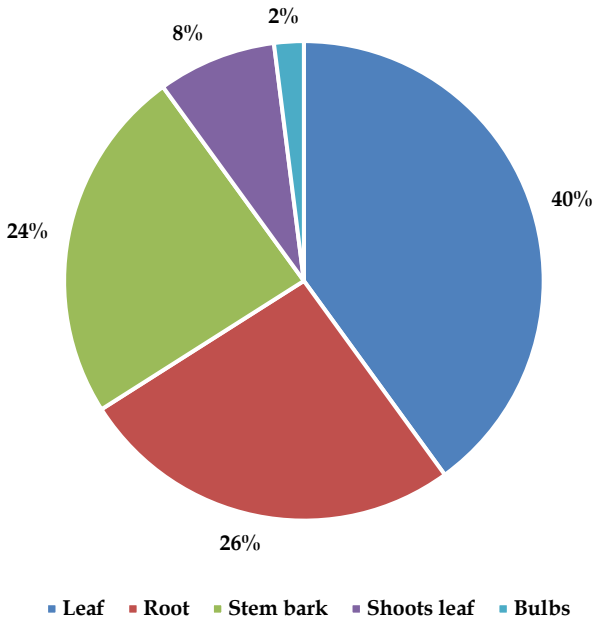

Figure 4. Parts of medicinal plants used for therapy of elderly sleep disorders in Tengger Tribe.

Ipomoea reptans contains notable levels of potassium and sodium[17]. These elements, often found as bromide salts, are known to exert a sedative effect by suppressing the central nervous system. Setiawan[18] proposed that the high potassium and sodium content in *I. reptans* binds with bromide to form bromide compounds. These bromide salts stimulate the inhibitory centers in the brainstem's reticular formation, leading to the opening of chloride channels and subsequent cell hyperpolarization[19]. This depolarization resistance contributes to the hypnotic and relaxing effects observed.

Quercetin, a flavonoid present in *I. reptans*, can also influence the central nervous system by stimulating the reticular formation's inhibitory centers. Additionally, quercetin modulates GABA receptors and ligand-gated ion channels, potentially inhibiting the conduction of nerve impulses and leading to a slower reaction time. Tissues containing quercetin were predominantly found in the roots (>50%), with some distribution in the stem and rhizome[20].

Aquilaria malaccensis, a medicinal plant traditionally used in cosmetics and aromatherapy, contains flavonoids, glycosides, tannins, and triterpenoids[21]. Previous research has demonstrated its potential neuroactive properties, including sedative effects[22]. Wang *et al*.[23] identified benzylacetone, alpha-gurjunene, and [+]-calarene as the major volatile components of *A. malaccensis* essential oil and reported its anesthetic effects in rats when inhaled. To further explore the sedative properties of benzylacetone, the study synthesized several derivatives and evaluated their sedative potency. The findings revealed that benzylacetone-like compounds exhibit sedative effects, with the strength of these effects influenced by the specific benzene ring substituents and carbon chain functional groups.

Plantago major, a member of the *Plantaginaceae* family, is a wild-growing medicinal plant commonly found in forests, fields, and damp areas. Previous studies have identified various bioactive compounds in P. *major* leaves, including phenolics, carboxylic acids, flavonoids, beta carotene, ascorbic acid, choline, and niacin[24]. Caro *et al*.[25] reported the traditional use of *Mentha spicata* and *P. major* tea for treating depression and insomnia in Colombian populations. These plants are believed to possess anxiolytic and hypnotic properties[26]. In Wistar rats, *P. major* extract (1000 mg/kg) was found to significantly prolong pentobarbital-induced sleep time[25].

Annona muricata fruits and leaves contain alkaloids like anonaine, nornuciferine, and asimilobine, which have known antidepressant properties[27]. Alkaloids can inhibit serotonin uptake in the brain, a neurotransmitter linked to mood regulation[28]. Previous studies on mice demonstrated that *A. muricata* leaf extract, when administered alongside a forced swimming test, exhibited antidepressant effects comparable to a positive control group receiving conventional antidepressants[29].

Furthermore, *A. muricata* leaves are known to contain flavonoids[30]. Flavonoids possess antioxidant properties due to their reactive hydroxyl groups. These compounds can neutralize free radicals, preventing oxidative stress-related diseases[31]. Flavonoids also interact with important enzymes in mitochondria and chelate divalent metal ions. Emerging evidence suggests that flavonoids may exert antidepressant effects by modulating monoamine neurotransmitter transmission in the brain[32]. While further research is warranted, the potential of *A. muricata* leaves as a natural alternative to conventional antidepressants warrants exploration, given their alkaloid and flavonoid content.

Five plants traditionally used by the Tengger Tribe for treating elderly sleep disorders were identified. Among these, only the leaves of *P. major* have been studied for their sedative and hypnotic properties[25]. The remaining four plants, *I. reptans*, *A. malaccensis*, *C. sintoc*, and *A. muricata*, have only been investigated for their sedative effects. This suggests a promising avenue for future research, particularly focusing on the hypnotic properties of these plants.

CONCLUSION

This ethnomedicinal study among the elderly Tengger people in Indonesia identified five prominent medicinal plants used to address sleep disorders: *I. reptans*, *A. malaccensis*, *C. sintoc*, *P. major*, and *A. muricata*. Leaves were the most commonly used plant part, and traditional processing methods often involved boiling and reciting mantras or prayers according to individual religious beliefs. Literature reviews support the potential of these plants for treating sleep disorders. The identified plants contain active compounds with sedative, antidepressant, and anxiety-reducing properties. Further research is warranted to validate these traditional uses and isolate the specific bioactive compounds responsible for their therapeutic effects.

ACKNOWLEDGMENT

We are grateful to the Institute for Research and Community Service of Universitas Airlangga for providing funding for this research through contract number 277/UN3.15/PM/2023.

AUTHORS' CONTRIBUTION

Conceptualization: Wiwied Ekasari, Aty Widyawaruyanti
Data curation: Devanus Lahardo, Wiwied Ekasari, Aty Widyawaruyanti
Formal analysis: Devanus Lahardo, Aty Widyawaruyanti
Funding acquisition: Aty Widyawaruyanti
Investigation: Devanus Lahardo
Methodology: Wiwied Ekasari, Aty Widyawaruyanti
Project administration: Devanus Lahardo, Wiwied Ekasari
Resources: Devanus Lahardo, Wiwied Ekasari, Aty Widyawaruyanti
Software: -
Supervision: Wiwied Ekasari, Aty Widyawaruyanti
Validation: Wiwied Ekasari, Aty Widyawaruyanti
Visualization: Devanus Lahardo
Writing - original draft: Devanus Lahardo, Wiwied Ekasari, Aty Widyawaruyanti
Writing - review & editing: Devanus Lahardo, Wiwied Ekasari, Aty Widyawaruyanti

DATA AVAILABILITY

The underlying data supporting the findings of this study are available upon request.

CONFLICT OF INTEREST

The authors declare there is no conflict of interest.

REFERENCES

1. Asfina R, Ovilia R. Be Proud of Indonesian Cultural Heritage Richness and be Alert of its Preservation Efforts in the Global World. Humanus J Ilmiah Ilmu Ilmu Human. 2016;15(2):195-206. DOI: 10.24036/jh.v15i2.6428

2. D'Almeida SA, Gbomor SE, Osaio-Kamara B, Olagunju MT, Abodunrin OR, Foláyan MNO. A scoping review of the use of traditional medicine for the management of ailments in West Africa. PLoS One. 2024;19(7):e0306594. DOI: 10.1371/journal.pone.0306594; PMCID: PMC11230574; PMID: 38976677

3. Pirintsos S, Panagiotopoulos A, Bariotakis M, Daskalakis V, Lionis C, Sourvinos G, et al. From Traditional Ethnopharmacology to Modern Natural Drug Discovery: A Methodology Discussion and Specific Examples. Molecules. 2022;27(13):4060. DOI: 10.3390/molecules27134060; PMCID: PMC9268545; PMID: 35807306

4. Junsongduang A, Kasemwan W, Lumjoomjung S, Sabprachai W, Tanming W, Balslev H. Ethnomedicinal Knowledge of Traditional Healers in Roi Et, Thailand. Plants. 2020;9(9):1177. DOI: 10.3390/plants9091177; PMCID: PMC7570034; PMID: 32927919

5. Snow AD, Castillo GM, Nguyen BP, Choi PY, Cummings JA, Cam J, et al. The Amazon Rain Forest Plant Uncaria Tomentosa (Cat's Claw) and Its Specific Proanthocyanidin Constituents Are Potent Inhibitors and Reducers of Both Brain Plaques and Tangles. Sci Rep. 2019;9(1):561. DOI: 10.1038/s41598-019-38645-0; PMCID: PMC6365538; PMID: 30728442

6. Shin YJ, Midgley GF, Archer ERM, Arneth A, Barnes DKA, Chan L, et al. Actions to halt biodiversity loss generally benefit the climate. Glob Chang Biol. 2022;28(9):2846-74. DOI: 10.1111/gcb.16109; PMCID: PMC9303674; PMID: 35098619

7. Hellström A, Hellström P, Willman A, Fagerström C. Association between Sleep Disturbances and Leisure Activities in the Elderly : A Comparison between Men and Women. Sleep Disord. 2014;2014:595208. DOI: 10.1155/2014/595208; PMCID: PMC3915532; PMID: 24575303

8. Wong R, Lovier MA. Sleep Disturbances and Dementia Risk in Older Adults: Findings From 10 Years Of National U.S Prospective Data. Am J Prev Med. 2023;64(6):781–7. DOI: 10.1016/j.amepre.2023.01.008; PMID: 36707315

9. Miner B, Kryger MH. Sleep in the Aging Population. Sleep Med Clin. 2017;12(1):31-8. DOI: 10.1016/j.jsmc.2016.10.008; PMCID: PMC5300306; PMID: 28159095

10. Tsou M. Healthcare Service Utilization and Associated Factors in Community- Dwelling Elderly in Northern Taiwan : One Medical Center ' s Experience. Int J Gerontol. 2018;12(2):144–9. DOI: 10.1016/j.ijge.2018.02.015

11. Fauziah E, Hartati S, Kamesyworo. The Effectiveness of Elderly Exercise in Decreasing the Level of Insomnia. J Appl Nurs Health. 2022;4(1):71-7. DOI: 10.55018/janh.v4i1.55

12. Jadid N, Kurniawan E, Himayani CES, Andriyani, Prasetyowati I, Purwani KI, et al. An ethnobotanical study of medicinal plants used by the Tengger tribe in Ngadisari village, Indonesia. PLoS One. 2020;15(7):e0235886. DOI: 10.1371/journal.pone.0235886; PMCID: PMC7357767; PMID: 32658902

13. Ramli MR, Malek S, Milow P, Aziz NJ. Traditional knowledge of medicinal plants in the Kampung Orang Asli Donglai Baru, Hulu Langat, Malaysia. Biodiversitas J Biol Div. 2021;22(3):1304-9. DOI: 10.13057/biodiv/d220329

14. Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K. Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. Adm Policy Ment Health. 2015;42(5):533-44. DOI: 10.1007/s10488-013-0528-y; PMCID: PMC4012002; PMID: 24193818

15. Abubakar AR, Haque M. Preparation of Medicinal Plants: Basic Extraction and Fractionation Procedures for Experimental Purposes. J Pharm Bioallied Sci. 2020;12(1):1-10. DOI: 10.4103/jpbs.jpbs_175_19; PMCID: PMC7398001; PMID: 32801594

16. Rabizadeh F, Mirian MS, Doosti R, Kiani-Anbouhi R, Eftekhari E. Phytochemical Classification of Medicinal Plants Used in the Treatment of Kidney Disease Based on Traditional Persian Medicine. Evid Based Complement Alternat Med. 2022;2022:8022599. DOI: 10.1155/2022/8022599; PMCID: PMC9357710; PMID: 35958915

17. Saikia K, Dey S, Hazarika SN, Handique GK, Thakur D, Handique AK. Chemical and biochemical characterization of Ipomoea aquatica: genoprotective potential and inhibitory mechanism of its phytochemicals against α-amylase and α-glucosidase. Front Nutr. 2023;10:1304903. DOI: 10.3389/fnut.2023.1304903; PMCID: PMC10772144; PMID: 38192648

18. Setiawan I. Hypnotic Effect of Ethanol Extract of Swamp Cabbage (Ipomoea aquatica Forsk.) in Male Swiss Webster Mice Induced by Phenobarbital. J Med Planta. 2021;2(1):93-100.

19. Astuti KI, Fitriyanti F. Uji Potensiasi Efek Sedatif-Hipnotik Ekstrak Etanol Kangkung Air (Ipomoea aquatic) Asal Gambut Kalimantan Selatan. Borneo J Pharmascientech. 2018;2(2):59–64. DOI: 10.51817/bjp.v2i2.198

20. Fan HR, Du WF, Zhu T, Wu YJ, Liu YM, Wang Q, et al. Quercetin Reduces Cortical GABAergic Transmission and Alleviates MK-801-Induced Hyperactivity. EBioMedicine. 2018;34:201-23. DOI: 10.1016/j.ebiom.2018.07.031; PMCID: PMC6116474; PMID: 30057312

21. Eissa MA, Hashim YZHY, Azziz SSSA, Salleh HM, Isa MLM, Warif NMA, et al. Phytochemical Constituents of Aquilaria malaccensis Leaf Extract and Their Anti-Inflammatory Activity against LPS/IFN-γ-Stimulated RAW 264.7 Cell Line. ACS Omega. 2022;7(18):15637-46. DOI: 10.1021/acsomega.2c00439; PMCID: PMC9096934; PMID: 35571776

22. Alamil JMR, Paudel KR, Chan Y, Xenaki D, Panneerselvam J, Singh SK, et al. Rediscovering the TherapeuticPotential of Agarwood in the Management of Chronic Inflammatory Diseases. Molecules. 2022;27(9):3038. DOI: 10.3390/molecules27093038; PMCID: PMC9104417; PMID: 35566388

23. Wang S, Wang C, Peng D, Liu X, Wu C. Agarwood Essential Oil Displays Sedative-Hypnotic Effects through the GABAergic System. Molecules. 2017;22(12):2190. DOI: 10.3390/molecules22122190; PMCID: PMC6149890; PMID: 29232839

24. Samuelsen AB. The traditional uses, chemical constituents and biological activities of Plantago major L. A review. J Ethnopharmacol. 2000;71(1-2). DOI: 10.1016/s0378-8741(00)00212-9; PMCID: PMC7142308; PMID: 10904143

25. Caro DC, Rivera DE, Ocampo Y, Franco LA, Salas RD. Pharmacological Evaluation of Mentha spicata L. and Plantago major L., Medicinal Plants Used to Treat Anxiety and Insomnia in Colombian Caribbean Coast. Evid Based Complement Alternat Med. 2018;2018:5921514. DOI: 10.1155/2018/5921514; PMCID: PMC6106973; PMID: 30158996

26. Triastuti A, Pradana DA, Setiawan ID, Fakhrudin N, Himmi SK, Widyarini S, et al. In vivo anti-inflammatory activities of Plantago major extract and fractions and analysis of their phytochemical components using a high-resolution mass spectrometry. Res Pharm Sci. 2022;17(6):665-76. DOI: 10.4103/1735-5362.359433; PMCID: PMC9872180; PMID: 36704431

27. Zubaidi SN, Nani HM, Kamal MSA, Qayyum TA, Maarof S, Afzan A, et al. Annona muricata: Comprehensive Review on the Ethnomedicinal, Phytochemistry, and Pharmacological Aspects Focusing on Antidiabetic Properties. Life. 2023;13(2):353. DOI: 10.3390/life13020353; PMCID: PMC9968120; PMID: 36836708

28. Hamid HA, Ramli ANM, Yusoff MM. Indole Alkaloids from Plants as Potential Leads for Antidepressant Drugs: A Mini Review. Front Pharmacol. 2017;8:96. DOI: 10.3389/fphar.2017.00096; PMCID: PMC5328930; PMID: 28293192

29. Bikomo EO, Ojokuku SA, Niemogha M. Annona muricata L., Stem-Bark Exhibit Antidepressant-Like Activity in SpragueDawley Rats. Trop J Nat Prod Res. 2023;7(6):3236-9. DOI: 10.26538/tjnpr/v7i6.26

30. Makuasa DAA, Ningsih P. The Analysis of Total Flavonoid Levels In Young Leaves and Old Soursop Leaves (Annona muricata L.) Using UV-Vis Sepctrofotometry Methods. J Appl Sci Eng Technol Educ. 2020;2(1):11-7. DOI: 10.35877/454RI.asci2133

31. Hassanpour SH, Doroudi A. Review of the antioxidant potential of flavonoids as a subgroup of polyphenols and partial substitute for synthetic antioxidants. Avicenna J Phytomed. 2023;13(4):354-76. DOI: 10.22038/ajp.2023.21774; PMCID: PMC10474916; PMID: 37663389

32. Spencer JPE. The interactions of flavonoids within neuronal signalling pathways. Genes Nutr. 2007;2(3):257-73. DOI: 10.1007/s12263-007-0056-z; PMCID: PMC2474943; PMID: 18850181