International Journal of Innovative Research and Scientific Studies, 8(11) 2025, pages: 102-109

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Effects of red Indian water lily (*Nymphaea Pubescens* Willd.) tea on sleep quality and health-related quality of life in adults with sleep disorders: An uncontrolled pretest–posttest pilot Study

Tharathip Khamthanee[1], Sutthinee Luewong[1], Ongart Maneemai[2*]

[1]Consumer Protection and Public Health Pharmacy Department, Udon Thani Provincial Public Health Office, Udon Thani, Thailand.
[2]Division of Social and Administrative Pharmacy, Department of Pharmaceutical Care, School of Pharmaceutical Sciences, University of Phayao, Phayao, Thailand.

Corresponding author: Ongart Maneemai (*Email: ongart.ma@up.ac.th*)

Abstract

This research aimed to assess the efficacy of Red Indian Water Lily (*Nymphaea pubescens* Willd.) tea on enhancing sleep quality and improving quality of life among individuals experiencing sleep disorders. Employing a one-group pretest-posttest research design, the study was conducted at the Udon Thani Provincial Public Health Office, Thailand, between July and September 2023. The sample comprised 53 adult participants diagnosed with sleep disorders, presenting a mean age of 43.3 ± 9.7 years. Participants consumed a daily dosage of 1200 mg of *N. pubescens* tea for a period of four weeks. Sleep quality was quantitatively evaluated using the Pittsburgh Sleep Quality Index (PSQI), while quality of life was assessed through the EQ-5D-5L questionnaire. Additionally, sensory attributes were evaluated employing a 9-point hedonic scale. Post-intervention analysis revealed a statistically significant improvement in participants' overall PSQI scores, which decreased from a baseline mean of 8.92 ± 0.32 to 5.90 ± 0.25 ($p < 0.001$). Significant enhancements were specifically noted in sleep quality, sleep duration, and daytime dysfunction ($p < 0.001$). Furthermore, notable improvements in mental health were observed, with the EQ-5D-5L visual analogue scale scores showing a substantial rise from 73.7 ± 17.1 to 83.3 ± 8.3 ($p < 0.001$). The sensory evaluation indicated high consumer acceptance, with the highest satisfaction ratings for appearance (7.49 ± 1.05), whereas the taste/flavor attribute received the lowest ratings (6.58 ± 1.70). In conclusion, consumption of Red Indian Water Lily tea was effective in significantly enhancing sleep quality and alleviating symptoms of anxiety and depression in individuals suffering from sleep disorders. Despite favorable overall acceptance, improvements in flavor profile could further enhance consumer appeal. Additional controlled trials are recommended to substantiate these findings.

Keywords: Red Indian Water Lily, *Nymphaea pubescens*, Sleep quality, Quality of life, Herbal tea.

DOI: 10.53894/ijirss.v8i11.10817
Funding: This study received financial support from the Consumer Protection and Public Health Pharmacy Department, Udon Thani Provincial Public Health Office, Ministry of Public Health..
History: Received: 10 September 2025 / **Revised:** 3 October 2025 / **Accepted:** 7 October 2025 / **Published:** 5 November 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Acknowledgements: The authors would like to thank Manote Nagawajjana, Kanokporn Janthasri, and Visuda Likkhasitwattakul for their assistance and support throughout this study. Their dedication and expertise greatly contributed to the successful completion of this research. This research received financial support from the Consumer Protection and Public Health Pharmacy Department, Udon Thani Provincial Public Health Office, Ministry of Public Health, Udon Thani 41000, Thailand.
Publisher: Innovative Research Publishing

1. Introduction

Sleep is now recognised as a cornerstone of both somatic and psychological wellbeing. Large-scale prospective cohorts and meta-analyses have shown that curtailed or poor-quality sleep predicts impairments in executive functioning and mood regulation, as well as increased incidence of cardiometabolic conditions such as hypertension, coronary artery disease and type 2 diabetes [1, 2]. Although benzodiazepines and non-benzodiazepine receptor agonists remain commonly prescribed for chronic insomnia, systematic evaluations underscore concerns regarding next-day sedation, cognitive blunting, tolerance, and potential for dependency, thereby fuelling interest in non-pharmacological options including cognitive-behavioural therapy and evidence-based phytotherapeutics [3, 4].

In tandem with growing public scepticism toward long-term hypnotic drug use, interest in phytotherapeutic sleep aids has intensified worldwide. Population surveys now indicate that nearly one-third of adults with insomnia resort to herbal preparations as either primary or adjunctive therapy [5]. Among the botanicals most frequently investigated, valerian (*Valeriana officinalis*), chamomile (*Matricaria recutita*), and passionflower (*Passiflora incarnata*) have each demonstrated modest but statistically significant hypnotic or anxiolytic benefits in randomised controlled trials and subsequent meta-analyses [6, 7]. Convergent pre-clinical evidence further suggests that their bioactive constituents modulate γ-aminobutyric acid (GABA) neurotransmission—either by binding to $GABA_A$ receptor subtypes or by inhibiting GABA-catabolising enzymes—thereby promoting neuronal inhibition and facilitating sleep onset [8, 9].

Although the evidence base for herbal sleep aids is expanding, scholarly attention is increasingly turning toward under-explored aquatic botanicals such as the Red Indian water lily (*Nymphaea pubescens* Willd.), indigenous to wetlands throughout South-East Asia. Classical Ayurvedic texts and regional ethnobotanical surveys describe decoctions of its flowers and rhizomes for relieving insomnia, nervous agitation and inflammatory conditions [10]. Modern phytochemical investigations have revealed a rich profile of flavonoids, isoquinoline alkaloids and condensed tannins, several of which exhibit affinity for GABA receptors or inhibit GABA-catabolising enzymes, thereby providing a plausible mechanistic basis for its traditional sedative use [11]. In murine models, hydro-ethanolic extracts of *N. pubescens* significantly prolonged pentobarbital-induced sleep and produced anxiolytic-like behaviour in the elevated plus-maze without impairing motor coordination, effects comparable to diazepam [12, 13]. These pre-clinical findings, coupled with longstanding ethnomedical utilisation, warrant systematic clinical evaluation of *N. pubescens* as a promising phytotherapeutic candidate for the management of sleep disturbances.

Notwithstanding its long-standing use in Asian materia medica, rigorous laboratory evaluation of *Nymphaea pubescens* remains sparse. Available in-vivo evidence is largely restricted to a handful of rodent studies in which hydro-ethanolic flower or seed extracts produced central nervous system (CNS) effects compatible with anxiolysis and sedation. For example, Karmakar, et al. [12] reported that doses of 200–400 $mg\,kg^{-1}$ significantly prolonged pentobarbital-induced sleeping time and reduced exploratory behaviour in mice, with a magnitude of effect comparable to diazepam. More recently, an ethanolic seed extract attenuated trimethyltin-induced cognitive deficits and neuronal degeneration in mice, supporting broader neuro-modulatory activity [14]. A concise pharmacological review has also catalogued preliminary evidence for GABAergic, anti-inflammatory and antioxidant mechanisms that could underline such CNS actions [15]. Collectively, these pre-clinical data justify systematic clinical trials to clarify the translational potential of *N. pubescens* in the management of sleep and anxiety disorders.

Given the dearth of controlled human studies on *N. pubescens* [5, 16] the present investigation was designed to generate preliminary clinical evidence regarding the efficacy of Red Indian water lily tea on sleep and related quality-of-life outcomes in adults reporting insomnia symptoms. The study couples the Pittsburgh Sleep Quality Index—an extensively validated global measure of subjective sleep [17] with the EQ-5D-5L instrument to capture changes in health-related quality of life [18]. By integrating these complementary endpoints, we aim to establish a translational evidence base that can inform the rational incorporation of *N. pubescens* preparations into future evidence-based management algorithms for sleep disturbances.

2. Materials and Methods

2.1. Design and Participants

This research employed a one-group pretest-posttest study design conducted at the Udon Thani Provincial Public Health Office, Udon Thani Province, Thailand, from July to September 2023. Ethical approval was granted by the Human Ethics Committee of Udon Thani Provincial Public Health Office (Approval No. UDREC 9766), and the study adhered strictly to the principles outlined in the Declaration of Helsinki [19]. Written informed consent was obtained from each participant before commencement of the study.

Participants were recruited through multiple channels, including direct in-person postings at the public health office and online advertisements via digital platforms, notably LINE group communications. The inclusion criteria specified working adults aged over 20 years, who had self-reported sleep disturbances persisting for at least one month, accompanied by a Pittsburgh Sleep Quality Index (PSQI) score equal to or exceeding 5, indicative of impaired sleep quality [17]. Exclusion criteria were established to ensure participant safety and data integrity, including the presence of neurological or psychiatric disorders, recent pharmacological treatment for insomnia or any neuropsychiatric condition within one month prior to enrollment, pregnancy or breastfeeding status, plans for pregnancy within the subsequent six months, and current use of medications known to affect sleep parameters, such as antihistamines or antidepressants. Participants unable or unwilling to comply with study instructions were also excluded from participation [20, 21].

2.2. Intervention

The herbal tea utilized in this research consisted of 1,200 mg of Red Indian Water Lily (*N.pubescens* Willd.) per serving. The raw plant materials underwent cleaning, drying, and roasting processes before being accurately portioned into 3-gram teabags. Participants were provided standardized tumblers (250 ml capacity) and instructed to steep the teabag in hot water for at least 3 minutes prior to consumption. They were advised to consume the prepared tea once daily in the afternoon, specifically between noon and bedtime, over a continuous period of 4 weeks [22, 23].

2.3. Outcomes

Outcomes were measured at baseline and at the conclusion of the 4-week intervention. The primary outcome, sleep quality, was evaluated using the Pittsburgh Sleep Quality Index (PSQI), a validated instrument widely used to assess sleep quality and disturbances over the preceding month [17]. The PSQI consists of 19 self-rated items across seven components, namely subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component is scored from 0 to 3, with higher scores indicating greater impairment. The overall PSQI score ranges from 0 to 21, with scores exceeding 5 considered indicative of poor sleep quality [17].

Secondary outcomes included quality of life and consumer acceptance. Quality of life was assessed using the EQ-5D-5L questionnaire, a standardized instrument developed to measure health-related quality of life across five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression [18]. Consumer acceptance of the herbal tea was evaluated using a 9-point hedonic scale, a common method in sensory evaluation studies, where ratings range from 1 ("dislike extremely") to 9 ("like extremely") [24]. Participants assessed attributes such as appearance, color, odor, taste, and overall satisfaction.

2.4. Statistical Analysis

Statistical analyses were performed using STATA SE version 18.0. Baseline characteristics of participants were summarized using descriptive statistics; continuous variables were presented as means and standard deviations, and categorical variables as frequencies and percentages. Changes from baseline to the post-intervention assessment in primary and secondary outcomes were analyzed using paired t-tests for normally distributed data and Wilcoxon signed-rank tests for data not normally distributed. Statistical significance was set at a p-value less than 0.05 [25, 26].

3. Results

3.1. Baseline Characteristics

A total of 53 participants were enrolled in the study, of whom 38 were female (71.7%), with an average age of 43 ± 14 years. The average body mass index (BMI) was 23.2 ± 0.5 kg/m². Among the participants, 23 (43.4%) had underlying health conditions, and 14 (26.4%) reported consuming dietary supplements or herbal products in the month preceding the study. The baseline characteristics of the participants are presented in Table 1.

Table 1.
General characteristics of the participants (n=53).

Characteristics	Frequency (n=53)	Percentages
Gender		
Female	38	71.7
Male	15	28.3
Age group, years (mean 43.3 ± 9.7)		
20 – 29	7	13.2
30 – 39	10	18.9
40 – 49	21	39.6
50 – 59	15	28.3
Body Mass Index, kg/m^2 (mean 23.2 ± 0.5)		
< 18.5	2	3.8
18.5 – 22.9	27	50.9
23.0 – 24.9	11	20.8
25.0 – 29.9	9	17.0
> 30.0	4	7.5
Underlying diseases		
Haven't	30	56.6
Have	23	43.4
Dietary supplements or herbal products consumption		
Yes	39	73.6
No	14	26.4

3.2. Sleep Quality

The participants' sleep quality, measured by the Pittsburgh Sleep Quality Index (PSQI), improved significantly following the 4-week intervention (Table 2). The mean overall PSQI score decreased from 8.92 ± 0.32 at baseline to 5.90 ± 0.25 at follow-up, which was statistically significant ($p < 0.001$). Significant improvements were observed in several categories, including sleep quality (Category I), sleep duration (Category III), sleep disturbances (Category V), and daytime dysfunction (Category VII). However, no significant changes were found in sleep latency (Category II), habitual sleep efficiency (Category IV), or use of sleeping medication (Category VI).

Table 2.
Sleep quality (by PSQI).

PSQI score	Baseline	Follow-up	p-value*
Overall	8.92 ± 0.32	5.90 ± 0.25	< 0.001
Category I: Sleep quality	1.75 ± 0.58	1.11 ± 0.54	< 0.001
Category II: Sleep latency	1.70 ± 0.72	1.45 ± 0.61	0.05
Category III: Sleep duration	1.32 ± 0.67	0.79 ± 0.66	< 0.001
Category IV: Habitual sleep efficiency	0.66 ± 0.90	0.42 ± 0.77	0.088
Category V: Sleep disturbances	1.62 ± 0.59	0.96 ± 0.19	< 0.001
Category VI: Use of sleeping medication	0.50 ± 0.90	0.19 ± 0.56	0.011
Category VII: Daytime dysfunction	1.40 ± 0.7	0.98 ± 0.0	< 0.001

Note: *Wilcoxon Sign Rank test.

3.3. Quality of Life

Improvements in the participants' quality of life were observed after consuming the Red Indian Water Lily tea, as measured by the EQ-5D-5L scale (Table 3). A reduction in anxiety and depression was particularly noteworthy, with the proportion of participants experiencing anxiety or depression at level 3 decreasing to zero, while those reporting no problems (level 1) increased to 49.1% ($p < 0.001$). The EQ visual analogue scale (VAS) score also improved significantly from 73.7 ± 17.1 at baseline to 83.3 ± 8.3 at follow-up ($p < 0.001$). The overall utility score increased from 0.85 ± 0.12 to 0.91 ± 0.06 ($p < 0.001$), indicating an overall improvement in quality of life.

Table 3.
Quality of life (by EQ-5D-5L).

EQ-5D-5L	Baseline	Follow-up	p-value
I. EQ-5D-5L descriptive system*			
1. Mobility			0.104**
Level 1	41 (77.4)	46 (86.8)	
Level 2	10 (18.9)	7 (13.2)	
Level 3	2 (3.8)	0 (0.0)	
Level 4	0 (0.0)	0 (0.0)	
Level 5	0 (0.0)	0 (0.0)	
2. Self-care			0.969**
Level 1	51 (96.2)	51 (96.2)	
Level 2	2 (3.8)	2 (3.8)	
Level 3	0 (0.0)	0 (0.0)	
Level 4	0 (0.0)	0 (0.0)	
Level 5	0 (0.0)	0 (0.0)	
3. Usual activity			0.011**
Level 1	38 (71.7)	47 (88.7)	
Level 2	20 (37.7)	6 (11.3)	
Level 3	4 (7.6)	0 (0.0)	
Level 4	0 (0.0)	0 (0.0)	
Level 5	0 (0.0)	0 (0.0)	
4. Pain/ Discomfort			0.006**
Level 1	11 (20.8)	15 (28.3)	
Level 2	30 (56.6)	37 (69.8)	
Level 3	9 (17.0)	1 (1.98)	
Level 4	1 (1.9)	0 (0.0)	
Level 5	2 (3.8)	0 (0.0)	
5. Anxiety/Depression			
Level 1	17 (32.1)	26 (49.1)	<0.001**
Level 2	21 (39.6)	27 (50.9)	
Level 3	14 (26.4)	0 (0.0)	
Level 4	1 (1.9)	0 (0.0)	
Level 5	0 (0.0)	0 (0.0)	
II. EQ Visual Analogue Scale	73.7 ± 17.1	83.3 ± 8.3	< 0.001***
III. Overall Utility	0.85 ± 0.12	0.91 ± 0.06	< 0.001***

Note: *Level 1, no problems; Level 2, slight problems; level 3, moderate problems; level 4, severe problems, level 5, extreme problems; ** Wilcoxon Sign Rank test; *** paired t-test.

3.4. Consumer Acceptance

The sensory evaluation of the Red Indian Water Lily tea revealed high consumer satisfaction, with the highest scores given for the tea's appearance (7.49 ± 1.05), followed by its color (7.45 ± 1.12) and odor (7.04 ± 1.52). However, the taste/flavor was rated the lowest, with a score of 6.58 ± 1.70 (Table 4).

Table 4.
Sensory evaluation (by 9-point Hedonic scale).

Characteristics	**Average score** (mean ± SD)
Appearance / Shape	7.49 ± 1.05
Color	7.45 ± 1.12
Smell/Odor	7.04 ± 1.52
Taste/Flavor	6.58 ± 1.70
General satisfaction	7.38 ± 1.15

4. Discussion

This study aimed to investigate the effects of Red Indian Water Lily (*N. pubescens* Willd.) tea on sleep quality, quality of life, and consumer acceptance among individuals with sleep disorders. The findings demonstrate that the consumption of Red Indian Water Lily tea significantly improved sleep quality, particularly in the areas of sleep duration, disturbances, and daytime dysfunction. Additionally, participants reported enhancements in their overall quality of life, particularly in reducing anxiety and depression, and the tea was well-received in sensory evaluations, though some participants found the flavor less favorable compared to other attributes.

4.1. Sleep Quality

The notable reduction in the overall PSQI score from 8.92 at baseline to 5.90 following the four-week intervention demonstrates a clinically meaningful enhancement in sleep quality. Improvements were particularly marked in subjective sleep quality, sleep duration, and daytime dysfunction, aligning with evidence supporting the efficacy of herbal preparations containing calming and sedative properties to improve sleep parameters [6, 8, 27]. Bioactive compounds in *N.pubescens*, including flavonoids and alkaloids, are known for their sedative and anxiolytic properties and likely contributed to these observed effects [11, 12].

Nevertheless, the intervention did not produce statistically significant reductions in sleep latency or improvements in habitual sleep efficiency. Similar response patterns have been reported with other botanical sleep aids, where increases in total sleep time and subjective quality were not accompanied by faster sleep onset [8, 27]. Pharmacokinetic data indicate that the principal flavonoids identified in *N. pubescens* achieve peak plasma concentrations approximately 2–4 h after ingestion [11] potentially explaining the limited influence on latency when the infusion is taken during the late afternoon. Future investigations should evaluate alternative administration schedules—such as intake 30–60 min before bedtime—and explore dose-escalation strategies to determine whether these adjustments yield clinically meaningful benefits in sleep initiation and maintenance [21].

4.2. Quality of Life

Significant improvements were observed in participants' health-related quality of life, particularly within the anxiety/depression domain of the EQ-5D-5L questionnaire. The proportion of participants reporting no anxiety or depression (level 1) increased substantially from 32.1% at baseline to 49.1% post-intervention, and cases reporting moderate-to-severe symptoms (levels 3–5) were completely resolved. Correspondingly, the EQ-5D utility index increased from 0.85 to 0.91, accompanied by a significant enhancement in visual analogue scores, reflecting clinically meaningful improvements in perceived overall well-being [28].

These findings align well with existing meta-analytical research indicating that herbal preparations, particularly those rich in flavonoids and alkaloids, possess notable anxiolytic properties [16, 29]. Alkaloids from Nymphaea pubescens have been demonstrated in pre-clinical studies to function as positive allosteric modulators of $GABA_A$ receptors and to mitigate stress-related hormonal responses, which likely underpin their anxiolytic efficacy [11, 30].

Furthermore, improvements in mental health observed in this study could also be partly attributed to enhanced sleep quality, given the well-documented bidirectional relationship between insomnia and psychological distress [31]. However, no significant changes were found in mobility or pain/discomfort domains, possibly reflecting the short study duration or the relatively low baseline impairment in these areas among participants. Nevertheless, the overall improvement in the EQ-5D utility index highlights the beneficial impact of *N. pubescens* tea on daily functional status and quality of life.

Future studies with extended follow-up periods and comparative trials against standard treatments (e.g., cognitive-behavioral therapy or conventional hypnotics) are necessary to further validate and contextualize these findings [20].

4.3. Consumer Acceptance

Sensory evaluation revealed generally favorable acceptance of the Red Indian Water Lily tea among participants, with particularly high ratings for visual attributes such as appearance and color, as well as the olfactory attribute of odor. Conversely, the taste/flavor attribute scored lowest (6.58), suggesting room for improvement in this sensory aspect. Sensory attributes, especially taste, significantly influence consumer acceptance and adherence to herbal preparations [32]. The relatively lower rating for taste/flavor could be attributed to the unique and potentially unfamiliar profile of *N. pubescens*. To enhance long-term acceptability and adherence, future research should investigate formulation improvements, possibly by blending *N. pubescens* with complementary herbs or incorporating natural flavor enhancers to optimize palatability [24, 33].

4.4. Strengths and Limitations

One of the key strengths of this study is its focus on a natural, plant-based intervention for improving sleep quality and mental well-being, which aligns with the growing trend toward using herbal and non-pharmacological treatments for sleep disorders. Additionally, the study's use of validated tools like the PSQI and EQ-5D-5L enhances the reliability and relevance of the findings.

However, the current study has several limitations. The absence of a control group inherent to the one-group pretest-posttest design restricts causal inferences regarding the observed improvements, as changes may reflect placebo effects or other confounding factors [34]. Additionally, the relatively brief duration of the intervention (4 weeks) limits the ability to assess longer-term outcomes and sustainability of effects on sleep and quality of life. Future research should employ randomized controlled trial designs, larger sample sizes, and extended follow-up periods to better elucidate the efficacy, optimal dosage, and long-term safety profile of *N. pubescens* as a sleep-promoting agent [20, 21].

5. Conclusion

In conclusion, this study provides preliminary evidence that Red Indian Water Lily (*N. pubescens* Willd.) tea may be an effective natural intervention for improving sleep quality and enhancing quality of life, particularly by reducing anxiety and depression. The tea was well-accepted by consumers, though improvements in flavor may enhance its appeal. Further

research is warranted to confirm these findings and explore the long-term effects of *N. pubescens* on sleep and mental health.

References

[1] O. Itani, M. Jike, N. Watanabe, and Y. Kaneita, "Short sleep duration and health outcomes: a systematic review, meta-analysis, and meta-regression," *Sleep medicine*, vol. 32, pp. 246-256, 2017. https://doi.org/10.1016/j.sleep.2016.08.006

[2] G. Medic, M. Wille, and M. E. Hemels, "Short-and long-term health consequences of sleep disruption," *Nature and science of sleep*, pp. 151-161, 2017. https://doi.org/10.2147/NSS.S134864

[3] J. Glass, K. L. Lanctôt, N. Herrmann, B. A. Sproule, and U. E. Busto, "Sedative hypnotics in older people with insomnia: meta-analysis of risks and benefits," *Bmj*, vol. 331, no. 7526, p. 1169, 2005. https://doi.org/10.1136/bmj.38623.768588.47

[4] M. J. Sateia, D. J. Buysse, A. D. Krystal, D. N. Neubauer, and J. L. Heald, "Clinical practice guideline for the pharmacologic treatment of chronic insomnia in adults: an American Academy of Sleep Medicine clinical practice guideline," *Journal of clinical sleep medicine*, vol. 13, no. 2, pp. 307-349, 2017. https://doi.org/10.5664/jcsm.6470

[5] L. A. Erland and P. K. Saxena, "Melatonin natural health products and supplements: presence of serotonin and significant variability of melatonin content," *Journal of Clinical Sleep Medicine*, vol. 13, no. 2, pp. 275-281, 2017. https://doi.org/10.5664/jcsm.6462

[6] S. Bent, A. Padula, D. Moore, M. Patterson, and W. Mehling, "Valerian for sleep: a systematic review and meta-analysis," *The American journal of medicine*, vol. 119, no. 12, pp. 1005-1012, 2006. https://doi.org/10.1016/j.amjmed.2006.02.026

[7] A. Ngan and R. Conduit, "A double-blind, placebo-controlled investigation of the effects of Passiflora incarnata (Passionflower) herbal tea on subjective sleep quality," *Phytotherapy Research*, vol. 25, no. 8, pp. 1153-1159, 2011. https://doi.org/10.1002/ptr.3400

[8] S. Fernández, C. Wasowski, A. C. Paladini, and M. Marder, "Sedative and sleep-enhancing properties of linarin, a flavonoid-isolated from Valeriana officinalis," *Pharmacology Biochemistry and Behavior*, vol. 77, no. 2, pp. 399-404, 2004. https://doi.org/10.1016/j.pbb.2003.12.003

[9] J. R. Hanrahan, M. Chebib, and G. A. Johnston, "Flavonoid modulation of GABAA receptors," *British journal of pharmacology*, vol. 163, no. 2, pp. 234-245, 2011. https://doi.org/10.1111/j.1476-5381.2011.01228.x

[10] C. P. Khare, *Indian medicinal plants: An illustrated dictionary*. New York, USA: Springer, 2007.

[11] A. Ahmed, M. M. Hasan, and M. S. Islam, "Neuropharmacological effects of Nymphaea pubescens Willd. flower extracts in animal models," *Journal of Herbal Medicine*, vol. 22, p. 100353, 2020.

[12] S. Karmakar, P. Banik, A. Ghosh, and N. N. Biswas, "Pharmacological activities of Nymphaea pubescens Willd. flower," *Asian Journal of Pharmaceutical and Clinical Research*, vol. 8, no. 2, pp. 154–157, 2015.

[13] A. R. Chowdhury, Z. Al Mahmud, and T. Sharmin, "Neuro-behavioural and antioxidant effects of Nymphaea pubescens seeds in mice," *Journal of Ethnopharmacology*, vol. 270, p. 113831, 2021.

[14] J. Belahusna, S. Thachak, and O. Wongmekiat, "Protective effects of Nymphaea pubescens seed extract on trimethyltin-induced cognitive deficits in mice via antioxidative and anti-apoptotic mechanisms," *Nutrients*, vol. 15, no. 4, p. 1012, 2023.

[15] P. Vivekanandarajah and N. Rajamanoharan, "Pharmacological potential of Nymphaea pubescens: A mini-review," *Journal of Herbal Medicine*, vol. 28, p. 100435, 2021.

[16] J. Sarris, A. Panossian, I. Schweitzer, C. Stough, and A. Scholey, "Herbal medicine for depression, anxiety and insomnia: a review of psychopharmacology and clinical evidence," *European neuropsychopharmacology*, vol. 21, no. 12, pp. 841-860, 2011. https://doi.org/10.1016/j.euroneuro.2011.04.002

[17] D. J. Buysse, C. F. Reynolds III, T. H. Monk, S. R. Berman, and D. J. Kupfer, "The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research," *Psychiatry research*, vol. 28, no. 2, pp. 193-213, 1989. https://doi.org/10.1016/0165-1781(89)90047-4

[18] T. E. Group, "EuroQol-a new facility for the measurement of health-related quality of life," *Health policy*, vol. 16, no. 3, pp. 199-208, 1990. https://doi.org/10.1016/0168-8510(90)90421-9

[19] World Medical Association, "Declaration of Helsinki: Ethical principles for medical research involving human subjects," *JAMA*, vol. 310, no. 20, pp. 2191–2194, 2013. https://doi.org/10.1001/jama.2013.281053

[20] C. M. Morin *et al.*, "Insomnia disorder," *Nature reviews Disease primers*, vol. 1, no. 1, pp. 1-18, 2015. https://doi.org/10.1038/nrdp.2015.26

[21] D. Riemann *et al.*, "European guideline for the diagnosis and treatment of insomnia," *Journal of sleep research*, vol. 26, no. 6, pp. 675-700, 2017. https://doi.org/10.1111/jsr.12594

[22] F. S. Poswal, G. Russell, M. Mackonochie, E. MacLennan, E. C. Adukwu, and V. Rolfe, "Herbal teas and their health benefits: a scoping review," *Plant Foods for Human Nutrition*, vol. 74, no. 3, pp. 266-276, 2019. https://doi.org/10.1007/s11130-019-00750-w

[23] C. Ulbricht, J. Conquer, and D. Costa, "An evidence-based systematic review of lemon balm (Melissa officinalis) by the Natural Standard Research Collaboration," *Journal of Herbal Pharmacotherapy*, vol. 6, no. 4, pp. 71–114, 2011.

[24] D. R. Peryam and F. J. Pilgrim, "Hedonic scale method of measuring food preferences," *Food technology*, vol. 9, no. 11, pp. 9-14, 1957.

[25] A. Field, *Discovering statistics using IBM SPSS statistics*, 5th ed. Thousand Oaks, CA, USA: SAGE, 2017.

[26] P. Mishra, C. M. Pandey, U. Singh, A. Gupta, C. Sahu, and A. Keshri, "Descriptive statistics and normality tests for statistical data," *Annals of cardiac anaesthesia*, vol. 22, no. 1, pp. 67-72, 2019. https://doi.org/10.4103/aca.ACA_157_18

[27] K. Shinomiya, K. Fujimura, Y. Kim, and C. Kamei, "Effects of valerian extract on the sleep-wake cycle in sleep-disturbed rats," *Acta Med Okayama*, vol. 59, no. 3, pp. 89-92, 2005. https://doi.org/10.18926/AMO/31980

[28] M. Herdman *et al.*, "Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L)," *Quality of life research*, vol. 20, no. 10, pp. 1727-1736, 2011. https://doi.org/10.1007/s11136-011-9903-x

[29] X. Liu, Q. Xiang, Y. Xu, and Y. Zhang, "Effects of herbal medicine on anxiety and sleep quality: A systematic review and meta-analysis of randomized controlled trials," *Complementary Therapies in Medicine*, vol. 39, pp. 123–130, 2018.

[30] Z. Zhang, R. Zhang, and Y. Li, "The effects of alkaloids on GABA receptors: Pharmacological and therapeutic potentials," *Frontiers in Pharmacology*, vol. 11, p. 93, 2020.

[31] C. Baglioni *et al.*, "Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies," *Journal of affective disorders*, vol. 135, no. 1-3, pp. 10-19, 2011. https://doi.org/10.1016/j.jad.2011.01.011

[32] H. T. Lawless and H. Heymann, *Sensory evaluation of food: Principles and practices*, 2nd ed. New York, USA: Springer, 2010.

[33] H. Tuorila and E. Monteleone, "Sensory food science in the changing society: Opportunities, needs, and challenges," *Trends in Food Science & Technology*, vol. 20, no. 2, pp. 54-62, 2009. https://doi.org/10.1016/j.tifs.2008.10.007

[34] A. D. Harris *et al.*, "The use and interpretation of quasi-experimental studies in medical informatics," *Journal of the American Medical Informatics Association*, vol. 13, no. 1, pp. 16-23, 2006. https://doi.org/10.1197/jamia.M1749