



Herbal and Natural Supplements for Improving Sleep: A Literature Review

Ji Won Yeom and Chul-Hyun Cho✉

Department of Psychiatry, Korea University College of Medicine, Seoul, Republic of Korea

Objective Herbal and natural supplements have gained popularity as alternative treatments to insomnia and sleep disorders due to their perceived safety and potential effectiveness. This literature review summarizes the current evidence on the efficacy, safety, and mechanisms of action of commonly used supplements for sleep, including valerian, hops, kava, German chamomile, cherry, tryptophan, theanine, melatonin, magnesium, and zinc.

Methods We conducted literature review of clinical research on herbal and supplements for sleep reported to date. We summarized key findings and reviewed outcomes related to clinical efficacy and side effects.

Results Findings suggest that certain supplements, particularly valerian, hops, and melatonin, could be effective in improving sleep quality and reducing insomnia symptoms through modulation of neurotransmitter systems and regulation of sleep-wake cycles. However, the strength of the evidence varies with unestablished optimal dosages, formulations, and treatment durations. Although generally considered safe, these supplements are not without risks, such as rare but serious adverse effects associated with kava and potential interactions with prescription medications. The quality and purity of supplements also vary widely due to a lack of strict regulations.

Conclusion Healthcare providers should remain informed about the latest research and work closely with patients to develop personalized treatment plans. Herbal and natural supplements may offer promising alternatives or adjunct treatments for insomnia and sleep disorders, but their use should be guided by the best available evidence and individual patient requirements. Larger, well-designed clinical trials are needed to establish the efficacy and safety of these supplements for clinical decision-making.

Psychiatry Investig 2024;21(8):810-821

Keywords Herbal supplements; Natural supplements; Insomnia; Sleep disorders; Efficacy; Safety.

INTRODUCTION

Sleep is a crucial aspect of human health that plays a vital role in cognitive function, emotional regulation, physical health, and quality of life.¹ However, sleep disorders, particularly insomnia, have become increasingly prevalent in modern society. About 50–70 million adults in the United States experience sleep disorders, with insomnia being the most common.² Insomnia is characterized by difficulty falling asleep, maintaining sleep, or obtaining restful sleep, which causes daytime impairments such as fatigue, mood disturbances, and decreased performance.³

Received: April 8, 2024 Accepted: May 30, 2024

✉ Correspondence: Chul-Hyun Cho, MD, PhD

Department of Psychiatry, Korea University College of Medicine, 73 Goryeodae-ro, Seongbuk-gu, Seoul 02841, Republic of Korea
Tel: +82-2-920-5815, E-mail: david0203@korea.ac.kr

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Conventional treatments for insomnia often involve pharmacological treatment, such as benzodiazepines and non-benzodiazepine hypnotics.⁴ Although these medications can be effective in the short term, they are associated with various side effects, such as dependence, tolerance, and adverse reactions.⁵ Moreover, long-term use of these hypnotics can lead to rebound insomnia and withdrawal symptoms upon discontinuation.⁶

Given the limitations and potential risks associated with pharmacological treatments, there has been growing interest in alternative and complementary approaches for managing sleep disorders. Herbal and natural supplements have gained popularity as potential sleep aids because of their perceived safety, lower risk of dependence, and fewer side effects than conventional medications.⁷ These supplements often contain compounds with sedative, anxiolytic, or sleep-promoting properties, such as flavonoids, terpenes, and amino acids.⁸

The use of herbal and natural supplements for sleep has been documented in various traditional medicine systems, including Ayurveda, traditional Chinese medicine, and Euro-

pean herbal medicine,⁹ and the efficacy and safety of these supplements have been the subject of scientific research in recent years. Although some studies have reported promising results, the quality of the evidence varies, and there are concerns regarding the standardization, purity, and potential interactions of these supplements with other medications.¹⁰

This review aims to provide a comprehensive overview of the current knowledge regarding herbal and natural supplements for sleep by critically examining evidence from clinical studies on their efficacy and safety profiles. The proposed mechanisms of action and active compounds of these supplements will be discussed in detail. Furthermore, this review highlights the limitations and gaps in the current literature and identifies potential avenues for future research. Finally, based on the available evidence, recommendations are provided to guide healthcare professionals and consumers in making informed decisions regarding the use of these supplements in the management of sleep disorders.

HERBAL AND NATURAL SUPPLEMENTS

Valerian

Valerian (*Valeriana officinalis*) is a perennial flowering plant native to Europe and Asia that has a long history of use as a sedative and anxiolytic in traditional medicine.¹¹ Valerian roots and rhizomes contain a complex mixture of compounds, including valerenic acid, isovaleric acid, and various sesquiterpenes, which are known to contribute to their sleep-promoting effects.¹² Valerenic acid has been identified as one of the primary active compounds responsible for valerian sedative properties.¹³

The primary mechanism of action of valerian is believed to involve the modulation of gamma-aminobutyric acid (GABA) receptors in the brain. GABA is the main inhibitory neurotransmitter in the central nervous system, and its activation promotes relaxation and sleep.⁸ In vitro studies have demonstrated that valerenic acid and other valerian constituents can bind to GABA receptors and enhance their activity, leading to sedative effects.¹⁴ Additionally, valerian inhibits the enzymatic breakdown of GABA, thus prolonging its effects in the brain.¹⁵

Several clinical trials have investigated the efficacy of valerian for insomnia, but the results have been mixed. A meta-analysis of 16 randomized controlled trials (RCTs) reported that valerian improved sleep quality compared with placebo, with a standardized mean difference (SMD) of -0.70 (95% confidence interval [CI]: -1.05 to -0.35).¹³ However, the authors noted significant heterogeneity among the studies and called for further research to confirm their findings.

In a more recent meta-analysis of 18 RCTs, valerian was re-

ported to significantly reduce sleep latency (SMD: -0.71, 95% CI: -1.05 to -0.37) and improve sleep quality (SMD: -0.46, 95% CI: -0.77 to -0.14) compared with placebo.¹² The authors concluded that valerian could be an effective treatment for insomnia, particularly for improving sleep onset and subjective sleep quality. However, they cautioned that the quality of the evidence was low to moderate owing to methodological limitations and inconsistencies among the studies.

The safety profile of valerian is generally favorable, with a few reported adverse effects. In a systematic review of 37 studies, the most common adverse effects were headaches, dizziness, and gastrointestinal disturbances, which were mild and transient.¹⁶ However, case reports have suggested that valerian may interact with other sedative medications, such as benzodiazepines, leading to excessive drowsiness.¹⁷ Therefore, individuals taking sedative medications should consult their healthcare providers before using valerian.

Hops

Hops (*Humulus lupulus*) are climbing plants commonly used in beer brewing. Moreover, it has long been used as a sedative and hypnotic in traditional medicine.¹⁸ Female hops flowers contain a variety of bioactive compounds, including alpha-acids (humulones), beta-acids (lupulones), and essential oils, which are believed to contribute to their sedative effect.¹⁹ Humulones and lupulones are the primary active compounds responsible for the sleep-promoting effects of hop.²⁰

The sedative properties of hops are known to be mediated by several mechanisms, including the modulation of GABA, serotonin, and melatonin receptors.²¹ In vitro studies have shown that humulones and lupulones can bind to GABA receptors and enhance their activity, leading to increased neuronal inhibition and sedation.²² In addition, hops extracts have been reported to increase the release of serotonin and melatonin, which are involved in sleep regulation.²³

Clinical evidence for the efficacy of hops for insomnia is limited, with most studies using hops in combination with other herbal extracts, particularly valerian extract. In a randomized, double-blind, placebo-controlled trial, a combination of valerian and hops modestly improved sleep quality and reduced sleep latency compared with a placebo in 184 adults with insomnia.²⁴ The combination was well-tolerated, with no significant differences in adverse events between the treatment and placebo groups.

The safety of hops is generally considered good, with few reported adverse effects. The most common side effects of hops were gastrointestinal complaints, dizziness, and allergic reactions, which were mild and infrequent.²⁵ However, hops may interact with other sedative medications and alcohol, leading to increased drowsiness and functional impairments.²⁰

Therefore, individuals taking sedative medications or consuming alcohol should use caution when using hops. Although clinical evidence for the efficacy of hops as a standalone treatment for insomnia is limited, studies using hops in combination with valerian have shown promising results in improving sleep quality and reducing sleep disturbances. The sedative effects of hops are believed to be mediated by the modulation of GABA, serotonin, and melatonin receptors. Hops appears to be generally safe, but it may interact with sedative medications and alcohol, warranting caution in certain populations.

Kava

Kava (*Piper methysticum*) is a shrub native to the Pacific Islands. Moreover, it has been used for centuries in traditional medicine and cultural practices for its anxiolytic and sedative effects.^{26,27} Kava root contains a group of compounds known as kavalactones, which are believed to be responsible for its psychoactive properties.²⁸ The primary kavalactones include kavain, dihydrokavain, methysticin, dihydromethysticin, yangonin, and desmethoxyyangonin.²⁹

The primary mechanism of action of kavalactones is believed to involve the modulation of GABA receptors in the brain. *In vitro* studies demonstrated that kavalactones bind to GABA receptors and enhance their activity, thereby increasing neuronal inhibition and sedation.³⁰ Kavalactones have been shown to interact with other neurotransmitters, including dopamine, serotonin, and glutamate, which may contribute to their anxiolytic and mood-enhancing effects.²⁸

Several clinical trials have investigated the efficacy of kava in the treatment of anxiety as well as insomnia, with promising results. A meta-analysis of seven RCTs reported that kava significantly reduced anxiety symptoms compared with placebo.³¹ The authors noted that kava was particularly effective in reducing anxiety associated with generalized anxiety disorders and stress-induced insomnia. However, the authors noted that most studies had a short duration and involved small sample sizes, highlighting the need for larger sample sizes and long-term trials.

In a randomized, double-blind, placebo-controlled trial, a standardized kava extract (120 mg/day) significantly improved sleep quality and reduced stress-related insomnia in 61 adults with anxiety disorders.³² The study reported significant improvements in sleep latency, duration, and efficiency in the kava group compared with the placebo group, with no significant adverse effects. The authors suggest that kava may be a safe and effective alternative to benzodiazepines for the treatment of anxiety-related insomnia.

Despite its potential benefits, the use of kava has been associated with concerns regarding hepatotoxicity. In the early 2000s, several case reports linked liver toxicity, including hep-

atitis, cirrhosis, and liver failure, to kava consumption.³³ These reports have led to regulatory actions and market withdrawals of kava products in several countries.²⁷

However, subsequent research has suggested that the risk of hepatotoxicity may be related to the quality and composition of kava products and individual risk factors.³³ A systematic review of seven clinical trials reported no evidence of liver toxicity associated with the use of well-characterized aqueous kava extracts in a controlled setting.³⁴ Nevertheless, caution is advised when using kava, particularly in individuals with preexisting liver conditions or those taking medications that may affect liver function.

Kava is a promising herbal supplement for the treatment of anxiety- and stress-related insomnia, with evidence from RCTs and meta-analyses supporting its efficacy. Moreover, its primary mechanism of action involves the modulation of GABA receptors, promoting relaxation, and sedation. Although concerns about hepatotoxicity have been raised, the risk appears low when well-characterized aqueous extracts are used at the recommended doses. However, caution should be exercised in individuals with liver conditions or in those taking medications that may affect liver function.

German chamomile

German chamomile (*Matricaria chamomilla*) is an annual flowering plant native to Europe and Asia. Moreover, it has a long history of use in traditional medicine owing to its calming and sleep-promoting effects.³⁵ German chamomile flowers contain various bioactive compounds, including flavonoids (apigenin and luteolin), terpenoids (bisabolol and chamazulene), and coumarins, which are believed to contribute to their sedative properties.³⁶ Apigenin is one of the primary active compounds responsible for chamomile's anxiolytic and sedative effects.³⁷

The mechanisms underlying the sedative effects of German chamomile are not fully understood but may involve the modulation of GABA receptors and other neurotransmitter systems. *In vitro* studies have shown that apigenin, a major flavonoid in chamomile, can bind to GABA receptors and enhance their activity, leading to increased neuronal inhibition and relaxation.³⁸ Additionally, chamomile extracts have been reported to modulate serotonin and dopamine receptors, possibly contributing to their anxiolytic and mood-enhancing effects.³⁹

Despite its widespread use as a mild sedative and sleep aid, there is limited clinical evidence on the efficacy of German chamomile in treating insomnia. A randomized, double-blind, placebo-controlled trial investigated the effects of chamomile extract on sleep quality and fatigue in 60 older adult nursing home residents.⁴⁰ The study reported significant improvements in sleep quality and fatigue scores in the chamomile

group compared with the placebo group after four weeks of treatment. The authors suggested that chamomile may be a safe and effective alternative to conventional sleep medication in older adults.

Another randomized, double-blind, placebo-controlled trial examined the effects of chamomile tea on sleep quality and depression in 80 postpartum women.⁴¹ The study reported significant improvements in sleep quality and depression scores in the chamomile group compared with the placebo group after two weeks of treatment. The authors concluded that chamomile tea might be a safe and effective complementary therapy for improving sleep and mood in postpartum women.

German chamomile is generally considered safe, with few reported adverse effects. In a systematic review of 69 clinical trials, the most common side effects were mild and transient, including gastrointestinal complaints, dizziness, and allergic reactions.⁴² However, chamomile may interact with certain medications, particularly those metabolized by cytochrome P450 enzymes, leading to drug interactions.³⁶ Individuals with allergies to plants in the Asteraceae family (e.g., ragweed, chrysanthemums) should use chamomile with caution because cross-reactivity may occur.³⁵

Although clinical evidence for the efficacy of German chamomile in treating insomnia is limited, a few studies have shown promising results in improving sleep quality and reducing fatigue in specific populations, such as older individuals and postpartum women. The sedative effects of chamomile are believed to be mediated by the modulation of GABA receptors and other neurotransmitter systems. German chamomile appears to be generally safe but may interact with certain medications and cause allergic reactions in sensitive individuals. Further research is needed to establish the optimal dose, duration, and population for the use of chamomile in the treatment of insomnia.

OTHER SUPPLEMENTS

Tart cherry

Tart cherry (*Prunus cerasus*) is a fruit rich in various bioactive compounds, including melatonin, a hormone that regulates the sleep-wake cycle.⁴³ Tart cherries are rich in sleep-promoting compounds, such as tryptophan, serotonin, and proanthocyanidins.⁴⁴ The primary mechanism by which tart cherries improve sleep is due to their high melatonin content. Melatonin is a key regulator of the sleep-wake cycle, and its production increases in the evening and decreases in the morning.⁴⁵ Supplementation with exogenous melatonin has been shown to improve sleep quality, reduce sleep latency, and increase total sleep time in individuals with insomnia.⁴⁶

A pilot study investigated the effects of tart cherry juice on sleep quality and insomnia severity in 15 older adults with chronic insomnia.⁴⁷ The participants consumed tart cherry juice for 2 weeks. The study reported significant improvements in sleep quality, sleep latency, and insomnia severity in the tart cherry group compared to baseline. The authors suggested that the high melatonin content of tart cherries may be responsible for their sleep-promoting effects.

Tart cherry supplements have been investigated for their potential sleep-promoting effects. A randomized, double-blind, placebo-controlled trial examined the effects of tart cherry juice concentrate on sleep quality in 20 adults.⁴³ Participants consumed either tart cherry extract or placebo for 7 days. The study reported significant improvements in the time spent in bed, total sleep time, and total sleep efficiency in the tart cherry group compared with the placebo group, as measured by actigraphy. The authors suggested that the melatonin and tryptophan content of tart cherries may contribute to their sleep-enhancing properties.

Tart cherry juice and its supplements appear to be well-tolerated, with no significant adverse effects reported in clinical trials.⁴⁴ However, as with any dietary supplement, individuals should consult their healthcare providers before using tart cherry products, particularly if they have underlying health conditions or are taking medications that may interact with melatonin.

Tart cherries are a promising natural source of sleep-promoting compounds such as melatonin. Evidence from pilot studies and RCTs suggests that tart cherry juice and supplements may improve sleep quality, duration, and efficiency in individuals with insomnia and reduce anxiety symptoms. The primary mechanism of action is believed to be related to the high melatonin content of tart cherries, which helps regulate the sleep-wake cycle. Although tart cherry is generally well-tolerated, individuals should consult with their healthcare providers before consuming tart cherry products. Further research is needed to establish the optimal dose, duration, and formulation of tart cherry products for insomnia treatment.

Tryptophan

Tryptophan is an essential amino acid that serves as a precursor for the synthesis of serotonin and melatonin, two neurotransmitters involved in sleep regulation.⁴⁸ Serotonin is a neurotransmitter that plays a key role in mood, anxiety, and sleep-wake cycles, whereas melatonin regulates sleep timing and wakefulness.⁴⁹ Dietary sources of tryptophan include poultry, eggs, cheese, nuts, and seeds.⁵⁰

The primary mechanism by which tryptophan improves sleep is through its conversion to serotonin and melatonin in the brain. Once ingested, tryptophan is converted to 5-hy-

droxytryptophan by tryptophan hydroxylase and then to serotonin by aromatic L-amino acid decarboxylase.⁴⁹ Serotonin can subsequently be converted to melatonin by the enzymes serotonin N-acetyltransferase and hydroxyindole-O-methyltransferase.⁵¹ Therefore, increasing the availability of tryptophan in the brain may lead to increased production of serotonin and melatonin, thereby promoting sleep and relaxation.

Several studies have investigated the effects of tryptophan supplementation on sleep parameters in humans, with mixed results. Situational insomnia with difficulty falling asleep occurred quickly at varying doses.⁵² Chronic insomnia may require longer treatment with L-tryptophan for significant improvement, potentially continuing even after treatment stops. This lack of side effects and tolerance makes L-tryptophan a favorable option.⁵² A meta-analysis of 18 articles reported that tryptophan supplementation significantly reduced the time spent awake after initially falling asleep (waking after sleep onset).⁵³ Doses of 1 g or more were particularly effective compared with smaller doses. However, tryptophan supplementation does not appear to affect the other aspects of sleep.

Tryptophan supplements are generally considered safe at the recommended doses, with few reported adverse effects. The most common side effects of tryptophan supplementation are nausea, diarrhea, and headaches, which are typically mild and transient.⁵⁴ However, high doses of tryptophan (>5 g/day) have been associated with more serious adverse effects, such as eosinophilia-myalgia syndrome, a rare but potentially fatal condition characterized by muscle pain, skin rash, and blood abnormalities.⁵⁵ Therefore, individuals should be cautious when taking high-dose tryptophan supplements and consult with their healthcare providers before use.

Tryptophan is an essential amino acid that may exert sleep-promoting effects through its conversion to serotonin and melatonin in the brain. Although a few studies have reported significant improvements in sleep quality and duration following tryptophan supplementation, others have not. Therefore, evidence for the efficacy of tryptophan as a sleep aid is mixed, and more research is needed to establish its optimal dose and duration for the treatment of insomnia. Tryptophan supplements appear safe at the recommended doses, but high doses should be avoided because of the risk of serious adverse effects.

Theanine

L-Theanine is an amino acid found primarily in green tea (*Camellia sinensis*), with potential relaxation and sleep-promoting effects.⁵⁶ Theanine is structurally similar to the neurotransmitter glutamate and has been shown to cross the blood-brain barrier and influence brain function.⁵⁷ Green tea is the primary dietary source of theanine, with levels ranging from

0.9% to 3.1% of the dry weight of tea leaves.⁵⁸

Theanine may promote sleep primarily through its effects on the neurotransmitter systems involved in sleep regulation. Theanine increases the production and release of GABA, a key inhibitory neurotransmitter that promotes relaxation and sleep.⁵⁹ In addition, theanine has been reported to increase serotonin and dopamine levels in the brain, which may contribute to its mood-enhancing and anxiolytic effects.⁶⁰

Theanine supplements are generally considered safe, with few reported adverse effects. The most common side effects of theanine supplementation include headache, dizziness, and gastrointestinal discomfort, which are typically mild and transient.⁶¹ However, as with any dietary supplement, individuals should consult their healthcare providers before using theanine products, particularly if they have underlying health conditions or are taking medications that may interact with theanine.

L-Theanine is an amino acid found in green tea that may exert sleep-promoting effects by influencing the neurotransmitter systems involved in sleep regulation. Evidence from RCTs suggests that theanine supplementation, either alone or in combination with GABA, may improve sleep quality, sleep duration, and daytime functioning in individuals with insomnia. Although theanine is generally well-tolerated, individuals should consult with their healthcare providers before using theanine products. Further research is required to establish the optimal dose and formulation of theanine for the treatment of insomnia.

Melatonin

Melatonin is a hormone produced by the pineal gland that regulates the sleep-wake cycle.⁴⁵ Endogenous melatonin production is regulated by the suprachiasmatic nucleus of the hypothalamus, which receives input from the retina about the level of environmental light.⁶² Melatonin levels increase in the evening, reaching a peak in the middle of the night and then declining in the early morning, promoting wakefulness.⁶³

The primary mechanism by which melatonin promotes sleep is through its effects on the sleep-wake cycle, also known as the circadian rhythm. Melatonin binds to specific receptors in the suprachiasmatic nucleus and other brain regions involved in sleep regulation, such as the thalamus and hypothalamus.⁶⁴ Melatonin helps to initiate and maintain sleep by signaling these brain regions.

Melatonin supplements have been extensively studied for their effects on insomnia, jet lag, and shift-work sleep disorders. A meta-analysis of 19 RCTs found that melatonin supplementation significantly reduced sleep latency (time to fall asleep) and increased total sleep time compared with placebo in individuals with primary insomnia.⁴⁶ The authors noted that

the effects of melatonin were most pronounced in older adults and individuals with delayed sleep phase syndrome.

Another meta-analysis of 10 trials investigated the effects of melatonin on jet lag symptoms, including sleep disturbance.⁶⁵ The analysis observed that melatonin supplementation significantly reduced jet lag symptoms, including sleep latency and daytime fatigue, compared with placebo. Doses between 0.5 and 5 mg work well (with 5 mg aiding in falling asleep faster), but higher doses are not more beneficial. Precise timing is crucial, as taking melatonin early can disrupt the adjustment to a new time zone. The authors concluded that melatonin is an effective treatment for jet lag, particularly when traveling eastward across several periods.

Melatonin has been studied for its potential benefits in shift-work sleep disorders, a condition characterized by insomnia and excessive sleepiness related to working non-traditional hours (i.e., night shifts). A systematic review and meta-analysis of 15 RCTs reported that melatonin supplementation significantly improved sleep quality and duration in shift workers compared with placebo.⁶⁶ The authors noted that the optimal dose and timing of melatonin administration for shift-work sleep disorders require further investigation.

Melatonin supplements are generally considered safe for short-term use, with few reported adverse effects. The most common side effects of melatonin supplementation include headaches, dizziness, nausea, and drowsiness.⁶⁷ However, long-term safety data on melatonin use is lacking, and a few experts have raised concerns about the potential of melatonin to interact with other medications, such as blood thinners and sedatives.⁶⁷ Therefore, individuals should consult their healthcare providers before using melatonin supplements, particularly if they have underlying health conditions or are taking medications.

Melatonin is a hormone that plays a key role in regulating the sleep-wake cycle. Evidence from meta-analyses and systematic reviews suggests that melatonin supplementation may be effective in reducing sleep latency, increasing total sleep time, and improving sleep quality in individuals with primary insomnia, jet lag, or shift-work sleep disorders. Although generally well-tolerated in the short term, long-term safety data on melatonin use is lacking, and individuals should consult with their healthcare providers before using melatonin supplements. Further research is required to establish the optimal dose and timing of melatonin administration for various sleep disorders.

Magnesium

Magnesium is an essential mineral involved in numerous physiological processes, including sleep regulation.⁶⁸ Magnesium plays a role in the production and release of neurotrans-

mitters involved in sleep, such as GABA and melatonin.⁶⁹ Additionally, magnesium modulates the activity of the hypothalamic-pituitary-adrenal axis, which regulates the stress response and influences sleep.⁷⁰

The primary mechanism by which magnesium promotes sleep is through its effects on GABA, a primary inhibitory neurotransmitter in the central nervous system. Magnesium enhances GABA activity by increasing the sensitivity of GABA receptors and promoting the release of GABA from presynaptic neurons.⁷¹ By increasing GABA activity, magnesium may promote relaxation and reduce the time required to fall asleep.

Several clinical trials have investigated the effects of magnesium supplementation on sleep parameters in humans. A randomized double-blind clinical trial involving 46 older adults divided into magnesium and placebo groups who took 500 mg of magnesium and placebo daily for 8 weeks, respectively, reported that magnesium supplementation significantly increased sleep time, sleep efficiency, and serum levels of renin and melatonin while significantly reducing the insomnia severity index score, sleep onset latency, and serum cortisol levels.⁶⁸ These results suggest that magnesium supplementation can improve sleep quality and positively affect both the subjective and objective indicators of insomnia in older individuals.

In a double-blind, placebo-controlled clinical trial at a long-term care facility involving 43 older adult participants with primary insomnia, a nightly food supplement containing 5 mg melatonin, 225 mg magnesium, and 11.25 mg zinc mixed with pear pulp was tested against a placebo.⁷² Over 8 weeks, the supplement significantly improved sleep quality as measured by the Pittsburgh Sleep Quality Index, along with improvements in sleep ease, quality, morning alertness, and the restorative value of sleep observed through various other scales, such as the Leeds Sleep Evaluation Questionnaire and the Short Insomnia Questionnaire. Total sleep duration and quality of life, measured by the 36-item short form survey physical score, showed notable improvements. These findings suggest that the administration of melatonin, magnesium, and zinc can effectively enhance the quality of sleep and quality of life in older individuals with primary insomnia.

Magnesium supplements are generally considered safe at the recommended doses, with few reported adverse effects. The most common side effects of magnesium supplementation are diarrhea, nausea, and abdominal cramping, which are typically mild and transient.⁷⁰ However, high doses of magnesium can cause more severe adverse effects, such as hypotension, arrhythmias, and renal dysfunction, particularly in individuals with impaired kidney function.⁷³ Therefore, individuals should consult their healthcare providers before using magnesium supplements, particularly if they have un-

derlying health conditions or are taking medications that may interact with magnesium.

Magnesium is an essential mineral that may have sleep-promoting effects through its influence on the neurotransmitter systems involved in sleep regulation, particularly GABA. Evidence from RCTs suggests that magnesium supplementation may improve sleep quality and reduce insomnia severity in individuals with poor sleep quality. Although generally well-tolerated at the recommended doses, high doses of magnesium can cause adverse effects, and individuals should consult their healthcare providers before using magnesium supplements. Further research is required to establish the optimal dose and formulation of magnesium for the treatment of insomnia.

Zinc

Zinc is an essential trace element that plays a role in numerous physiological processes, including sleep regulation.⁷⁴ Zinc is involved in the synthesis and metabolism of neurotransmitters involved in sleep, such as serotonin and melatonin.⁷⁵ Additionally, zinc has been shown to modulate the activity of GABA and glutamate receptors in the brain, which are involved in sleep-wake regulation.⁷⁴

The primary mechanism by which zinc promotes sleep involves its effects on melatonin synthesis and secretion. Zinc is a cofactor of the enzyme serotonin N-acetyltransferase, which catalyzes the conversion of serotonin to N-acetylserotonin, a precursor of melatonin.⁷⁶ By increasing the activity of this enzyme, zinc may promote melatonin synthesis and release, thereby enhancing sleep.

In a randomized, double-blind, placebo-controlled trial with 120 healthy participants, the effect of zinc-rich and astaxanthin-containing foods on sleep was evaluated over 12 weeks using actigraphy to monitor night activities.⁷⁷ Participants were divided into four groups: a placebo group, a zinc-rich food group, a group consuming both zinc- and astaxanthin-rich food, and a placebo group supplemented with zinc-enriched yeast and astaxanthin oil. The results indicated that, compared with the placebo group, the zinc-rich food group experienced a significant reduction in the time to fall asleep and an improvement in sleep efficiency. Furthermore, the group that ingested both zinc-enriched yeast and astaxanthin oil showed significant improvement in sleep onset latency.

Zinc supplements are generally considered safe at the recommended doses, with few reported adverse effects. The most common side effects of zinc supplementation are nausea, vomiting, and abdominal discomfort, which are typically mild and transient.⁷⁸ However, high doses of zinc can cause more severe adverse effects, including copper deficiency, iron deficiency, and impaired immune function.⁷⁹ Therefore, individuals should consult their healthcare providers before using zinc supple-

ments, particularly if they have underlying health conditions or are taking medications that may interact with zinc.

Zinc is an essential trace element that may have sleep-promoting effects through its influence on neurotransmitter systems involved in sleep regulation, particularly melatonin. Evidence from RCTs suggests that zinc supplementation may improve sleep quality and reduce insomnia severity in individuals with sleep disturbances, such as shift-work disorder and age-related insomnia. Although generally well-tolerated at the recommended doses, high doses of zinc can cause adverse effects, and individuals should consult their healthcare providers before using zinc supplements. Further research is required to establish the optimal dose and formulation of zinc for insomnia treatment.

As shown in Table 1, various herbal and natural supplements have been investigated for their potential sleep-promoting effects, with varying levels of evidence. Although certain supplements, such as valerian, hops, and kava, have shown promise in clinical trials, other supplements, such as German chamomile and cherry, have shown limited evidence to support their efficacy. Melatonin, magnesium, and zinc have been studied for their potential roles in sleep regulation, but further research is needed to establish their optimal use in the treatment of insomnia. The quality, purity, and composition of herbal and natural supplements can vary widely, and a few products may contain contaminants or interact with medications. Therefore, individuals should consult healthcare professionals before using these supplements, particularly if they have underlying health conditions or are taking medications.

DISCUSSION

Evidence suggests that herbal and natural supplements can improve sleep quality and alleviate insomnia symptoms. However, the strength of the evidence varies among supplements, and several limitations and gaps in the literature must be addressed.

One of the main strengths of the available evidence is that several high-quality RCTs have been conducted to investigate the efficacy of supplements such as valerian, hops, and kava. These studies have provided valuable insights into the potential sleep-promoting effects of these supplements and have helped establish their safety profiles. Additionally, a few meta-analyses have pooled the results of multiple studies, increased the statistical power, and provided more robust estimates of treatment effects.^{7,13}

However, the current evidence has several limitations. Many of these studies were small and had short durations, and they used varying dosages and formulations of the supplements, making it difficult to draw definitive conclusions.⁷ Studies have

Table 1. Summary of herbal and supplements for improving sleep

Herbal/natural supplement	Key compounds	Proposed mechanisms of action	Evidence of efficacy	Safety considerations
Valerian	Valerenic acid, isovaleric acid, sesquiterpenes	Modulation of GABA receptors, serotonin receptors	Improved sleep quality and reduced sleep latency in several RCTs and meta-analyses	Generally well-tolerated; may interact with sedative medications
Hops	Alpha-acids (humulones), beta-acids (lupulones), essential oils	Modulation of GABA receptors, serotonin receptors, melatonin receptors	Improved sleep quality and reduced sleep latency when used in combination with valerian	Few reported adverse effects; may interact with sedative medications and alcohol
Kava	Kavalactones	Modulation of GABA receptors, dopamine, serotonin, and glutamate neurotransmitter systems	Reduced anxiety symptoms and improved sleep quality in several RCTs	Concerns about hepatotoxicity, particularly with non-aqueous extracts; may interact with sedative medications
German Chamomile	Flavonoids (apigenin, luteolin), terpenoids (bisabolol, chamazulene), coumarins	Modulation of GABA receptors, anxiolytic effects through serotonin and dopamine receptors	Limited clinical evidence; some studies show improved sleep quality in older adult and postmenopausal women	Generally well-tolerated; may cause allergic reactions in individuals sensitive to plants in the Asteraceae family
Cherry	Melatonin	Regulation of sleep-wake cycles	Improved sleep quality and duration in a small RCT	Well-tolerated; no significant adverse effects reported
Tryptophan	Tryptophan (amino acid)	Precursor for serotonin and melatonin synthesis	Small improvements in sleep latency and total sleep time in a meta-analysis	Generally safe; may cause mild side effects such as nausea and dizziness
Theanine	L-Theanine (amino acid)	Modulation of neurotransmitter systems involved in sleep regulation	Improved sleep quality and duration when used in combination with GABA in a small RCT	Well-tolerated; no significant adverse effects reported
Melatonin	Melatonin (hormone)	Regulation of sleep-wake cycles	Reduced sleep latency and increased total sleep time in individuals with primary insomnia in a meta-analysis	Generally safe for short-term use; long-term safety data lacking
Magnesium	Magnesium (mineral)	Involved in sleep regulation; deficiency associated with sleep disturbances	Improved sleep quality and reduced insomnia severity in older adults with insomnia in a small RCT	Well-tolerated; may cause gastrointestinal side effects at high doses
Zinc	Zinc (mineral)	Involved in neurotransmitter synthesis and sleep regulation; deficiency linked to sleep disturbances	Improved sleep quality and reduced insomnia severity in nurses with rotating night shifts in a small RCT	Generally safe at recommended doses; excessive intake may cause copper deficiency and other adverse effects

GABA, gamma-aminobutyric acid; RCT, randomized controlled trial

methodological limitations, such as lack of blinding, inadequate randomization, or high dropout rates, which can introduce bias and reduce the reliability of the findings.¹⁰

Another important consideration is the variability in the quality and composition of herbal and natural supplements. Unlike pharmaceutical drugs, which are highly regulated and standardized, herbal supplements vary widely in purity, potency, and composition.⁹ This variability makes it challenging to compare the results of different studies and to determine the optimal dosage and formulation for clinical use. In a few cases, herbal supplements may contain contaminants or adulterants that can pose safety risks to consumers.⁸⁰

The potential for herb-drug interactions is another concern that must be addressed when considering the use of herbal and natural supplements for sleep. Many herbal supplements interact with prescription medications by altering their metabolism, enhancing their effects, and reducing their efficacy.⁸ For example, valerian and kava may interact with sedative medications, such as benzodiazepines, leading to excessive drowsiness or functional impairment.^{17,81} Therefore, healthcare providers must be aware of the potential interactions and monitor patients closely when combining herbal supplements with conventional medications.

Despite these limitations, using herbal and natural supplements for sleep remains a popular and growing trend. Many individuals prefer these supplements to prescription medications because of their perceived safety, lower risk of dependence, and fewer side effects.⁷ However, healthcare providers must educate patients about the potential benefits and risks of these supplements and provide evidence-based recommendations for their use.

Based on the current evidence, healthcare providers may consider recommending certain herbal and natural supplements, such as valerian or melatonin, as adjunctive therapies for insomnia, particularly in patients who have not responded to conventional treatments or prefer natural alternatives.^{13,82} However, these recommendations should be made case-by-case, considering the patient's needs, preferences, and medical histories.

Healthcare providers should advise patients to use herbal and natural supplements under medical supervision and purchase them from reputable sources to ensure quality and safety. Patients should be instructed to start with low doses and monitor their symptoms and potential adverse effects. Regular follow-up visits should be scheduled to assess the effectiveness of the supplements and to make any necessary adjustments to the treatment plan.

In addition to using herbal and natural supplements, healthcare providers should emphasize the importance of good sleep hygiene practices, such as maintaining a regular sleep sched-

ule, creating a conducive sleep environment, and avoiding stimulating activities before bedtime.⁸³ Behavioral interventions, such as relaxation techniques and cognitive-behavioral therapy for insomnia, should be considered as first-line treatments for insomnia, either alone or in combination with herbal and natural supplements.⁴

In conclusion, herbal and natural supplements may play a role in managing insomnia and sleep disorders; however, further research is needed to establish their efficacy, safety, and optimal use. Healthcare providers should remain informed about the latest evidence and use a patient-centered approach when recommending these supplements. By combining herbal and natural supplements with other evidence-based treatments and lifestyle modifications, healthcare providers can help patients achieve better sleep quality and improve their overall health and well-being.

CONCLUSION

Herbal and natural supplements have gained popularity as treatment options for insomnia and sleep disorders. This review examined the current evidence on the efficacy, safety, and mechanisms of action of several commonly used supplements, including valerian, hops, kava, German chamomile, cherry, tryptophan, theanine, melatonin, magnesium, and zinc.

Available evidence suggests that a few of these supplements, particularly valerian, hop, and melatonin, may be effective in improving sleep quality and reducing insomnia. These supplements function through various mechanisms, such as modulating GABA and serotonin receptors, promoting relaxation, and regulating sleep-wake cycles.^{8,45} However, the strength of the evidence varies, and more research is needed to establish optimal dosages, formulations, and treatment durations.

Although herbal and natural supplements are generally considered safe, they are not without risks. Supplements, such as kava, have been associated with rare but serious adverse effects, including liver toxicity.⁸¹ Additionally, the quality and purity of these supplements can vary widely because they are not as strictly regulated as pharmaceutical drugs.⁹ The interactions between herbal supplements and prescription medications are of concern, highlighting the importance of medical supervision and monitoring when using these products.

In conclusion, herbal and natural supplements may offer promising alternatives or adjunct treatments for individuals with insomnia and sleep disorders. However, their use should be guided by the best available evidence and the individual needs and preferences of the patient. Healthcare providers should be informed of the latest research on these supplements. They should work closely with patients to develop personalized treatment plans that optimize benefits and minimize risks.

Future research should focus on conducting larger well-designed clinical trials to establish the efficacy and safety of herbal and natural supplements for sleep. Studies should investigate the optimal dosages, formulations, and durations of treatment and the potential interactions with other medications and health conditions. By advancing our understanding of these supplements and their role in sleep health, we can improve the quality of life of many individuals with insomnia and sleep disorders.

Availability of Data and Material

Data sharing not applicable to this article as no datasets were generated or analyzed during the study.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Chul-Hyun Cho. Funding acquisition: Chul-Hyun Cho. Investigation: Ji Won Yeom, Chul-Hyun Cho. Methodology: Ji Won Yeom, Chul-Hyun Cho. Project administration: Ji Won Yeom, Chul-Hyun Cho. Supervision: Chul-Hyun Cho. Writing—original draft: Ji Won Yeom, Chul-Hyun Cho. Writing—review & editing: Ji Won Yeom, Chul-Hyun Cho.

ORCID iDs

Ji Won Yeom <https://orcid.org/0000-0003-0038-2101>
Chul-Hyun Cho <https://orcid.org/0000-0002-1663-9680>

Funding Statement

This work was supported by the National Research Foundation (NRF) of Korea grants funded by the Ministry of Science and Information and Communications Technology (MSIT), Government of Korea (NRF-2020R1C1C1007463 and NRF-2021R1A5A8032895), Information and Communications Technology and Future Planning for Convergent Research in the Development Program for R&D Convergence over Science and Technology Liberal Arts (NRF-2022M3C1B6080866), and the Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No. RS-2023-00224823).

Acknowledgments

None

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