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Ashwagandha as an Adaptogen: Its Influence on Sleep Patterns, Stress Response, and Anxiety in Modern Life

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ABSTRACT

Background:

Ashwagandha (*Withania somnifera*), a prominent adaptogen in traditional Ayurvedic medicine, has gained substantial attention for its potential to enhance resilience to modern stressors, improve sleep quality, and alleviate anxiety. Preclinical and clinical studies have demonstrated that Ashwagandha's active compounds, particularly withanolides, influence the hypothalamic-

pituitary-adrenal (HPA) axis, leading to reductions in cortisol levels and a more balanced stress response.

Puropose: This review aims to consolidate current evidence on Ashwagandha's efficacy in modulating stress response, improving sleep patterns, and reducing anxiety levels.

Material and methods: The review was based on the analysis of materials collected in the databases "Pubmed", Google Scholar, ResearchGate, books and other scientific articles. The search was conducted using keywords: "Ashwagandha", "Withania somnifera", "adaptogen", "stress", "anxiety", "sleep", "cortisol". "HPA axis".

Results: A review of the literature has shown Ashwagandha anxiolytic properties, with effects comparable to standard anti-anxiety medications but with fewer side effects. Additionally, Ashwagandha has been shown to significantly improve sleep onset latency, sleep duration, and overall sleep quality, particularly in individuals suffering from stress-induced sleep disorders.

Conclusions: Ashwagandha shows significant potential as a natural therapy for managing stress, improving sleep quality, and reducing anxiety, primarily through its effects on the hypothalamic-pituitary-adrenal (HPA) axis and cortisol regulation. Clinical trials have demonstrated its efficacy in improving sleep and reducing anxiety, with a generally favorable safety profile. However, further research is needed, particularly to better understand the long-term effects and safety of Ashwagandha supplementation.

Key words: Ashwagandha, Withania somnifera, adaptogen, stress, anxiety, sleep, cortisol, HPA axis

Ashwagandha – Background information

Ashwagandha (*Withania somnifera*), also known as "Indian ginseng" or "winter cherry", has been a staple in Ayurvedic medicine for over 3,000 years. Its name is derived from the Sanskrit words "*ashwa*" meaning horse, and "*gandha*" meaning smell, referring to both the strong odor of its root and the belief that consuming Ashwagandha imparts the vigor and strength of a horse. Traditionally, it has been considered a *Rasayana* in Ayurveda, a class of herbs known for their rejuvenating and longevity-promoting properties [22]. Ancient texts describe Ashwagandha as a tonic for increasing vitality, physical strength, and overall health, making it highly valued in managing stress, aging, and chronic conditions [13].

Ashwagandha exerts its effects on multiple systems of the body, including the immune, neurological, endocrine, and reproductive systems. In modern research, the herb has demonstrated its ability to improve cognitive function, enhance memory, and provide neuroprotection against degenerative diseases like Alzheimer's and Huntington's disease [3].

Studies have shown that Ashwagandha can significantly improve learning ability, reduce memory loss, and alleviate cognitive dysfunction. Moreover, it has been found to increase the resilience of the body to stress by modulating the hypothalamic-pituitary-adrenal axis, reducing cortisol levels, and restoring normal adrenal function [17].

Beyond its neuroprotective and adaptogenic properties, Ashwagandha has shown promise in improving physical performance, enhancing cardiovascular health, and boosting the immune system [19]. Its role in reproductive health is also noteworthy, as it supports both male and female sexual function [16]. Despite its broad therapeutic potential, caution is advised during pregnancy, and its interactions with other medications need further study [24].

Ashwagandha is available in several forms, making it accessible for various preferences and therapeutic needs. The most common form is powder (*churna*), which can be mixed with water, milk, or honey. This traditional Ayurvedic form is often used for general health and vitality enhancement. Capsules and tablets are widely available, offering a convenient and standardized way to consume a precise dosage of Ashwagandha, commonly used in clinical trials for stress and anxiety management [21]. Additionally, liquid extracts or tinctures are available, often taken as drops for faster absorption. These are particularly useful for those seeking a quick and easy way to integrate Ashwagandha into their routine [6]. Ashwagandha is also available in gummies or as an ingredient in various supplements, aimed at promoting stress relief, cognitive function, and sleep. Finally, topical formulations, such as creams and ointments, are used for their anti-inflammatory properties, particularly in the management of joint pain and skin conditions [16].

Biochemical Properties of Ashwagandha and Its Mechanisms of Action

This potent herb owes its remarkable therapeutic properties to a diverse range of bioactive compounds. These compounds, primarily withanolides, alkaloids, flavonoids, and saponins, play a crucial role in Ashwagandha's pharmacological activity, exerting significant effects on various physiological systems in the body [18]. Understanding the composition and specific actions of these compounds provides insight into the herb's broad therapeutic potential [23].

The most prominent group of active substances in Ashwagandha is the **withanolides**, which are steroidal lactones with a core ergostane structure. These include key compounds such as withaferin A, withanolides A-Y, withanone, and sitoindosides IX and X [4]. Withanolides exhibit potent neuroprotective properties, making them valuable in the treatment of neurodegenerative disorders like Alzheimer's and Parkinson's diseases [20]. They work by reducing the aggregation of β -amyloid plaques and tau proteins, which are hallmarks

of Alzheimer's disease. Withaferin A, in particular, has been shown to reduce oxidative stress and neuroinflammation, protecting neurons from damage and potentially slowing the progression of neurodegenerative conditions [19]. Additionally, withanolides possess anti-inflammatory properties, which are beneficial in conditions like rheumatoid arthritis, where chronic inflammation plays a key role [8]. Through their ability to modulate inflammatory cytokines such as IL-6 and TNF- α , withanolides help reduce tissue damage and promote healing [17]. Their anticancer effects are also notable, as withaferin A has been observed to induce apoptosis in cancer cells, showing potential in the treatment of breast, colon, lung, and prostate cancers [16].

The second major group of compounds in Ashwagandha is the **alkaloids**, including withanine, somniferine, tropine, and pseudotropine. Alkaloids play a crucial role in regulating the nervous system and maintaining neuroendocrine balance [22]. They contribute to cognitive enhancement by improving neurotransmitter regulation, which is particularly beneficial in managing stress, anxiety, and sleep disorders [10]. Ashwagandha's alkaloids help reduce cortisol levels and balance the hypothalamic-pituitary-adrenal (HPA) axis, thus reducing the body's stress response and promoting relaxation [5]. Furthermore, alkaloids have been found to improve sleep quality, making Ashwagandha a natural remedy for insomnia and other sleep-related issues [6]. These compounds act synergistically with withanolides, enhancing the overall neuroprotective and anti-stress effects of the herb [23].

Flavonoids, such as quercetin, kaempferol, and their glycosidic derivatives, also contribute to Ashwagandha's health benefits. These compounds are powerful antioxidants, protecting cells from oxidative damage caused by free radicals [3]. Flavonoids enhance cardiovascular health by improving blood circulation and reducing the risk of atherosclerosis [16]. Additionally, they possess anti-inflammatory properties that further support immune regulation, making Ashwagandha beneficial in managing conditions like cardiovascular diseases and chronic inflammation [9].

Saponins, including sitoindosides VII and VIII, are another important group of bioactive compounds in Ashwagandha. These steroidal saponins have significant immunomodulatory effects, boosting the body's immune response by enhancing the activity of white blood cells and improving the ability to combat infections [7]. Saponins are also known to promote reproductive health, particularly by improving sperm quality and testosterone levels in men, thus aiding in the treatment of male infertility [17]. In women, Ashwagandha has been observed to support hormonal balance, which can enhance reproductive health and overall vitality [5].

Other notable compounds in Ashwagandha include coumarins (such as scopoletin), chlorogenic acid, and steroidal lactones, which collectively contribute to the herb’s cardioprotective and metabolic health benefits [1]. These compounds help regulate lipid metabolism, reduce blood pressure, and promote healthy glucose levels, making Ashwagandha a potential adjunct therapy for cardiovascular diseases and diabetes [7].

In summary, Ashwagandha's therapeutic efficacy can be attributed to its rich phytochemical profile. Each of the active compounds—whether withanolides, alkaloids, flavonoids, or saponins—plays a specific role in maintaining and restoring health by targeting different physiological systems in the body. Their synergistic effects underline Ashwagandha's status as a multifaceted adaptogen with a broad spectrum of health benefits.

Table 1.: Key Compounds in Ashwagandha and Their Effects

Active Compound	Physiological System	Key Effects
Withanolides (e.g., Withaferin A, withanolides A-Y, sitoindosides IX and X)	Nervous System, Immune System, Inflammatory Response	Neuroprotective (prevents neurodegeneration), anti-inflammatory (modulates cytokines), anticancer (induces apoptosis)
Alkaloids (e.g., Withanine, somniferine, tropine)	Neuroendocrine System	Reduces cortisol, balances HPA axis, improves sleep quality, reduces anxiety and stress
Flavonoids (e.g., Quercetin, kaempferol)	Cardiovascular System, Immune System	Antioxidant (protects cells from oxidative stress), anti-inflammatory, supports cardiovascular health
Steroidal Saponins (e.g., Sitoindosides VII and VIII)	Reproductive System, Immune System	Boosts immune response, improves sperm quality, supports hormonal balance
Coumarins (e.g., Scopoletin)	Cardiovascular System	Cardioprotective (improves blood circulation, reduces blood pressure)

Chlorogenic Acid	Metabolic System	Regulates glucose levels, supports metabolic health
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Impact of Ashwagandha on Stress

Ashwagandha has been extensively studied for its potential to reduce stress, and numerous clinical trials support its efficacy in this area [1]. The herb is known for significantly lowering levels of cortisol, the primary hormone released in response to stress. By regulating the hypothalamic-pituitary-adrenal (HPA) axis, Ashwagandha helps the body better manage stress, restoring hormonal balance and reducing the physiological strain caused by chronic stressors [5]. Clinical studies have consistently shown that individuals who supplement with Ashwagandha experience significant reductions in perceived stress levels, as measured by the Perceived Stress Scale (PSS), and improved overall well-being [17]. These improvements have been observed both in short-term interventions, typically lasting 4 to 12 weeks, and in longer-term studies [16].

In terms of dosage, studies have demonstrated that Ashwagandha is effective in doses ranging from 250 mg to 600 mg daily, with visible effects on stress reduction often observed after 6 to 8 weeks of consistent use [9]. In a randomized controlled trial by Della Porta et al. (2023), participants taking 600 mg of Ashwagandha extract daily for 8 weeks showed a substantial decrease in cortisol levels, along with significant improvements in their ability to cope with stress [5]. Similar findings were reported by Majeed et al. (2021), where participants taking 300 mg twice daily also exhibited lowered salivary cortisol and marked reductions in stress-related symptoms after 6 weeks [19].

The stress-reducing effects of Ashwagandha are primarily attributed to its active compounds, particularly withanolides, such as withaferin A and withanolide A [4]. These compounds act as adaptogens, helping the body better manage and respond to stressors by modulating the HPA axis, which controls cortisol production [17]. By lowering excess cortisol levels, Ashwagandha restores hormonal balance and reduces the physiological effects of chronic stress [18].

Moreover, Ashwagandha has been shown to enhance levels of GABA (gamma-aminobutyric acid), a neurotransmitter that plays a crucial role in calming the nervous system and reducing anxiety [23]. This neurochemical regulation, combined with the anti-inflammatory properties of withanolides, helps mitigate the long-term effects of stress on the body, reducing inflammation and promoting mental resilience [18].

Impact of Ashwagandha on anxiety

Ashwagandha has gained increasing recognition for its anxiolytic properties. It is being actively studied as a potential treatment for anxiety disorders, including generalized anxiety disorder (GAD). Both the World Federation of Societies of Biological Psychiatry (WFSBP) and the Canadian Network for Mood and Anxiety Treatments (CANMAT) have provisionally recommended its use for GAD, with effective doses ranging between 300 to 600 mg daily [1, 18, 31].

Ashwagandha's beneficial effects are primarily attributed to its ability to modulate the hypothalamic-pituitary-adrenal (HPA) axis, thereby reducing cortisol, the body's primary stress hormone, which is often elevated in individuals with chronic anxiety [5, 17]. Additionally, preclinical research has shown that Ashwagandha can inhibit neuroinflammation by suppressing pro-inflammatory cytokines such as IL-1 β and TNF- α , both of which play a role in stress-induced neural damage [18].

Clinical evidence supports its anxiolytic efficacy. A meta-analysis of randomized controlled trials demonstrated significant improvements in anxiety symptoms, comparable to those seen with standard medications such as lorazepam but with fewer side effects [1, 9]. Animal studies also indicate that Ashwagandha can mitigate the cognitive and behavioral effects of chronic stress, suggesting its broader therapeutic potential [7, 8].

However, despite these promising findings, not all studies have produced consistent results. Some clinical trials failed to observe statistically significant differences between Ashwagandha and placebo in anxiety reduction, indicating variability in individual responses [9, 30]. Nevertheless, its overall safety profile is favorable, with minimal adverse effects, making Ashwagandha a viable alternative or complementary treatment option for anxiety disorders [24].

In summary, Ashwagandha offers a promising natural intervention for managing anxiety, particularly GAD. Its ability to lower cortisol, reduce neuroinflammation, and enhance stress resilience is well-supported by current evidence, though further large-scale clinical trials are needed to confirm its long-term efficacy and optimize dosing protocols [18, 30].

Impact of Ashwagandha on sleep

Ashwagandha has demonstrated considerable potential in enhancing sleep quality, particularly in individuals dealing with insomnia and sleep disturbances. Numerous randomized controlled trials and systematic reviews have provided robust evidence showing that Ashwagandha can effectively reduce sleep onset latency, increase total sleep duration, and improve overall sleep

quality [2, 6, 16]. These improvements are especially pronounced in individuals with chronic insomnia, with optimal effects observed at doses of 600 mg daily, administered over a period of 8 to 12 weeks [6, 23].

The mechanisms underlying Ashwagandha's sleep-enhancing properties are linked to its regulatory effects on the hypothalamic-pituitary-adrenal (HPA) axis, which plays a critical role in the body's stress response. By reducing cortisol levels, Ashwagandha alleviates stress, a primary contributor to sleep disturbances and insomnia [5, 17]. Furthermore, its active compounds, including withanolides, are believed to modulate GABAergic activity, which is associated with sedation and the regulation of sleep cycles [4].

In clinical settings, Ashwagandha has been reported to significantly improve sleep efficiency, mood upon awakening, and overall sleep quality, making it a promising natural alternative for individuals seeking non-pharmacological interventions for sleep disorders [2, 6]. Most studies highlight Ashwagandha's favorable safety profile, with only mild side effects such as stomach upset, nausea, or drowsiness reported in a small subset of users [15, 27]. However, as with any supplement, individual responses may vary, and long-term safety data remain limited, necessitating further research into its prolonged use and potential interactions with other medications [24].

Adverse effects of Ashwagandha supplementation

Ashwagandha is generally regarded as safe for short-term use, with most clinical studies indicating minimal adverse effects [27, 24]. Randomized controlled trials consistently show that Ashwagandha is well-tolerated at doses between 250 and 600 mg per day, typically administered for 8 to 12 weeks [6, 24]. The most commonly reported side effects are mild and include gastrointestinal discomfort such as stomach upset, nausea, diarrhea, and occasional drowsiness [15].

However, the safety of Ashwagandha during long-term use is less well-established due to limited research beyond three months of continuous supplementation [13, 27]. There have been some reports of adverse effects associated with prolonged or high-dose consumption, including rare cases of liver dysfunction. In a few isolated instances, Ashwagandha has been linked to liver toxicity, with symptoms like jaundice and elevated liver enzymes occurring after several weeks or months of use [10, 24]. Although these cases are rare and most symptoms resolve after discontinuation, they underscore the importance of cautious long-term use [13].

Moreover, Ashwagandha may interact with various medications, including thyroid hormone replacement, sedatives, and immunosuppressants [4]. Its potential to increase testosterone

levels could pose risks for individuals with hormone-sensitive conditions, such as prostate cancer [4, 22]. Additionally, there is limited data on its effects during pregnancy and breastfeeding, with some studies indicating a potential risk of spontaneous abortion, leading to recommendations against its use in these populations [24].

In conclusion, while Ashwagandha is safe for short-term use with minimal side effects, more research is needed to fully understand its long-term safety. Patients considering prolonged use, especially at higher doses, should be monitored for potential adverse effects, particularly in relation to liver function and hormone-sensitive conditions [13, 24].

Discussion

The review of current literature highlights Ashwagandha's significant potential as an adaptogenic herb in managing stress, anxiety, and sleep disorders. The herb's primary mechanism involves modulation of the hypothalamic-pituitary-adrenal (HPA) axis, which results in reduced cortisol levels, a key factor in stress and anxiety regulation. Studies consistently show that Ashwagandha supplementation lowers stress-related biomarkers and enhances the body's resilience to chronic stress, with several randomized controlled trials reporting improvements in perceived stress, anxiety, and overall well-being [5, 17, 19]. Additionally, the role of withanolides, particularly withaferin A, in reducing neuroinflammation and oxidative stress further underscores Ashwagandha's neuroprotective benefits [4, 18]. These findings align with Ashwagandha's traditional use in Ayurveda as a Rasayana herb, promoting mental and physical rejuvenation [22]. However, variability in clinical outcomes, particularly in anxiety trials, suggests that individual responses to Ashwagandha supplementation may depend on various factors, including dosage, duration, and the severity of the condition being treated [9, 30]. Moreover, while the herb's efficacy in improving sleep quality, especially for those with stress-induced insomnia, is well-documented [2, 6, 16], long-term data on its safety remains limited. Reports of mild gastrointestinal discomfort and rare cases of liver dysfunction raise the need for cautious use, especially in individuals on long-term or high-dose regimens [10, 24].

Conclusions

Ashwagandha emerges as a promising natural intervention for managing stress, anxiety, and sleep disorders, primarily through its effects on the HPA axis and cortisol regulation. Its ability to enhance stress resilience, improve sleep quality, and alleviate anxiety symptoms is well-supported by preclinical and clinical studies, with fewer side effects compared to conventional medications [1, 5, 17]. The herb's rich phytochemical composition, particularly withanolides

and alkaloids, contributes to its neuroprotective, anti-inflammatory, and anxiolytic properties [4, 23]. However, despite these promising findings, more large-scale, long-term clinical trials are needed to confirm its safety profile, especially concerning its use beyond 12 weeks and in combination with other medications [13, 24]. Future research should focus on optimizing dosing strategies, understanding individual variability in response, and further investigating the potential interactions of Ashwagandha with various medications. Nevertheless, Ashwagandha's overall safety and efficacy position it as a viable complementary treatment option for stress, anxiety, and sleep disorders.

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