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Enhancing Physical Performance and Health: The Effects of Withania Somnifera on Strength, Endurance, and Overall Well-being

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ABSTRACT

Introduction: Withania Somnifera (Ashwagandha), an ancient ayurvedic remedy, has been valued for centuries in traditional medicine due to its versatility of beneficial properties on the body system. Contemporary research aims to expand the medicinal use of Ashwagandha and fully harness its adaptogenic potential. Recently, Ashwagandha has gained the rising interest of sportsmen seeking effective and natural ways to enhance their performance.

Purpose of the work: The aim of this study is to review existing research on the effects of Withania Somnifera (Ashwagandha) supplementation on performance, as well as its beneficial impact on overall health and well-being of athletes.

Materials and methods: A comprehensive literature search and analysis was conducted on PubMed, Google Scholar, Scopus and Science Direct databases using combinations of the following phrases: "Withania Somnifera"; "Ashwagandha"; "Adpatogens"; "Health Benefits of Ashwagandha"; "Ashwagandha and Physical Performance"; "Ashwagandha and Endurance"; "Adverse Effects of Ashwagandha".

Results: Supplementation of Ashwagandha has been demonstrated to enhance physical performance and recovery in athletes, as well as significantly improve strength and muscle mass. Furthermore, supplementation provides various health benefits for the body, with emphasis on improved sleep quality and reduced stress and anxiety. Research recognises Ashwagandha as safe and well-tolerated.

Keywords: Withania Somnifera, ashwagandha, adaptogens, physical performance, muscle mass, sleep quality

INTRODUCTION

Withania Somnifera (Ashwagandha), known as "Indian ginseng" or "winter cherry", belongs to the Solanaceae family and is part of the canon of medicinal plants [1]. Its names "ashwa" (horse) and "ghanda" (scent) refer to its properties in colloquial translation as "horse-power-giving". This plant is native to India, Afghanistan and Pakistan, as well as some regions of the Middle East and Africa. For nearly 3,000 years, this adaptogenic gold has been used to strengthen the body, treat anxiety disorders and insomnia, improve fertility and libido, reduce rheumatoid pain and inflammation, as well as enhance energy [2].

Stress is defined as any internal or external stimulus that is capable of eliciting an organismal response. It is often associated with the onset or exacerbation of pathophysiological conditions. Stress is a factor that not only affects the homeostasis of the body, but also, when acting in the long term, is capable of leading to death [3]. Research indicates that stress can cause structural changes in the brain, alter brain function, and impair cognitive function, depending on the intensity and duration of exposure [4]. However, stress affects many areas of the body due to its effects on the central nervous system (CNS) and activation of the sympathetic nervous system [5]. Unfortunately, it contributes to the development of many diseases and worsens the quality of life [6].

Scientists are still looking for a substance to support the body's response to stress. One promising suggestion is Ashwagandha, which stands out from other plants for its long-standing, rich history of use, as well as its adaptogenic properties.

Adaptogens are a group of herbal and nutritional substances that help enhance the body's ability to cope with stress, increase resilience, and support overall survival under challenging conditions [7]. Consuming them is linked to better regulation of metabolic processes as well as improved mental and physical performance. The biological effects of plant adaptogens are linked to the variety of active compounds they contain. These plants have a diverse and rich composition of phytochemicals [8].

Ashwagandha is considered an adaptogen, similarly to Asparagus racemosus willd [9] and Panax-ginseng [10]. The active ingredients present in Withania Somnifera are withanolides, alkaloids, saponins and flavonoids, which provide its anti-inflammatory, anti-oxidant, adaptogenic and immunomodulatory effects [11].

The positive stress-protective impact of adaptogens is attributed to their ability to regulate homeostasis through various mechanisms. These include actions on the stress response system through the hypothalamic-pituitary-adrenal axis and the modulation of key stress response mediators, such as molecular chaperones (like Hsp70), cortisol and nitric oxide (NO) [12], as well as modulation of the immune response and stimulation of the central nervous system (CNS) [13].

The aim of our study is to review the effects of Withania Somnifera on strength, endurance, and overall well-being, with a particular emphasis on its potential to enhance physical performance and promote overall health.

ASHWAGANDHA OVERVIEW:

Active Substances Found in Withania Somnifera

When subjected to phytochemical analysis a wide range of chemicals with diverse properties can be obtained from Withania Somnifera. Interestingly, different substances can be found in different parts of the plant. Numerous studies have allowed the scientists to isolate and describe about 40 withanolides, just over 12 alkaloids, as well as sitoindosides. The main active substances of Ashwagandha are withaferin-A and withanolide-A [14]. The infographic below (Figure 1.) presents the active compounds found in Ashwagandha [15].



Figure 1. Active compounds found in Ashwagandha [15].

Adaptogenic Properties of Withania Somnifera

Numerous studies have been conducted in recent years on the adaptogenic properties of Ashwagandha. One of the studies involved an eight-week, randomized, double-blind, placebocontrolled trial to assess the effects of Ashwagandha root extract on stress in healthy adults. Sixty participants with high baseline stress levels were assigned to receive either 125 mg or 300 mg of Ashwagandha extract, or a placebo, twice daily Authors reported reduced anxiety, stress and cortisol levels with improved quality of sleep at the end of the study for the Ashwagandha group [16]. Another study involved a clinical trial with 64 participants over 60 days to assess the safety and effectiveness of a high-concentration, full-spectrum Ashwagandha root extract in alleviating stress and anxiety. The study found a significant reduction in all stress assessment scale scores and serum cortisol levels compared to the placebo group [17]. In another clinical trial, a 12-week, randomized, double-blind, placebo-controlled design was used with participants aged 65-80, who received either 600 mg/day of Ashwagandha root extract or a placebo. The effectiveness of the treatment was assessed using the WHOQOL-BREF questionnaire, sleep quality, mental alertness, and the Physician's Global Assessment of Efficacy to Therapy (PGAET), while safety was monitored through adverse event reporting and the Patient's Global Assessment of Tolerability to Therapy (PGATT). The findings showed that Ashwagandha significantly improved quality of life, sleep, and mental alertness in elderly participants, suggesting its potential value for this age group [18]. Each of these studies prove the positive effects of Ashwagandha on the human body, its great contribution to stress reduction which consequently improves the quality of life.

Another study assessed the impact of an ethanolic extract of Withania Somnifera roots on acute stress induced in mice. The results demonstrated that pre-treating the animals with the extract enhanced their swimming duration. Additionally, Ashwagandha treatment notably reversed the stress-induced changes in blood glucose, triglyceride levels and plasma cortisol [19].

Immunomodulatory Properties of Withania Somnifera

Another characteristic of Ashwagandha is its immunomodulatory properties, meaning its ability to affect the cellular and humoral response of the adaptive immune system [20]. It is often compared to ginseng by its calming effects on the immune system [21]. Research indicates that Ashwagandha holds an anti-inflammatory effect. It contains chemicals such as withaferin A, which properties attenuate inflammation by reducing the number of proinflammatory cytokines like II-1 β , II-6, IL-18, TNF- α and inhibiting the activation of NLRP3 [22]. Ashwagandha root was also found to inhibit the NF- κ B and MAPK (mitogen-activated protein kinase) pathways [23]. COVID-19 was studied as well [24]. Although the levels of proinflammatory markers and serum IgG for COVID-19 were comparable for both auyda and the control group, the Authors reported that ayuda interventions (Ashwagandha and Zingiber Officinale) give promise in the reduction of the duration of clinical recovery [24].

EFFECTS OF WITHANIA SOMNIFERA ON PHYSICAL PERFORMANCE

Maximal Oxygen Uptake (VO2 max)

Maximal oxygen uptake (VO₂ max) is a commonly acknowledged parameter for assessing the individual endurance and cardiovascular fitness. It reflects the maximal oxygen uptake of the body during exercise, beyond which no further increase is observed with additional effort [25]. Since VO₂ max is a body mass-dependent indicator, it is generally expressed in milliliters per kilogram of body weight per minute (ml/kg/min). VO₂ max has been demonstrated to strongly correlate with athletic performance in endurance sports [26,27]. It is now considered an international standard for evaluating the aerobic capacity [25].

A meta-analysis conducted by Pérez-Gómez et al. (2020) included five studies with a total of 162 participants (81 in the placebo group and 81 in the Ashwagandha group). In the study exclusively endurance-focused athletes and healthy individuals were evaluated regarding the effect of Ashwagandha on VO₂ max [28]. The study demonstrated that the administration of Ashwagandha (300-1000 mg/day for 2-12 weeks) increased VO₂ max level. Withania Somnifera was administered in various forms, such as gelatin capsules, root extract capsule, and aqueous extract in the capsule form. There is a lack of long-term studies comparing the effects of dose and duration on endurance. It is worth noting that in studies where higher doses of Ashwagandha were supplemented, the effect was improved, and the difference between the control and research groups was more measurable. This implies that a higher dose of Ashwagandha and longer administration may have a better effect on increasing VO₂ max, but further assessment is needed. Studies involving individuals undergoing resistance training demonstrated improvement in VO₂ max after Ashwagandha supplementation [29].

A study, which acknowledges the results of previously published meta-analysis, was conducted by Bargale Sushant Sukumar et al. (2021), where oral supplementation of Withania Somnifera with milk was shown to increase VO_2 max as well as the hemoglobin level [30].

Hematological Parameters

Ashwagandha supplementation significantly enhances hemoglobin levels and hematological parameters, including mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular volume (MCV) as demonstrated in a Bayesian meta-analysis conducted in 2021 [31]. Additionally, it was observed to provide protective effects against oxidative stress, as indicated by increased levels of super-oxide dismutase (SOD) and malondialdehyde (MOD) [32]. These changes in hematological parameters may play an essential role in explaining the mechanisms underlying the detected increases in VO₂ max [31].

Muscle Mass and Strength

Ashwagandha has also been investigated for muscle strength and hypertrophy, which are crucial to assess overall fitness level. A randomized controlled trial demonstrated that consuming 600 mg/day of Ashwagandha root extract for eight weeks combined with resistance training contributed to greater strength results than the control group both in male and female participants [29]. Similarly, twice a day supplementation of Ashwagandha root extract at a dose of 300 mg over an eight week period resulted in increased muscle strength in lower and upper body [33]. A significant improvement in strength results compared to the control group was also observed in the group taking 500 mg/day Sensoril®, a commercially available dietary supplement comprising the aqueous extract of the roots and leaves of Withania somnifera [34].

However, there still remains some inconsistency regarding the effects of Ashwagandha on muscle size. While two studies found no significant effect of Ashwagandha extract on muscle size [29] and general body composition [34], another reported a statistically significant change in muscle size between the control and study groups (except for the thigh muscles) [33].

Muscle Recovery

Ashwagandha has demonstrated promising benefits in improving post-exercise muscle recovery. A 60-day study that measured muscle inflammatory markers including high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF α), serum lactate dehydrogenase (LDH) and myostatin. All the previously mentioned markers showed a progressive decrease in the Ashwagandha extract group compared to the placebo group, where these markers showed an increasing trend [35]. Interestingly, a rise in serum creatine phosphokinase (CPK) levels was observed in the Ashwagandha group between days 7 and 60 of the experiment, but 24-48h post-resistance training CPK levels were significantly lower than in the control group, stating greater recovery [33].

Subjective recovery assessment methods also supported the beneficial influence of Ashwagandha. A study conducted by Ziegenfuss TN et al (2018), which used a visual analog scale to assess perceived recovery, muscle pain, mood, willingness to train and more found that the group taking 500mg/d of Sensoril[®] improved in perceived recovery and no substantial changes were observed in perceived muscles soreness over the course, while no changes were noted in perceived recovery and an increase in muscle soreness in the placebo group [34]. Another study noted improvements in Ashwagandha group in general stress, lack of energy, and fitness injury score using the Daily Analysis of Life Demands for Athletes (DALDA) questionnaire and the Recovery-Stress Questionnaire for Athletes (RESTQ) [36].

Moreover, in a 2021 study conducted by Raut et al. Ashwagandha was identified as a potential therapeutic agent for the treatment of sarcopenia [35]. However, the study was limited to a group of healthy exclusively male participants. In another study from 2024, where the impact of Withania Somnifera extract on age-related muscular deteriorations in mice was explored, it was found that Ashwagandha suppresses production of IL-1 β and TNF- α and promotes numerous factors related to mitochondrial biogenesis, which ultimately leads to enhancing muscle regeneration and mitigating symptoms of sarcopenia [37]. The above-mentioned studies indicate a possible promising effect of Ashwagandha in the treatment and improvement of the quality of life of patients with sarcopenia. Nonetheless, further investigation is needed.

Testosterone Levels

Testosterone as a critical hormone for enhancing physical performance in both men and women, has been evaluated in context of supplementation of Ashwagandha [38]. Two studies analyzing the effect of Withania Somnifera on testosterone levels observed an increase in Ashwagandha group but only in men. However, the increase was not statistically significant, presumably due to small sample size [33,39].

HEALTH BENEFITS OF WITHANIA SOMNIFERA

Effects on Sleep and Well-Being

Withania Somnifera has been extensively studied for its potential to improve sleep. Research indicates that supplementing 225mg of the liposomal form of Withania Somnifera once daily over a period of 30 days can improve reaction time, short-term memory, attention and alertness in healthy young adults [40,41]. Furthermore, Ashwagandha has shown great promise in improving general well-being, mental alertness, and sleep quality in the elderly population [18]. Supplementation of 300mg of Ashwagandha twice a day has been documented to improve sleep quality and reduce sleep onset latency. Research also suggests that the total sleep time significantly increases after treatment [42]. A systematic review and meta-analysis concluded by Cheah et al. (2021) [43] confirms a small but significant effect of Ashwagandha on overall sleep, outlining more prominent results for patients with insomnia, with the administration dosage of \geq 600 mg daily and treatment duration exceeding 8 weeks [43].

Effects on Stress, Anxiety and Depression

Ashwagandha has been researched mostly in view of alleviating stress and anxiety, as compared to managing depression. Supplementation appears to be effective in managing mental disorders either as a monotherapy or in combination with piperine (a natural alkaloid isolated from black pepper) [44], which was discovered to have a positive impact on individuals diagnosed with depression and anxiety [45]. Because of its ability to improve physiological, cognitive, and psychological effects of stress [41]. Withania Somnifera could be considered an alternative addition to conventional treatment options for these diseases. However, authors recognize the quality of evidence as low and report that further high-quality studies are needed to fully evaluate the effectiveness of Withania Somnifera [46].

The mechanism of action of Ashwagandha in managing stress-related mental disorders is not fully understood yet. Majeed et al. (2023) [45] suggest that one of the possible mechanisms of action is through serotonin, as demonstrated by a notable rise in serotonin serum levels in the Ashwagandha group compared to placebo. Nonetheless, not considering the changes in cortisol, noradrenaline, dopamine and GABA levels, which are also considered key factors in the development of stress, anxiety and depression, remains a limitation [45].

The Anti-Obesity Effect

Studies suggest that Ashwagandha can be used for body weight management in adults under chronic stress. Psychical strain leads to deterioration of eating behaviors, using it as a coping mechanism. Increased serum cortisol level can also cause intensified visceral fat deposition in humans [47]. Ashwagandha has been reported to reduce cortisol levels even about 23% [39]. Reducing stress and serum cortisol levels is correlated with improving eating behaviors, such as decreased food intake and increased physical activity, as well as diminished food cravings [47]. In skeletal muscle and adipose tissue this herb improves mitochondrial function as a result of enhancing energy expenditure. Withania Somnifera supplementation increased oxygen consumption and enhanced mitochondrial activity in brown fat and skeletal muscle in mice fed a high-fat diet [48]. These data suggest that Withania Somnifera has an anti-obesity effect because of withanolides in this herb. Further research is needed to establish whether a prevention of weight gain caused by chronic stress can be achieved by the supplementation.

Effects on Fertility in Men

Supplementation of root extract of Ashwagandha in dosage of 675 mg per day is a possible treatment of decreased fertility in males. This herb can help by an increase in sperm concentration, ejaculate volume, and motile sperm count. This is due to the increased spermatogenesis and secretion of the accessory sex organs, which results from the increased level of both Testosterone and LH (luteinising hormone) [49]. Research by Lopresti et al. (2019) reported an increase of Testosterone level up to 11,5% [39]. Another study confirmed these results and suggested other possible ways of how this herb can treat infertility in men.

Withania Somnifera reduces oxidative stress by inhibiting lipid peroxidation and protein carbonyl content. Supplementation recovered the seminal plasma levels of antioxidant enzymes, vitamins A, C, and E, as well as fructose. Moreover, treatment significantly reduced the level of FSH (follicle-stimulating hormone) and PRL (prolactin) [50].

Effects on Sexual Function in Women

The study by Dongre et al. (2015) [51] demonstrated that Ashwagandha may improve sexual function in healthy women. It can alleviate symptoms such as reduced libido, vaginal dryness, reduced genital perception and arousal, pain during intercourse and problems with achieving orgasms. These symptoms are caused by underlying neurovascular, hormonal, or psychogenic problems. Treatment was useful in relieving symptoms of FSD (female sexual disorders) by increasing Testosterone level and relieving stress [51].

There have also been studies on the effects of this supplement on perimenopause. Serum estradiol has increased and, at the same time, FSH and LH levels have significantly decreased. Better well-being was also noted in the examined women. These findings suggest that Ashwagandha root extract can relieve certain symptoms of perimenopause in women, such as insomnia, fatigue, hot flashes, headache and weight gain [52].

Effects on the Cardiovascular System

Investigations into the cardiovascular effects of Withania Somnifera so far have been concluded on animal models [53,54,55]. Research on albino rats with myocardial necrosis induced by isoprenaline treatment showed that Ashwagandha may present a cardioprotective effect. Treatment restored the myocardial oxidant-antioxidant balance due to decreased activity of superoxide dismutase (SOD), catalase, creatinine phosphokinase, and lactate dehydrogenase [53]. Further findings confirm that Withania Somnifera preserves the integrity of myocardial cell membrane in rats with ischemia [54]. The effects of Ashwagandha have been associated with an increase in endothelial nitric oxide synthase (eNOS) expression in the lungs of rats, which elevates NO levels and exhibits vasodilatory, anti-inflammatory, and apoptosis-inducing effects. Preventive treatment improved endothelial dysfunction, and reversed the remodeling of pulmonary vasculature associated with pulmonary hypertension [55].

SAFETY AND ADVERSE EFFECTS

Ashwagandha (Withania Somnifera) appears to be safe and well-tolerated. In a randomized, double-blind study involving 80 healthy participants over an 8-week period there was no found deviation in biochemical parameters [56]. Moreover, Ashwagandha supplemented for up to 12 weeks does not appear to cause severe adverse effects [57]. No abnormalities in biochemical,

hematological, liver and kidney function parameters have been noted. Though the abovementioned studies have not reported severe adverse effects related to Withania Somnifera supplementation, the lack of long-term assessment along with specific dose recommendations remains a limitation. However, the extract from Withania Somnifera is contraindicated in patients suffering from autoimmune diseases. It also should not be taken in hyperthyroidism, because of the fact that root of Ashwagandha increases concentration of T3 (triiodothyronine) and T4 (thyroxine) in blood [58]. There are reports of hepatotoxicity associated with Ashwagandha supplementation, however, the evidence supporting this claim is limited [15]. Notably, liver function parameters typically return to baseline within 1 to 5 months after discontinuation of supplementation [59].

CONCLUSIONS

Ashwagandha (Withania Somnifera) has been valued for centuries in traditional medicine, due to its versality of beneficial properties on the body system. The review confirmed numerous health-promoting properties of Ashwagandha and its multi-directional effects. This supplement seems to be particularly promising for professional athletes not only due to a positive effect on endurance and strength parameters, but also by improving sleep quality, lowering cortisol levels and having a positive effect on hematological parameters. Moreover, some clinical trials suggest that Ashwagandha may be an applicable adjunctive agent in treating muscular, cardiovascular and fertility disorders. However, these reports are limited and further clinical trials are required to fully establish its potential and therapeutic use. Additionally, it is vital to determine safe and effective doses and test the supplement in the context of adverse effects. Although current findings do not indicate any, it is important to emphasize that the studies conducted to date have been limited by small sample size and short duration time. Despite the challenges and limitations regarding Ashwagandha, its multifaceted effects may contribute to its wide-spread use in the future.

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