International Journal of Physical Education and Sports
www.phyedusports.in
Volume: 2, Issue: 12, Pages: 16-24, Year: 2017
Impact Factor: 3.125 (RIF)

Ashawgandha (Withania Somnifera) A Rasayna in Ayurveda and Benefits of Its Use than Other Performance Enhancing Substances in Sports Medicine – A Review Article

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Received Nov 21, 2017; Accepted Dec 06, 2017; Published Dec 07, 2017

Abstract

OBJECTIVE: The objective of this paper is to review the literature regarding Ashwagandha (Withania somnifera) a commonly used herb in Ayurvedic medicine. Specifically, the literature was reviewed for articles pertaining to therapeutic actions, toxicity and benefits of Ashwagandha than performance enhancing substances (PES) in sports medicine. DESIGN: This review is in a narrative format and consists of all publications relevant to Ashwagandha that were identified by the authors through a systematic search of major computerized medical databases; no statistical pooling of results or evaluation of the quality of the studies was performed due to the widely different methods employed by each study. RESULTS: Studies indicate Ashwagandha possesses anti-inflammatory, antitumor, antistress, antioxidant, immunomodulatory, hemopoetic, adaptogenic and rejuvenating properties. It also appears to exert a positive influence on the endocrine, cardiopulmonary, and central nervous systems. Toxicity studies reveal that ashwagandha appears to be a safe compound whereas other performance enhancing substances have lot of side effects. CONCLUSION: Preliminary studies have found various constituents of ashwagandha exhibit a variety of therapeutic effects with little or no associated toxicity. These results are very encouraging and indicate this herb should be studied more extensively to confirm these results and reveal its benefits than other performance enhanacing substances.

Key Words: Ashwagandha, performance enhancing substances, adaptogens

1. Introduction:

Ashwagandha (Withania somnifera) roots are classified as a "*Rasayana*" (rejuvenator), and have been used toward promoting health and longevity, slowing the aging process, revitalizing the body and generally creating a sense of well-being [1,2]. The use of *Ashwagandha* was to increase energy, youthful vigour, endurance, strength, health, nurture the time elements of the body, increase vital fluids, muscle fat, blood, lymph, semen and cell production. It helps counteract chronic fatigue, weakness, dehydration, bone weakness, loose teeth, thirst, impotency, premature aging emaciation, debility, convalescence and muscle tension. It helps invigorate the body by rejuvenating the reproductive organs, just as a tree is invigorated by feeding the roots.[3,4]. This herb has powerful antioxidant properties that seek and destroy the free radicals which have been implicated in aging and numerous disease states. Even more remarkable, emerging evidence suggests that *Ashwagandha* has anti-cancer benefits as well. Both the modern medical literature and Ayurveda writings report many potential health benefits of the *Ashwagandha* herb (Withania somnifera, also known as Indian Ginseng or Winter Cherry) under the rubrics of anti-stress effects, neuroprotective effects, immunomodulatory effects, and rejuvenating effects, via the herb's interplay with the nervous system, the endocrine system, the cardiopulmonary system, the energy production system and the immune system including analgesic, antimicrobial, anti-inflammatory, anti-tumor, anti-stress, anti-diabetic, neuroprotective, immunoprotective and cardioprotective effects [5,6].*Ashwagandha* is a member of the family of herbs referred to as "adaptogens". [7] The adaptogen family of herbs has many members, noteworthy among them being rhodiola, ginseng, schisandra and maca [8]. Adaptogens are used commonly for stress relief, brain health, adrenal health and for ameliorating HPA-axis dysfunction. More recently, adaptogens have started to be used in sports supplements that aim to enhance physical fitness. Recent research has

found adaptogens to be promising in this application domain [9]. Studies in healthy normal adults demonstrated that ashwagandha improves muscular strength/coordination, and cardiorespiratory endurance [10]. Studies in humans show that *Ashwagandha* is well tolerated and is associated with decreases in cortisol [11], and increases in testosterone [12]. Research suggests that *Ashwagandha* may reduce increases of blood urea nitrogen, lactic acid, corticosterone in response to stress [13] and also reduce the tendency of dopamine receptors in the brain to activate under stress [14].

Physical activity and exercise is one of the main foundation of health and well-being. Unfortunately, trends indicate that our culture is more in student athletes for their talent rather than health care and encouragement. So the stress of performance is so high that many professional athletes use banned performance enhancing drugs. Recent studies suggest that familial and social pressure for performance may encourage our young athletes to start using performance enhancing substances (PES). Moreover Adolescents in developed countries frequently use dietary supplements despite a lack of knowledge about possible harmful effects or drug interactions. Often males turn to dietary supplements in an attempt to increase their performance for sports while females are more concerned with preventing illness and disease. As these anabolic androgenic steroids and health supplements are associated with early coronary artery disease & other health side effects. So Greater awareness is needed of the potential risks of these drugs and use of herbs like *ashawgandha* should be done which not only helpful in strengthening but also give benefits in maintaining overall health. [15]

USE OF HEALTH SUPPLEMENTS AND THEIR SIDE EFFECTS

To understand the underlying reasons and sources of recommendation for dietary supplement use among adolescents in Slovenia, researchers at the University of Ljubljana studied both athletes and non-athletes. After analysis of the data, enhancement of sport performance was cited as the top reason for consuming dietary supplements by both male athletes and non-athletes, followed by growth and development of bones and muscles. Similarly, improving their immune system was named as the primary reason for both female athletes and non-athletes, followed by sports performance. Adolescents using dietary supplements at least several times a year were more likely to be engaged in team sports such as football and basketball than in individual sports. Over 40 percent of both genders decided to use supplements on their own, while 30 percent based their usage on a recommendation from parents or other relatives. Study found the use of dietary supplements was high in nonathletes and athletes of both genders although available evidence warns against noncritical use. This is likely due to marketing campaigns from manufacturers and uncritical coverage in lay publications [16].

In another study, it was found that anabolic androgenic steroid abuse among young people is a widespread problem worldwide with adverse events such as sudden cardiac death and heart attack have been reported in athletes. In this study it was also examined whether anabolic androgenic steroids could be associated with early coronary artery disease and also tested whether reduced high-density lipoprotein (HDL) function could be a mechanism leading to coronary artery disease in anabolic androgenic steroid users. The study included 51 men with an average age of 29 years (range 23 to 43 years). Of those, 21 did weight lifting and had taken anabolic androgenic steroids for at least two years, 20 did weight lifting but did not take steroids, and ten were healthy but sedentary. Participants underwent computed tomography coronary angiography to assess the presence of atherosclerosis in the coronary arteries. A urine test was performed in all participants to confirm steroid use. Blood samples were taken to measure lipid levels including HDL. The researchers used cell cultures to measure the ability of each participant's HDL to perform its normal function of removing cholesterol from macrophages (white blood cells). The researchers found that 24% of steroid users had atherosclerosis in their coronary arteries, compared to none of the non-users and sedentary participants. The steroid users with atherosclerosis also had significantly reduced HDL levels and HDL function. Study suggests that anabolic androgenic steroid use may be associated with the development of coronary artery disease in apparently healthy young people. Steroids may have an impact on the ability of HDL to remove cholesterol from macrophages, thereby promoting atherosclerosis. Researchers observed coronary atherosclerosis in young anabolic androgenic steroid users, which in combination with lower HDL levels and reduced HDL function could increase the risk of cardiovascular events. [17].

Another study has revealed that Retired professional footballers are far more prone to develop knee pain with osteoarthritis and face problems with their knees earlier in life than the average person. More than 1,200 ex-footballers

with an average age of 59 years were recruited via the PFA and from individual league clubs and professional football associations in the UK and compared to more than 4,000 general population men from the East Midlands region with an average age of 62.8 years. The study reported that male ex-footballers were two to three times more likely to suffer from knee pain and knee osteoarthritis and require a total knee replacement, even after adjustment for other risk factors including significant knee injury. Ex-footballers reported more knee pain, structural knee osteoarthritis on x-ray and total knee replacements across all age groups in the study and especially in younger age groups (40-54 years). Other novel findings include: ex-footballers had more osteoarthritis in the end joints of their fingers (nodal OA), were more likely to have an index finger shorter than their ring finger - also known as a pattern three-digit ratio, which has been previously linked to osteoarthritis risk; and reported significantly more body pain, knee misalignment and use of painkillers. This study concludes that the 'repetitive microtrauma' of professional football, regardless of significant injury, is likely to be the main cause of increased risk of knee osteoarthritis. It's worth reminding people who take part in regular sports or physical activity, such as football, that regular exercise is important for all ages and the long-term health benefits are immense. [18]

EFFECTS ON THE NERVOUS SYSTEM

In anxiety and depression, *ashwagandha* has been demonstrated to be as effective as some tranquilizers and antidepressant drugs. Specifically, oral administration of *ashwagandha* for five days suggested anxiety-relieving effects similar to those achieved by the anti-anxiety drug lorazepam (Ativan®), and antidepressant effects similar to those of the prescription antidepressant drug imipramine (Tofranil®).[19 When *ashwagandha* extract was administered by re-searchers one hour before a daily stress-inducing procedure, all of the aforementioned parameters of free radical damage normalized in a dose-dependent manner. Premature aging associated with chronic nervous tension may be related to increased oxidative stress, which is abolished by the potent antioxidant properties of *ashwagandha* extract.[21] In a remarkable animal study, examination of the brains of sacrificed animals showed that 85% of the brain cells observed in the animals exposed to chronic stress showed signs of degeneration. It is this type of cellular degeneration that can lead to long-term cognitive difficulties. Amazingly, when ashwagandha was administered to chronically stressed animals, the number of degenerating brain cells was reduced by 80%[22].

In one of the most complete human clinical trials to date, researchers studied the effects of a standardized extract of ashwagandha on the negative effects of stress, including elevated levels of the stress hormone cortisol. The participants subjectively reported increased energy, reduced fatigue, better sleep, and an enhanced sense of well-being. The participants showed several measurable improvements, including a reduction of cortisol levels up to 26%, a decline in fasting blood sugar levels, and improved lipid profiles.[23] Furthermore, ashwagandha extract supported the reconstruction of synapses, the junctions where nerve cells communicate with other cells. The investigators concluded that ashwagandha extract helps to reconstruct networks of the nervous system, making it a potential treatment for neurodegenerative diseases such as Alzheimer's [24]. Researchers found that ashwagandha helped support the growth of nerve cell dendrites, which allow these cells to receive communications from other cells. The researchers noted that ashwagandha helped promote the growth of both normal and damaged nerve cells, suggesting that the herb may boost healthy brain cell function as well as benefit diseased nerve cells.[25]

POTENT ANTI-CANCER ACTIVITY

In addition to ashwagandha's documented neuroprotective effects, exciting recent evidence suggests that it also has the potential to stop cancer cells in their tracks. In fact, researchers reported that withaferin A, a specific compound extracted from ashwagandha, was more effective than doxorubicin in inhibiting breast and colon cancer cell growth.[26] Additionally, laboratory analysis indicates that ashwagandha extract possesses anti-angiogenic activity, also known as the ability to prevent cancer from forming new blood vessels to support its unbridled growth. [27] Ashwagandha's protective effect against skin cancer has been shown in other studies as well. [28] A recent experiment demonstrated that ashwagandha extract produced a marked increase in life span and a decrease in tumor weight in animals with experimentally induced cancer of the lymphatic system.[29] All these findings lend further support to ashwagandha's potential role in fighting cancer.

ANTI-INFLAMMATORY PROPERTIES -

The effectiveness of *ashwagandha* in a variety of rheumatologic conditions may be due in part to its anti-inflammatory properties, which have been studied by several authors. In a study, WS was found to cause considerable reduction in inflammation. Acute phase reactants of the blood monitored by crossed immunoelectrophoresis showed changes in the concentration of many serum proteins (α2-glycoprotein, major acute phase α1protein, and pre-albumin) in the WS group. The α2-glycoprotein found only in inflamed rat serum was decreased to undetectable levels in the WS group. Phenylbutazone, on the other hand, caused a considerable increase in the α2glycoprotein in both arthritic and healthy rats. Another acute phase protein (peak 2, α-1 major acute phase) which increased approximately 200 percent by inflammation was brought back to normal levels by WS treatment but only to 132 percent of normal by phenylbutazone. WS influenced several modulator proteins in normal rats, suggesting that several plant chemicals in WS possibly interact with the liver protein synthesis process. [30] Another study found WS caused dose-dependent suppression of α2-macroglobulin (an indicator for anti-inflammatory drugs) in the serum of rats inflamed by sub-plantar injection of carrageenan suspension. The doses of WS root powder were 500, 1000, 1500, or 1200 mg/kg given as suspension orally 3-4 hours prior to induction of inflammation. Maximum effect (about 75%) was seen at 1000 mg/kg [31]. In a another study it was found that WS decreased the glycosaminoglycans content in the granuloma tissue by 92 percent, compared with 43.6 percent by hydrocortisone (15 mg/kg) treatment and no effect by phenylbutazone treatment (100 mg/kg). WS also uncoupled the oxidative phosphorylation by significantly reducing the ADP/O ratio in mitochondria of granuloma tissue. It increased the Mg2+ dependent-ATPase enzyme activity and also reduced the succinate dehydrogenase activity in the mitochondria of the granuloma tissue; no such effect was produced by the reference drugs. [32] In another study, WS caused significant reduction in both paw swelling and degenerative changes as observed by radiological examination in rats. The reductions were better than those produced by the reference drug, hydrocortisone (15 mg/kg).[33] One clinical trial supports the possible use of WS for arthritis[34]. In a double-blind, placebo-controlled cross-over study, 42 patients with osteoarthritis were randomized to receive a formula containing ashwagandha (see Table 1 for formula) or placebo for three months. Patients were evaluated for one month, pretreatment, during which time all previous drugs were withdrawn. During both the pretreatment and treatment phase, pain and disability scores were evaluated weekly while erythrocyte sedimentation (SED) rate and radiological studies were conducted monthly. The herbal formula significantly reduced the severity of pain ($p<0.001$) and disability ($p<0.05$) scores, although no significant changes in radiological appearance or SED rate were noted.[23] Few studies have been conducted on the mechanism of action for the anti-inflammatory properties of WS. In one study, rats injected with 3.5-percent formaline in the hind leg footpad showed a decrease in absorption of 14C-glucose in rat jejunum.[35] Glucose absorption was maintained at the normal level by both WS and the cyclooxygenase inhibitor oxyphenbutazone. Both drugs produced antiinflammatory effects. Similar results were obtained in parallel experiments using 14C-leucine absorption from the jejunum.[36] These studies suggest cyclooxygenase inhibition may be involved in the mechanism of action of WS.

ANTIOXIDANT EFFECT

The brain and nervous system are relatively more susceptible to free radical damage than other tissues because they are rich in lipids and iron, both known to be important in generating reactive oxygen species. [37] The brain also uses nearly 20 percent of the total oxygen supply.[38] Free radical damage of nervous tissue may contribute to neuronal loss in cerebral ischemia and may be involved in normal aging and neurodegenerative diseases, e.g., epilepsy, schizophrenia, Parkinson's, Alzheimer's, and other diseases.[39] The active principles of WS, sitoindosides VII-X and withaferin A (glycowithanolides), have been tested for antioxidant activity using the major free-radical scavenging enzymes, superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPX) levels in the rat brain frontal cortex and striatum. An increase in these enzymes would represent increased antioxidant activity and a protective effect on neuronal tissue. Active glycowithanolides of WS (10 or 20 mg/kg intraperitoneally) were given once daily for 21 days to groups of six rats. Dose-related increases in all enzymes were observed; the increases comparable to those seen with deprenyl (a known antioxidant) administration (2 g/kg/ day intraperitoneally). This implies that WS does have an antioxidant effect in the brain which may be responsible for its diverse pharmacological properties.[40] In another study, an aqueous suspension of WS root extract was evaluated for its effect on stress-induced lipid peroxidation (LPO) in mice and rabbits. It was found that Oral administration of WS extract (100 mg/kg) prevented an increase in LPO. [41]

REJUVENATING EFFECT

He growth-promoting effect of WS was studied for 60 days in a double-blind study of 60 healthy children, age 8-12 years, who were divided into five groups of 12. [42]Group 1 was given purified and powdered WS 2 g/day fortified in 100 cc of milk (no details about purification and powdering methods were disclosed). Similarly, Group 2 received 2 g daily of a mixture of equal parts WS and punarnava (Boerhaavia diffusa), Groups 3 and 4 were given ferrous fumarate 5 mg/day and 30 mg/day, respectively, and Group 5 received placebo. Group 1 experienced a slight increase in hemoglobin, packed cell volume, mean corpuscular volume, serum iron, body weight, and hand grip, and significant increases in mean corpuscular hemoglobin and total proteins ($p<0.01$) at the end of 60 days when compared to the initial level and the placebo group. There was an increase in body weight in all groups over the control group. It was also noted that 13 of 15 children had an increase in body weight, 10 children had an increase in hemoglobin and packed cell volume, and 11 children had an increase in serum iron. The study demonstrated that WS may be useful as a growth promoter and hematinic in growing children. In another clinical trial, WS purified powder was given 3 g/day for one year to 101 normal healthy male volunteers, age 50-59 years. All subjects showed significantly increased hemoglobin and RBC count, and improvement in hair melanin and seated stature. They also showed decreased SED rate, and 71.4 percent of the subjects reported improvement in sexual performance. In summary, these studies indicate WS may prove useful in younger as well as older populations as a general health tonic.[43]

EFFECTS ON THE ENDOCRINE SYSTEM

Based on the observations that WS provides protection from free radical damage in the mouse liver, studies were conducted to determine the efficacy of WS in regulating thyroid function. Mice were given WS root extract (1.4 g/kg by gavage, daily for 20 days). The treatment significantly increased the serum levels of 3,3',5-triiodothyronine (T3) and tetraiodothyronine (T4), while the hepatic concentrations of glucose 6-phosphatase activity and hepatic iodothyronine 5'-monodeiodinase activity did not change significantly. WS significantly reduced hepatic lipid peroxidation and increased the activity of superoxide dismutase and catalase. The results suggest WS stimulates thyroidal activity and also promotes hepatic antioxidant activity[44,45]. A combination formula of WS, Tinospora cordifolia, Eclipta alba, Ocimium sanctum, Picorrhiza kurroa, and shilajit was found to cause a dose-related decrease in streptozotocin-induced hyperglycemia. None of the herbs given individually, however, produced any effect on the hyperglycemia, indicative perhaps of why Ayurvedic medicine generally prefers combinations of herbs rather than single herbs [46].

EFFECTS ON THE CARDIOPULMONARY SYSTEM

WS may be useful as a general tonic, due in part to its beneficial effects on the cardiopulmonary system, as reported in the following studies. The effect of AG was studied on the cardiovascular and respiratory systems in dogs and frogs.[47] The alkaloids had a prolonged hypotensive, bradycardiac, and respiratory-stimulant action in dogs. The study found that the hypotensive effect was mainly due to autonomic ganglion blocking action and that a depressant action on the higher cerebral centers also contributed to the hypotension. The alkaloids stimulated the vasomotor and respiratory centers in the brain stem of dogs. The cardio-inhibitory action in dogs appeared to be due to ganglion blocking and direct cardio-depressant actions. The alkaloids produced immediate predominant but short lived cardio-depressant effects and a weak but prolonged cardiotonic effect in isolated normal and hypodynamic frog hearts. The pharmacological actions of the total extract of WS roots on the cardiovascular and respiratory systems appeared to be due to its alkaloid content. The total alkaloids were more than twice as active as the 70-percent alcohol extract of WS root. These studies were found to be consistent with the use of WS as a tranquilizing agent.

GENERAL TOXICITY STUDIES

The acute toxicity data found as a part of pharmacological studies are summarized here. In one central nervous system study, a two-percent suspension of ashwagandholine (total alkaloids from the roots of WS) prepared in ten-percent propylene glycol using twopercent gum acacia as suspending agent was used to determine acute toxicity. The acute LD50 was 465 mg/kg (332-651 mg/kg) in rats and 432 mg/kg (299-626 mg/kg) in mice. [48]

In one long-term study, WS was boiled in water and administered to rats in their daily drinking water for eight months while monitoring body weight, general toxicity, well being, number of pregnancies, litter size, and progeny

weight. In the four-week study, the weight gain in the treated group was comparable to that of the control group. The body temperature in the WS treated group was 1.7ºC lower than the controls. The WS treatment caused an increase in lung and liver weights and a decrease in adrenocortical activity as was evident from the reduction in adrenal weight and a significant reduction in plasma cortisol ($p<0.001$). Histopathologically, all organs were normal. The authors attributed the increase in liver weight to an increase in glycogen storage because WS contains many steroids and glucocorticoids known to enhance liver glycogen stores. Reduction in metabolic rate also leads to underutilization of glycogen stores in the liver, leading to its accumulation. The reduced adrenocortical activity may be attributed to steroid moieties in WS roots which may act like exogenous adrenocortical steroids, lowering the ACTH secretion and consequently, endogenous steroid production. The authors concluded the decoction of WS promoted growth especially during the active growth period and helped produce healthier progeny. The WS group was devoid of any toxic effects after eight months of daily dosing in this study. [49]

EFFECT ON MUSCLE

In one of the study it was found that extracts from W. somnifera have the potential to improve muscle strength and endurance in aged subjects. The therapeutic management of sarcopenia with *Ashawgandha* (Withania Somnifera) is critical in improving the quality of life of the elderly and reducing morbidity. In the study it was also found that the blood creatine kinase levels declined a lot in the 3-month trial. We found that the herb W. Somnifera may have the potential to improve muscle strength and endurance for the aged subjects. It has also shown a significant role in improving muscle functioning. The changes in blood creatine kinase levels with the use of the W. somnifera suggest a possible increase in muscle metabolism or a possible decline in muscle catabolism.[50]

Another study was designed to investigate the effect of supplementation of WS on the Core Muscle Strength and Stability in Hockey players. Thirty two male hockey players, with a mean age of 17.3 ± 1.8 years and BMI 20.7 ± 2.8 kg/m2 volunteered for the study. Subjects were randomly assigned into two groups Group I (n= 24): Withania somnifera group (experimental group) and Group II (n=24): Placebo (control) group. The experimental group received 500 mg capsules of aqueous roots of *Ashwagandha* twice daily for eight weeks, whereas the placebo group received starch capsules. Core Muscle Strength & Stability was assessed with Mackenzie B. (2002) Core Muscle Strength and Stability Test in both experimental and control groups before and after the administration of Withania somnifera and placebo respectively. A significant improvement in the Core Muscle Strength & Stability after 4 weeks ($t = 2.99$, $p< 0.021$, on tail rest) and 8 weeks ($t = 9.05$, $p < 0.02$, one tail test) in experimental group was found. Whereas, no significant improvement in the control group for Core Muscle Strength & Stability after 8 weeks of placebo supplementation was found.[51]

Aphale et al. (1998) reported in a study conducted on rats, intake of ginseng and ashwagandha for 90 days, researchers found significant increase in body weight, food consumption and liver weight, and improved hematopoiesis. They did not reveal any toxicity of brain, heart, lung, liver, spleen, kidneys, stomach, testis and ovaries.[52] Further the side effects of WS were not significantly different from those experienced by placebo-treated individuals.[53,54]

The growth-promoting effect of WS was studied for 60 days in a double-blind study of 60 healthy children, age 8-12 years, experienced a slight increase in hemoglobin, packed cell volume, mean corpuscular volume, serum iron, body weight, and hand grip, and significant increases in mean corpuscular hemoglobin and total proteins ($p<0.01$) at the end of 60 days when compared to the initial level and the placebo group.[55] WS may induce the synthesis of inducible nitric oxide expression likely by acting at transcriptional level[56]. In an another study found that eight weeks of *Ashwagandha* supplementation increased endurance, respiration capacity and metabolic efficiency among cycling athletes.[57]

DISCUSSION

As outlined above, results from various studies indicate *Ashwagandha* possesses many qualities, including anti-inflammatory, antitumor, immunomodulatory properties, performance enhancer as well as exerting an influence on the endocrine, nervous, and cardiopulmonary systems. Further clinical studies should be conducted, as well as studies in multiple animal-based models using a variety of suitable biochemical markers (e.g., urinary excretion of pyridinoline and deoxypyridinoline) to understand its mechanism of action. Any protective or prophylactic effect it may have on the

development of arthritis should also be investigated, as well as effects it may have on cartilage degradation or regeneration. As for its use in fighting cancer, confirmatory studies in several other animal tumor systems must be conducted for more definitive findings. Studies should also be carried out to determine the effects, if any, of WS on existing antitumor agents when given in combination with WS. Regarding the effects observed in animals on the endocrine and cardiopulmonary systems, the therapeutic significance of these biochemical markers is not clear. Studies points benefit of WS in muscular system and as a performance enhancer and further studies required to establish *ashwagandha* as a performance enhancing substance (without any side effect) in sports medicine. The review indicates that WS not only useful as adaptogen or performance enhancing substance but also in many ailments, including arthritis and other musculoskeletal disorders, stress-induced nervous exhaustion, and hypertension. There are a few preliminary studies available on the effects of WS on the immune system, central nervous system, hemopoetic system, and general growth promotion to form a basis for further studies but not enough evidence to provide a firm scientific basis for definitive therapeutic uses.

CONCLUSION:

Use of performance enhancing drugs is very common in young as well as professional athletes. Although the results from this review are quite promising for the use of *ashwagandha* as performance enhancing drug or healthy supplement or multi-purpose medicinal agent, but several limitations currently exist in the current literature. While *ashwagandha* has been used successfully in Ayurvedic medicine for centuries, more clinical trials should be conducted to support its therapeutic use. It is also important to recognize that WS may be effective not only in isolation, but may actually have a potentiating effect when given in combination with other herbs or drugs in sports medicine.

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