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DISCOVERING THE POTENTIAL OF ASHWAGANDHA FOR HORMONAL BALANCE: A COMPLETE REVIEW

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ABSTRACT

Ashwagandha has the botanical name *Withania Somnifera* (WS) and family name *is Solanaceae*, a medicinal plant of herbs. Owing to its numerous health benefits, it has been traditionally used in Indian medication. This detailed review unfolds the outlook as whether WS may have an ability to normalize hormone levels, specifically focusing on its impact over pituitary gland functioning, thyroid function regulation, adrenal system homeostasis and likewise sexual & reproduction functions. The bioactive compounds existing in WS, predominantly withanolides, show a vital role in facilitating its pharmacologic actions. The review too highlights the nutritive composition of WS, highlighting its protein, fiber, and vital mineral content. Systematic studies have proved the capability of WS to improve male fertility and normalize thyroid hormones. It also moderates stress related hormones, thereby refining cognitive function and sleep excellence. Furthermore, WS shows distinguished antioxidant and anti-inflammatory properties, additional contributive to its beneficial versatility. Though, in spite of these auspicious results, additional in vivo studies are required to clarify the primary mechanisms of WS's bioactivities and to authenticate its beneficial potential in hormone stability and additional health aids. This review highlights the standing of continuous research to found the effectiveness of WS as a therapeutic mediator.

***Keywords*:** Ashwagandha, Hormonal balance, Withanolides, Traditional medicine, Reproductive health, Antioxidant properties.

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1. INTRODUCTION

Ashwagandha is scientifically acknowledged as WS of the *Solanaceae* family, it is broadly utilized as an herbal medication since 6000 B.C. It is a perennial woody plant and is mentioned by numerous names such as "Indian winter cherry" or "Indian ginseng" in English, and "Asgand" in Urdu (Paul *et al*., 2021). This plant has been used in traditional Indian medication for a momentous period of time, and its roots are merged into over 200 different preparations (Sharifi-Rad *et al*., 2021). WS has an extensive history of traditional usage for numerous psychological and physical health aids. It is known as a plant-derived nutritious constituent. So, WS can be considered mutually an herbal medicine and a plant-derived nutritious constituent (Gomez Afonso *et al.*, 2023). The plant leaves are acknowledged that it has 12 Withanolide, tannin, flavonoid, glycoside, and free amino acid. Alternatively, the plant root hold steroid, volatile oil, alkaloid and reducing sugars (Abdelwahed *et al*., 2023) WS is certainly a noteworthy plant with numerous health benefits. Scientific studies have revealed that it has revitalizing properties and can encourage development in the body, predominantly in muscles and bone marrow, by being supportive to mitochondrial health. It is also used as an immunomodulator for curing arthritis. The roots of WS are acknowledged for their aphrodisiacal, tranquillizing, and deobstruent effects, whereas the leaves have anti-inflammatory, hepatoprotective, and antibacterial properties. The fruits and seeds are taken as diuretics. Moreover, the active ingredients in WS have proved potential as anti-carcinogenic agents and can recover cognitive function and reminiscence. It is also considered a effective nervine stimulant (Jain & Mathur, 2020). Study shown on animal models has provided indication supporting the anti-stress effects of WS extracts (Wang *et al*., 2021). In current times, wide researches have exposed the notable cytotoxic action of Withaferin A (WFA), a bioactive compound found in WS. This action proposes its probability like a chemotherapeutic agent in curing numerous types of cancers (Dutta *et al*., 2019). Scientific studies have revealed that WS has a noteworthy impact on the hormonal function. It is detected for controlling pituitary system function, help thyroid gland balance, adjust activity of adrenal, and apply impact on the reproductive system. These effects are credited to the existence of exclusive compounds found in WS (Wicinski *et al.*, 2023). As the acceptance of WS supplements lingers to increase, it develops progressively significant to

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systematically comprehend its biological properties in order to authenticate and enhance its usage (M. Ali, 2021). Furthermore, the administration of WS has revealed potential in enhancing male fertility action and regulating thyroid hormone levels in persons with subclinical hypothyroidism (Della Porta *et al*., 2023).

Energy composition and bioactive compounds

WS has an energy content of 245 kilocalories per 100 grams. it a calorie-dense food. It contains 3.9 grams protein. The fat content is low at 0.3 grams per 100 grams, representing a low fat profile, while it is also characterized by a high crude fiber content of 32.3 grams per 100 grams. Fiber is helpful for gastrointestinal health and gives a sensation of fullness. Carbohydrates 49.9 grams providing energy for the body. WS also contains vital minerals, such as 3.3 mg of iron and 23 mg of calcium per 100g. it includes carotene at 75.7 micrograms and vitamin C 5.8 milligrams, contributive to its antioxidant properties and possible immune system support. These nutrient values highlight WS's potential as a nourishing and advantageous dietary supplement or ingredient (Sharifi-Rad *et al*., 2021). It contains a diversity in bioactive compound in different plant parts, for example roots, shoots, and leaves. WS contains many bioactive ingredients, such as withaferinA, withanolideD, withanosiides, withanones and sitoindosides, anaferine, and sopelletierine and alkaloids, steroidal lactones, and saponins. These composites have therapeutic properties as anti-stress agents and revitalizing stimulants. WS is also rich in iron, which is crucial for the development of red blood cells and the conveyance of oxygen to numerous organs, thus enlightening energy levels in the body. Continuing research is engrossed on understanding the mechanisms of action of these phytochemicals, together with their connections with drug receptors and the atmosphere in which they interrelate (Chen & Russo-Neustadt, 2023). The principal bioactive compounds are called withanolides, which have numerous therapeutic effects and may benefit with hormonal balance (Shinde *et al*., 2023). There are also other compounds found in WS, like caffeine, somniferine, gallic acid, linoleic acid, apigenin, quercetin, palmitic acid, and oleanolic acid. These compounds pay to WS's antioxidant, anti-inflammatory, and hypothetically hormone-regulating properties (Sharma & Singh, 2023). WS has been known for its noteworthy adaptogenic properties, contributing important protective health benefits and therapeutic consequences for centuries. However, it is vital to create standardized procedures for WS and additional herbal agents to guide the supervisory procedure and confirm indication-specific results. In a specific study, the subcellular effects of two different WS extracts were systematically investigated, as well as the actions of numerous commercially accessible WS extracts. It was detected prominent differences in activity amongst different extracts, prominence the importance of emerging indication-specific differences that can efficiently target specific drug receptors to possibly treat numerous situations such as premature aging, cancer, oxidative stress, and even alopecia. While patients every so often experience some level of benefit from these substitute medicines, medical physicians must have reliable systems prepared to certify steady and appropriately studied extracts for expectable consequences beyond a generic "WS extract" description (Cavaleri *et al*., 2023). Table 1 explains about the nutritional components of Ashwagandha and Table 2 explains the bioactive compounds of Ashwagandha. Table 3 shows the effect of Ashwagandha for hormonal balance.

Table 1: Nutritional components of Ashwagandha

Components	Nutrient Value (per 100 g)	Citation
Energy	245 kcal	(Sharifi-Rad *et al*., 2021)
Protein	3.87g	
Fat	0.31g	
Crude Fiber	32.30g	
Carbohydrate	49.90g	
Vitamin C	5.8mg	
Calcium	23mg	
Iron	3.31mg	
Carotene	75.7 µg	

Table 2: Bioactive compounds of Ashwagandha

Compounds	Part of Plant	Citation
Withanolides	Roots, shoot, leaves, whole plant	(Shinde *et al*., 2023)
Caffeine	Fruits, Roots	(Sharma & Singh, 2023)
Somniferine	Roots	(B.M & Banu, 2022)
Apigenin	Berries	
Quercetin	Whole plant	
Gallic acid	whole plant	
Linoleic acid	Roots and leaves	
Palmitic acid	Roots and leaves	
Oleanolic acid	Roots	

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Abbreviations: WS, Withania somnifera; FSFI, Female Sexual Function Index; FSDS, Female Sexual Distress Scale; SSEs, Sexual Satisfaction Events; PSS-10, Perceived Stress Scale-10; SF-12, Short Form Health Survey-12; QoL, Quality of Life; OECD, Organisation for Economic Co-operation and Development; T3, Triiodothyronine; T4, Thyroxine; TSH, Thyroid Stimulating Hormone; LH, Luteinizing Hormone; FSH, Follicle Stimulating Hormone; MENQOL, Menopause Specific Quality of Life Questionnaire; PCOS, Polycystic Ovary Syndrome; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; VLDL, Very Low Density Lipoprotein; MDA, Malondialdehyde; CAT, Catalase; ALT, Alanine Aminotransferase; AST, Aspartate Aminotransferase; IIEF, International Index of Erectile Function; SDI-2, Sexual Desire Inventory-2; HRV, Heart Rate Variability; DHEA-S, Dehydroepiandrosterone Sulfate; DISF-M, Derogatis Interview for Sexual Function-Male; PTU, Propylthiouracil; HPA, Hypothalamic Pituitary Adrenal; BDNF, Brain Derived Neurotrophic Factor; TrkB, Tropomyosin Receptor Kinase B.

Therapeutic uses in managing fertility hormones

Infertility happens when pairs are incapable to conceive for one year of consistent intercourse without protection. It distresses near 10 to 15% of pairs globally. Conferring to the World Health Organization (WHO), about 50 to 80 million persons suffer from infertility internationally, with male aspects accounting for around 20-30% of cases. Analysis of male infertility mainly depend on semen analysis, which evaluates parameters such as appearance, sperm concentration, and motility (Babakhanzadeh *et al*., 2020). Developing countries have a greater number of couples looking for treatment. Having no children can have adverse effects on societal, emotional, and health well-being, foremost to higher rates of mental sufferings like depression and anxiety in women (Bisht, 2019). Current evidence suggests that male infertility may be associated with an increased risk of mortality and broader health disorders; accordingly, male reproductive capacity appears to be closely linked with overall health status. (Del Giudice *et al*., 2020). For eight weeks, 62 healthy women aged 18 to 50 participated in a randomized, double-blind, placebo-controlled study to assess the safety and effectiveness of WS root extract (ARE, 600 mg/day). When compared to a placebo, the results demonstrated significant improvements in the Female Sexual Function Index ($p = 0.002$), Perceived Stress Scale ($p = 0.0009$), and SF-12 Quality of Life ($p = 0.044$) scores. Hormonal and safety parameters stayed normal, but there was a noticeable improvement in the areas of sexual desire and satisfaction. Based on the study findings, ARE demonstrated good tolerability and therapeutic potential by successfully improving sexual function and quality of life in women with sexual dysfunction (A. S. Mutha *et al*., 2025). The effects of standardized aqueous extracts of WS, shatavari (*Asparagus racemosus*), and their combination on menopausal symptoms and associated parameters were assessed in a double-blind randomized study in postmenopausal women (40–55 years). In comparison to a placebo, supplementation resulted in a dose-dependent decrease in MENQOL scores, reflection index, bone turnover markers, and serum indicators of oxidative stress and inflammation after 24 weeks. According to the research, postmenopausal women who take shatavari or WS extracts on a daily basis report better vascular and bone health, a reduction in inflammation and oxidative stress, and an effective alleviation of menopausal symptoms (Pingali *et al*., 2025). WS root powder's therapeutic effects on letrozole-induced PCOS in female rats were assessed in an experimental study. Gallic acid, quercetin, and kaempferol were among the phenolic and flavonoid compounds found in the extract, which also demonstrated potent antioxidant activity ($IC_{50} = 36.57$ µg/ml). Rats fed dietary *Withania somnifera* root powder at 2.5%, 5%, and 7.5% for 28 days exhibited increased high density lipoprotein, follicle stimulating hormone, progesterone, and catalase activity, along with significantly ($p < 0.05$) reduced body weight, lipid profile abnormalities, luteinizing hormone, thyroid stimulating hormone, and malondialdehyde levels. Histopathological and biochemical improvements were most pronounced in the 7.5% group. These findings suggest that powdered *Withania somnifera* root may serve as a supportive treatment for polycystic ovary syndrome. (Ismail *et al*., 2025). A study originate some certainly fascinating enhancements in sexual activity and semen quality after men took WS Root Extract for 8 weeks (A. Mutha, 2023).

In another study, the effects of Withania somnifera were compared with pentoxifylline on sperm in men with inexplicable infertility. They initiate that both treatments enhanced sperm parameters without producing any major problems. WS improved sperm count, motility, and enhanced morphology. Pentoxifylline improved semen volume, motility, and enhanced morphology. In General, both treatments were effective in enlightening sperm quality (Nasimi Doost Azgomi *et al*., 2018). In another study, it was examined the role of WS on hormone levels in aged men. Bulky men of age between 40 to70 were specified either a placebo or WS extract for 8 weeks. It was seem that WS consumption led to improved levels of DHEA-S and testosterone in contrast to the placebo (Lopresti *et al*., 2019). It was verified how WS affected rat fertility hormones. The rats were separated into control and test groups, with the test group getting WS in diverse forms. After one month, they found that WS had encouraging effects on fertility hormones in the test group (M. Ali, 2021). In alternative study, they randomly allocated 50 participants with lesser sexual desire to take any WS or a placebo twice daily for 8 weeks. They measured the participants' sexual functioning, testosterone levels, prolactin levels, and quality of life before and after the intervention. The outcomes exhibited that the group taking WS had a noteworthy rise in sexual functioning scores and testosterone levels vs the placebo group.

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Table 3: Effect of Ashwagandha for hormonal balance

Study Subject	Study Type / Induction	Duration	Methodology	Evaluation Parameters	Results	Conclusion	Citation
Healthy women (18–50 years)	Clinical trial / randomized, double-blind, placebo-controlled	8 weeks	N=62, 31 Ashwagandha Root Extract 600 mg/day, 31 placebo	FSFI, FSDS, SSEs, PSS-10, SF-12 QoL, serum hormones, liver and renal profile	Increased FSFI, SSEs, and SF-12 scores, reduced PSS; hormonal and safety parameters remained unchanged	WS Root Extract improved female sexual function and quality of life, showing good safety and tolerability	(A. S. Mutha *et al.*, 2025)
Adult Wistar rats (10 males / 13 females per group) and their pups	In vivo / Oral administration of WS Root Extract	4 weeks	aqueous WS root extract at 500, 1000, or 2000 mg/kg/day or control (carboxymethylcellulose) following OECD Guideline 421	Body weight, reproductive organ weight, thyroid hormones (T4, TSH), reproductive performance, pup development	Body weight, reproductive organs, and thyroid hormones unchanged; no toxicity observed	WS root extract up to 2000 mg/kg was safe with no adverse reproductive or developmental effects	(Kalaiselvan *et al.*, 2025)
Postmenopausal women (aged 40–55 years)	Randomized double-blind placebo-controlled trial	24 weeks	Women received placebo, WS (250 or 500 mg), Shatavari (250 or 500 mg), or combination (250 mg each).	MENQOL score, bone mineral density, bone turnover markers, reflection index, inflammatory and oxidative stress markers	Decreased menopausal symptoms, bone turnover, inflammation, and oxidative stress; increased bone protection and vascular health	WS and Shatavari extracts reduced menopausal symptoms and improved bone and vascular function safely	(Pingali *et al.*, 2025)
Female albino rats (150 ± 5 g)	In vivo / Letrozole-induced PCOS (1 mg/kg orally)	7 weeks	N=35 divided into 5 groups (7 rats each): control (-), control (+) (PCOS), and 3 treatment groups receiving WS root powder at 2.5%, 5%, and 7.5% levels for 28 days	Body weight, lipid profile, LH, FSH, TSH, progesterone, HDL, MDA, catalase activity, and ovarian histopathology	Decreased body weight, MDA, LH, TSH; improved lipid profile; increased HDL, FSH, progesterone, and catalase activity; best improvement at 7.5% WS root powder	bettered hormonal imbalance, oxidative stress, and ovarian dysfunction in Letrozole-induced PCOS rats	(Ismail *et al.*, 2025)
Male rats	In vivo / High-fat diet-induced obesit	8 weeks	N=40 divided into control (-), control (+), and 6 treatment groups receiving WS, Maca, or their mixture (500 or 1000 mg/kg orally)	Body weight, lipid profile, glucose, liver and kidney function, MDA, TSH, T3, T4, testosterone, liver and kidney histology	Decreased body weight, glucose, MDA, ALT, cholesterol, triglycerides, LDL, VLDL, urea, creatinine; increased HDL, AST, CAT, T3, T4, TSH, and testosterone; improved liver and kidney histology	Enhanced thyroid and reproductive hormones and protected liver and kidney function	(Fahmy *et al.*, 2024)
Male Wistar rats (200–250 g)	In vivo / Morphine-induced addiction	1 week	N=60, four groups: control, morphine-addicted, WS-treated control, WS-treated addicted	Gonadotropins (LH, FSH) and sex hormones (testosterone, estrogen)	Morphine reduced LH, FSH, testosterone, estrogen; WS increased all	WS reversed morphine-induced hormonal decline	Basam *et al.*, 2021
Healthy adult men	Clinical trial, double-blind, randomized, placebo-controlled	8 weeks	N=100 (50 WS, 50 placebo), 300 mg WS twice daily	Sexual function (IIEF, SDI2), sperm quality, QoL	Increased sperm count, morphology, semen volume, libido, and QoL	WS improved male sexual performance and fertility	Mutha, 2023
Healthy women (40–65 yrs)	Clinical trial, placebo-controlled, double-blind	84 days	N=117, capsule twice daily	MENQOL, hormone levels, physical indicators	Improved MENQOL scores, reduced hot flushes, unchanged hormones	WS reduced menopausal symptoms safely	Steels *et al.*, 2018
Obese/overweight adults (40–75 yrs)	In vivo / Oral WS 200 mg twice daily	12 weeks	N=120 (60 WS, 60 placebo)	Stress, fatigue, HRV, hormones	Decreased stress and fatigue, increased HRV and testosterone	WS showed anti-fatigue and hormonal improvement	Smith *et al.*, 2023
Infertile males	In vivo / Oral WS vs Pentoxifylline	90 days	N=100 (50 each group)	Sperm count, motility, morphology, volume	WS improved sperm count, motility, morphology	WS enhanced sperm quality similar to Pentoxifylline	Nasimi Doost Azgomi *et al.*, 2018
Overweight males (40–70 yrs)	Placebo-controlled, double-blind, crossover	112 days	N=57, WS vs placebo	DHEA-S, testosterone, cortisol, estradiol	Increased DHEA-S and testosterone, unchanged cortisol and estradiol	WS enhanced male hormone levels	Lopresti *et al.*, 2019a
Elderly individuals (65–80 yrs)	Clinical trial, placebo-controlled, double-blind	84 days	N=50 (25 WS, 25 placebo), 600 mg/day	QoL, sleep, mental alertness	Improved sleep, QoL, and alertness	WS supported elderly wellness and sleep	Kelgane and Salve, 2020
Male rats (115±5 g)	In vivo / Sodium valproate-induced testicular injury	1 month	N=42 (control & treated)	Lipid profile, liver enzymes, kidney function, fertility hormones	Improved HDL, reduced liver enzymes, enhanced kidney and fertility hormones	WS + L-carnitine improved fertility and organ function	M. Ali, 2021
Adult males	Placebo-controlled,	56 days	N=50 (25 WS, 25 placebo), 300 mg twice daily	Sexual function (DISF-M), testosterone,	Increased DISF-M and testosterone, unchanged	WS improved sexual health and	Chauhan *et al.*, 2022

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	double-blind, randomized			prolactin, QoL	prolactin	testosterone
Juvenile male Wistar rats	In vivo / PTU-induced hypothyroidism	30 days	N=30 (control, PTU, PTU+WS)	Thyroid hormones (T3, T4, TSH), histology	PTU reduced T3/T4; WS restored hormone levels and tissue structure	WS protected against PTU-induced hypothyroidism	Ibrahim *et al.*, 2023
Stressed healthy adults	Placebo-controlled, double-blind	60 days	N=60 (30 WS, 30 placebo), 240 mg/day	Anxiety, stress, cortisol, DHEA-S, testosterone	Decreased anxiety and cortisol, increased testosterone in men	WS reduced stress via HPA-axis modulation	Lopresti *et al.*, 2019b
Healthy adults (mild stress/anxiety)	Placebo-controlled, double-blind	60 days	N=54 (27 WS, 27 placebo)	Stress, anxiety, QoL, cognition, hormones	Lower cortisol, higher serotonin, better cognition	WS improved mood, cognition, and stress resilience	Majeed *et al.*, 2023
Adults with insomnia & anxiety	Clinical trial / Oral capsules	10 weeks	N=60 (40 WS, 20 placebo)	Sleep latency, duration, quality, anxiety	Improved sleep onset, efficiency, and anxiety	WS aided natural sleep and anxiety relief	Langade *et al.*, 2019
Healthy adults (20–55 yrs)	Placebo-controlled, double-blind	90 days	N=130 (60 WS, 70 placebo)	Memory, stress, sleep, happiness, cortisol, BDNF	Improved memory, sleep, happiness, and stress	WS enhanced cognition and emotional well-being	Gopukumar *et al.*, 2021
WSextract	In vitro	—	Standard assays	Antimicrobial activity	Methanol extract active against bacteria and fungi	WS shows antimicrobial potential for supplements	Elias and Mohammed, 2020
Pregnant rat embryos	In vitro	—	Hippocampal cultures	TrkB signaling and pathway activity	WS and withanolide A increased TrkB activation	WS supports neuronal survival under nutrient stress	Chen and Russo-Neustadt, 2023
Female Sprague Dawley rats	In vivo / DHEA-induced PCOS	21 days	DHEA with Apigenin and Metformin	Body weight, lipid profile, hormones, ovary histology	Apigenin reversed DHEA effects, normalized hormones and follicles	WS-like effects comparable to Metformin in PCOS	Peng *et al.*, 2022

But no variation in prolactin levels. The results of this study propose that WS may recover sexual well-being and rise testosterone levels (Chauhan *et al*., 2022). A study showed an inclusive examination and exposed that Withaferin A (WA) shows important efficiency in upgrading reproductive disfunctions made by diabetes mellitus (DM) in male mice. The fundamental mechanism includes the increase of endogenic testosterone and estrogen levels, joined with the upregulation of gonadotropin-releasing hormone type I (GnRH-I) and estrogen receptor alpha (ERα) appearance in the brain, as well as ERα expression in the testes. These innovative conclusions highlight the possible therapeutic application of WA for speaking DM-associated reproductive losses (Baghel *et al*., 2023). Polycystic ovarian syndrome, is a important supplier to the increased levels of androgens, obesity, and menstrual indiscretions (Abraham Gnanadass *et al*., 2021). Female Sprague Dawley rats were directed Dehydroepiandrosterone (DHEA) at a dose of 6 mg/100g to induce in model rat of polycystic ovarian syndrome (PCOS) resulting a post-pubertal method. Metformin was used as the typical treatment. The rats received the treatments for 3 week, and coloproctological analysis was directed. Afterward the treatment period, biochemical examination was accomplished on blood plasma samples, while the ovaries were exposed to histopathological examination. The outcomes exhibited that DHEA treatment directed to disturbed lipid profile and antioxidant status, improved weight, ovarian width, and lumps in rats, confirmative the growth of PCOS. But, treating with Apigenin revealed a valuable effect by improving the lipid profile and antioxidant status. It also regulated body weight, lowered ovarian diameter and cysts, and reestablished healthy follicles associated to the control rats. Apigenin treatment also stifled the levels of estradiol and testosterone compared to the control group, while rising progesterone levels in the Apigenin-treated rats. Moreover, Apigenin treatment suppressed the levels of inflammatory cytokines TNFa and IL6. The effects of Apigenin were slightly parallel to the standard drug Metformin, these results authorize that Apigenin recovers troubled hormonal levels, lipid profile, and antioxidant status in PCOS rats (Peng *et al*., 2022).

Therapeutic uses in managing Thyroid hormones

Thyroid autoimmunity and/or thyroid disfunction are predominant among women of propagative age. These situations have been autonomously linked with adverse consequences in fertility and pregnancy, both in cases of natural conception and supported reproductive technology. So, it is sensible to consider screening for thyrotropin and thyroid peroxidase autoantibodies (in infertile women who are aimed to conceive. Though, in spite of monitoring for other variables, creating a conclusive fundamental relationship amongst fertility, thyroid dysfunction, and Thyroid autoimmunity remains challenging (Unuane & Velkeniers, 2020). An experimental study examined the effects of maca and WS extracts, individually and in combination, on thyroid and reproductive hormones in obese male rats. Rats fed a high-fat diet were treated orally with 500 or 1000 mg/kg of WS, maca, or their mixture for six weeks. Supplementation significantly reduced body weight,5lucosee, liver and kidney markers, MDA, cholesterol, triglycerides, LDL-c, and

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VLDL-c, while increasing HDL-c, T3, T4, TSH, testosterone, and catalase activity. Histopathological improvements in liver and kidney tissues were most pronounced in the combined extract group. The study concluded that co-administration of maca and WS effectively enhances thyroid and reproductive function while protecting hepatic and renal health (Fahmy *et al*., 2024). A study evaluated the role of *Withania somnifera* methanolic extract in improving thyroid function in propylthiouracil-induced hypothyroid rats. Hypothyroidism significantly increased serum thyroid stimulating hormone and oxidative stress markers while reducing thyroid hormones, antioxidant enzymes, and hematological parameters. Treatment with the methanolic extract effectively restored thyroid hormone levels, reduced oxidative stress, and improved thyroid histopathology, showing stronger effects than the standard anti-hypothyroid drug (Abdel-Wahhab *et al*., 2019). One more study evaluate effect of WS root extract on neurochemical variations in cortex and hippocampus formed by thyroid dysfunction induced by propylthiouracil. Male rats divided into different groups; control rats were treated with WS extract and rats with hypothyroidism treated by any WS extract or L-thyroxine (T4). The hypothyroidism rats exhibited lower levels of T3 and T4, amplified oxidative stress in the brain, and variations in certain chemicals. Both AE and T4 assisted in reestablishing T3 and T4 levels. In the brain, T4 lowered some of the oxidative stress markers, while WS extract prohibited certain variations induced by hypothyroidism. In General, WS extract displays potential in stopping thyroid dysfunction-related problems in the nervous system (Hosny *et al*., 2021). Researchers examined the effect of WS extract and quercetin on the variation of THRβ1 in mice with hypothyroidism. The study provided mice, cypermethrin orally for 28 days. It instigated hypothyroidism, with amplified body weight and reduced thyroid gland weight. Biochemical markers exhibited high levels and reduced enzyme activity. Histopathology and immunohistochemistry established the effects. Co-administration of WS and quercetin protected in contradiction of these effects (Namdev *et al*., 2023).

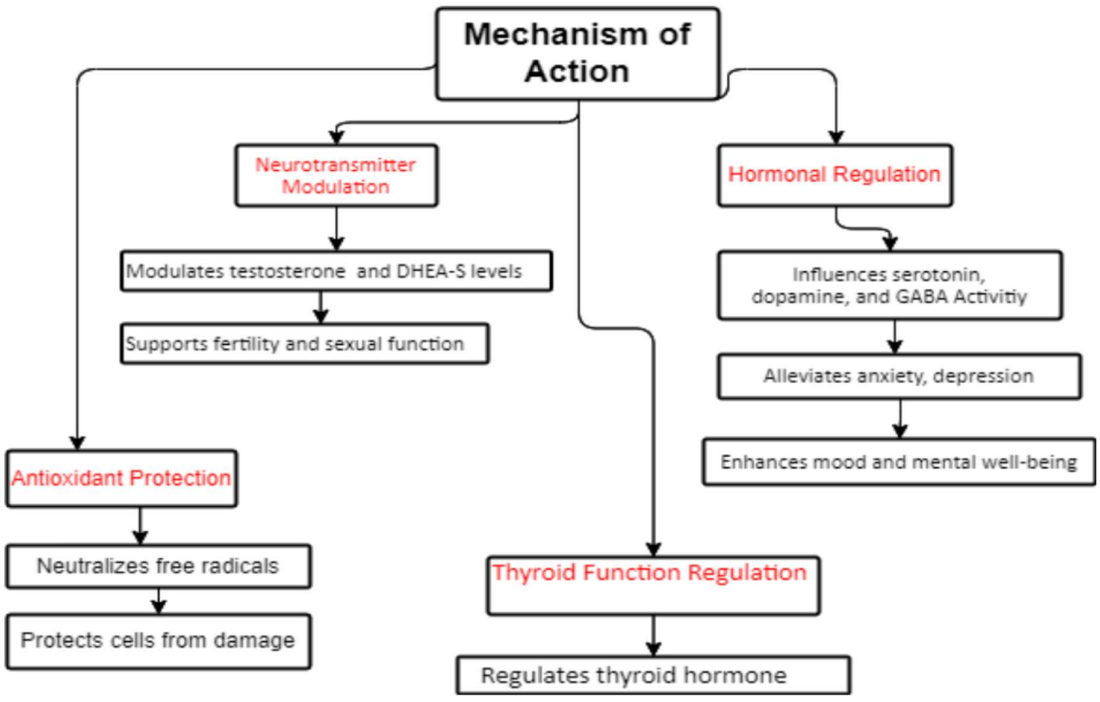

Figure 1: Mechanism of action of *Withania somnifera* (Ashwagandha)

Therapeutic uses in managing stress hormones

Stress can be demarcated as any variation that roots physical, emotional, or psychological problem. Although some stress can be constructive and adaptive, continuing stress can have adverse effects on mental health and raise the danger of neuropsychiatric conditions such as depression and anxiety. Studies have revealed that a noteworthy percentage of the overall population experiences anxiety-related indications, and depression is a foremost reason of debility (O'Connor *et al*., 2021). A study showed to evaluate the anti-neuroinflammatory effects of a sustained-release preparation of WS sustained-release (AshwaSR). In vitro study, inspected the appearance of pro-inflammatory cytokines (TNFα and IL1β) in human monocytes and the antioxidant effects in human monocytic cells. In the in vivo

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study, estimated the effectiveness of AshwaSR on anxiety and depression in rats with behavioral tests. The outcomes exhibited that AshwaSR reduced the creation of pro-inflammatory cytokines and superoxide. Moreover, it established anxiolytic and stress-relieving effects. These results propose that AshwaSR has potential in dealing stress-related indications (Krishnaraju *et al*., 2023). A double-blind, randomized, placebo-controlled trial was directed to evaluate the effects of a 300 mg WS root extract on intellectual function, stress levels, sleep quality, and psychological well-being completed in a period of 90 days, with 125 participants finishing the study. The group getting WS established noteworthy enhancements in memory performance, as demonstrated by higher scores in memory tests, compared to the placebo group. Moreover, participants in the WS SR group stated lower levels of perceived stress (measured by PSS-10), condensed cortisol levels, better sleep quality (measured by PSQI), and improved psychological well-being (measured by OHQ) compared to the placebo group. Significantly, no contrary events were informed throughout the study, The 90-day administration of WS lead to in enhanced memory, reduced stress levels, improved sleep quality, and enhanced psychological well-being, without any informed contrary effects (Gopukumar *et al*., 2021). A study with adults suffering perceived stress says that taking a exclusive WS supplement enhanced cognitive capabilities, reduced cortisol levels, and positively obstructed mood, stress, and food desires. The WS groups exhibited improved cognitive performance and lesser cortisol levels compared to the placebo group (Remenapp *et al*., 2022). One more study was directed to evaluate the influence of WS supplementation on the well-being of college scholars. The contributors were separated into two groups and given either WS or placebo pills for a period of 30 days. The results exposed that WS supplementation led to improved perceived well-being, with enhanced energy levels, improved mental clearness, and improved sleep quality amongst the college students (Baker *et al*., 2022). In a case report evaluated adrenal function via the Short Synacthen Test before and after WS treatment. During a ten-week period of daily WS supplementation (21.4 mg of Withanolides), the Short Synacthen Test exhibited a negligeable answer to an intramuscular injection of Synacthen (250 µg). Cortisol levels persisted comparatively stable throughout the test, with slight variations compared to the morning baseline cortisol level preceding to WS supplementation. But, after suspending WS for two weeks, a recurrence SST verified a entirely regular adrenal response, with meaningly higher cortisol levels at T30 min and T60 min compared to the early test. This proposes that ten weeks of WS supplementation may lead to impermanent adrenal hypofunction, which can be upturned with a discontinuity from the supplement (Fry *et al*., 2022). Studies have essentially established that WS can endorse a sense of slackening, possibly leading to better-quality sleep. It seems to have anxiolytic effects that are equivalent to the treatment with lorazepam. This proposes that WS could be a capable natural substitute for persons looking for relaxation and sleep support (Poojari *et al*., 2019).

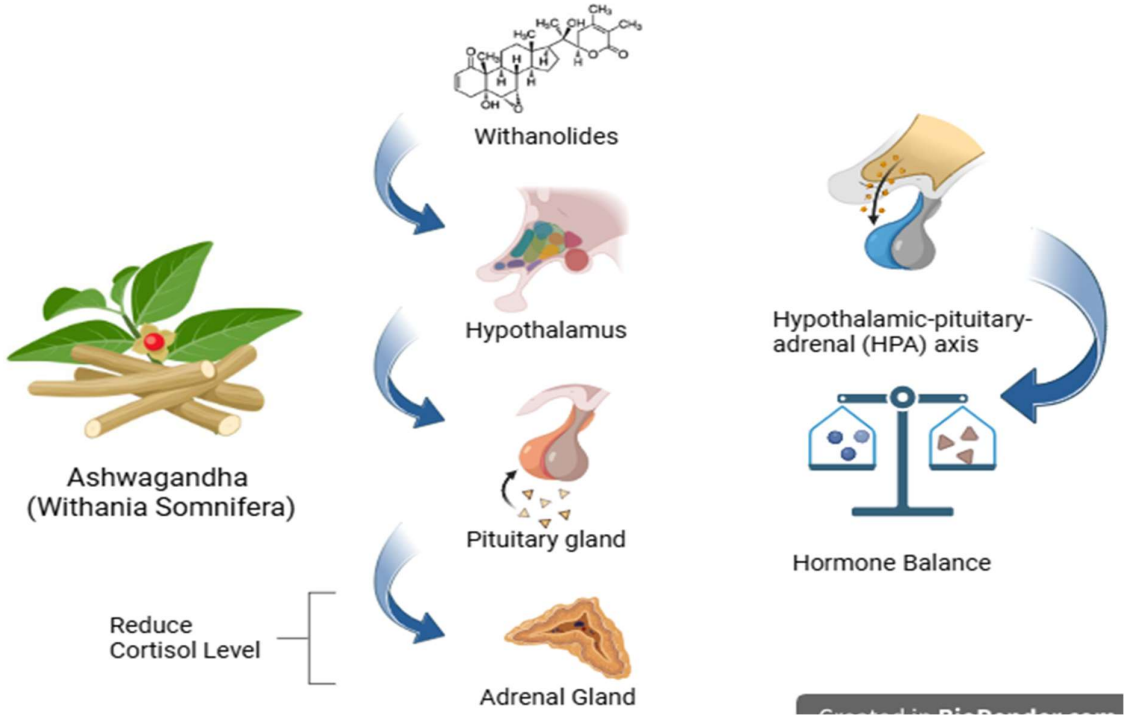

Figure 2: Ws Mechanism For Hormonal Balance

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Therapeutic uses in cognitive enhancement

WS has been used in traditional Ayurvedic medicine to improve memory, recover cognition, and increase physical performance variables. A study was directed to examine the effects of acute WS extract ingestion on decision-making function. Thirteen well-unpaid helpers contributed in the study and experienced numerous cognitive function tests earlier and later eating either a placebo or WS extract. The outcomes exhibited that acute WS supplementation enhanced working memory, continuous attention, and the capability to distinguish and move to new instructions. It also endorsed quicker response times and lowered mental tiredness. But, it did not meaningfully affect precision compared to the placebo (Xing *et al*., 2022). Stress is a response to stimulating impetuses that can influence both physical and mental health. This response is facilitated by the hypothalamic-pituitary-adrenal (HPA) axis, which releases cortisol through times of stress. Continued initiation or suppression of the HPA axis can have adverse effects on general health. Moreover, stress can disturb sleep patterns, foremost to lesser sleep quality. Persons with HPA axis dysregulation or high anxiety levels might experience lesser sleep quality and weakened cognitive function (Bertollo *et al*., 2020). A double-blind, randomized controlled trial meant to evaluate the effect of WS root extract on cognitive function, anxiety levels, sleep quality, general well-being, and protection in persons facing stress. The trial contained 130 healthy adults who were randomly allocated to either the WS group or the placebo group. Over a period of 90 days, contributors consumed one capsule of any WS or a placebo daily. The outcomes exposed noteworthy enhancements in recall memory and a lowered error rate in the WS group compared to the placebo group. Furthermore, participants in the WS group stated lesser perceived stress levels. These conclusions propose that WS may have probable assistances for cognitive function and stress managing (Gopukumar *et al*., 2021). A study revealed that WS root extract can aid decrease stress and anxiety in well persons with minor to modest symptoms by directing a 60-day study with a group of partakers taking WS and alternative group taking a placebo. Evaluating parameters like quality of life, cognitive scores, perceived stress, anxiety levels, and various biochemical markers. The outcomes exhibited that the group taking WS had noteworthy enhancements in perceived stress, anxiety, and quality of life compared to the placebo group. They also accomplished improved in cognitive tasks and exhibited variations in cortisol levels and urinary serotonin (Majeed *et al*., 2023). WS, a traditional medicine used in Ayurveda, is supposed to have adaptogen properties that aid the body manage with stress. While the precise mechanism is still indefinite, studies have revealed that WS extract can improve sleep quality. In a study with rats, the extract improved activity in the delta and gamma bands of the electroencephalogram (EEG), which are linked with sleep (Basani *et al*., 2021).

Therapeutic uses as antioxidant and anti-inflammatory agent

WS roots have been initiate to have antioxidant activity in earlier studies. Antioxidants benefit in guarding cells from impairment began by destructive molecules called free radicals. A study was directed with objective to evaluate the antioxidant and antibacterial properties of various components of WS. The investigators employed the DPPH free radical scavenging technique to evaluate the antioxidant activity of numerous extracts. Furthermore, bacteria existing in WS roots were secluded using the pour-plate technique, and the antibacterial activity of the extracts was assessed via filter paper methods and the agar well method. The ethanol-water extracts displayed a higher produce of extractible substance compared to the methanol extracts. Particularly, the fresh root extract showed meaningfully more antioxidant activity than other plant fragments and commercially available WS. Furthermore, the ethanol-water extract established slight antibacterial activity contrary to pathogenic P. aeruginosa, while the minimal inhibitory concentration (MIC) values against Salmonella Sp and Candida Sp >256 mg/L. These conclusions highlight the potential antioxidant and antibacterial properties of WS (W W *et al*., 2021). Chandrasekaran and their team directed studies, examined the chemo protective effects of Withaferin A (WFA) in transgenic adenomatous polyposis coli and azoxymethane/dextran sodium sulfate mouse models of colon cancer. The mice were orally administered doses of 3 and 4 mg/kg of WFA. the outcomes displayed a noteworthy decrease (59 %) in tumor and polyp instigation and development in the WFA-treated mice compared to the control group. WFA treatment also directed to downregulation of inflammatory markers (IL6, TNFα, COX2) and pro-survival markers (Notch-1, NFκβ) in the cancerous lumps (Chandrasekaran *et al*., 2018).

Safety and Concerns

In accordance with OECD Guideline 421, a randomized controlled study assessed the reproductive and developmental safety of aqueous WS root extract (500–2,000 mg/kg/day) in Wistar rats. Thyroid hormone levels, body weight, reproductive organ weight, and reproductive performance in both parent rats and pups were found to be unaffected. With a No Observed Adverse Effect Level (NOAEL) of 2,000 mg/kg, WS root extract given orally is safe and has no effect on rat development or reproduction (Kalaiselvan *et al*., 2025).

2. CONCLUSION

Ashwagandha, scientifically known as WS, shows potential as a herbal therapy for modulating hormonal

balance, reproductive health, and general well-being. Its bioactive constituents, mainly withanolides, contribute to a variety of pharmacological activities, with antimicrobial, antitumor, anti-stress, and neuroprotective effects. Preclinical and clinical studies have providing indication of the capability of WS to improve male fertility, normalize thyroid function, reduce stress-induced hormonal imbalances, and display effective antioxidant properties. Furthermore, its nutritive profile, containing fiber, protein, vital minerals, and antioxidants, further supports its worth as a nutritional supplement. But further research is necessary to explain the exact mechanisms of action and enhance its clinical applications. Overall, WS holds important potential as a natural and multipurpose therapeutic agent for encouraging hormonal health and general well-being. As added evidence appears, it is predictable that WS will remain to be known as an appreciated natural therapeutic agent with an extensive range of potential benefits.

Declarations

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