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Recent Review on Innovative Prospectives of *Withania somnifera* (L.) Dunal

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ABSTRACT Withania somnifera L.(2n=) is endangered perennial herb (family), have strong therapeutic potency used for its analgesic, anti-inflammatory, anti-cancerous, hepato-protective, anti-diabetic, antioxidant pharmacological activity, immunoinhencer, immunomodulater, antistress. Due to increasing demand by pharmaceutical and herbal drug industries and over exploitation from its wild sources, its population diminishing from natural habitat. The medicinal plants contribute to cater 80% of the raw materials used in the preparation of drugs. Medicinal and aromatic plants important for human health national economy, and related industries for yield and quality of secondary metabolites, like withamine withaferine A, withanone, withanolideA withanolide D and quality components.

Keywords: *Withania somnifera*, therapeutic effect, toxicity, life quality

Introduction:

Withania somnifera (L.) Dunal commonly known as Indian ginseng or winter cherry (Andallu and Radhika, 2000) poison gooseberry, belonging to family Solanaceae (Dafni and Yafni, 1994), a family with 84 genera and around 3000 species that are found worldwide (Mirjalili et al. 2009) with chromosome 2n = 24 and NCBI: txid126910. The plant has a wide geographic distribution, primarily in Africa, Asia, Australia, and Europe. In India, ashwagandha is commonly cultivated in the states of Madhya Pradesh, Uttar Pradesh, the Punjabi plains, and the country's northwest, including Gujrat and Rajsthan and is readily accessible through farming; in addition to being therapeutic, it also serves as a bioremediation for phytoextractions (Abhilash et al. 2008; Singh and Kumar 2011).The Rasavatam offers dietary and behavioural advice for all stages of life in Indian traditional medicine (Ayurveda), which may postpone the onset of ageing. As a result, there are many different rasavatam preventative or therapeutic strategies with different health goals. Out of the 26 species of *Withania* existing worldwide, *W. somnifera* and *W. coagulans* are the two most significant and prevalent species in India (Chadha, 1976). Recently, reports of the third species *W. ashwagandha* from Indian genetic material have also been made (Mir et al. 2011). Asgand Nagori has greater potential therapeutic benefits than Asgand Dakani, one of the two forms of ashwagandha that have been identified and mentioned in traditional Unani literature. The common name *Withania* pays homage to the well-known English author Henry Thomas Maire Witham by changing the final 'm' to a 'n' and adding a commemorative conclusion. The particular epithet The name somnifera, which is a combination of the Latin words somnus, which means sleep, and fero, which means to carry, relates to the plant's sedative effects. One of the most

popular herbs in Ayurveda, it is recognised as a potent adaptogen and anti-stress agent (a substance that increases generalised resistance to toxic substances or physical, pharmacological, biological, and psychological "stressors," restoring individuals' equilibrium) (Brekhman and Dardymov 1969). The knowledge of medicinal plants has been acquired over many years based on the many medical systems, such as Unani, Siddha, and ayurveda, which have a significant impact on the development of new therapies and employ it in more than 100 formulations. The Rasayana includes this root of the plant. *Withania* belongs to the tribe Physaleae, subtribe Withaninae, genus Withania, species somnifera, and sub-family Solanoideae. Classification by Taxonomic System Continent: Plantae, Subkingdom: Spermatophyta, Seed plants; Super division: Tracheobionta, Vascular plants; Kingdom: Angiosperm Tubiflorae, in order the Solanaceae family the *Withania* genus somnifera (L.) Dunal, a species. Plants contain a variety of bioactive compounds in their leaves, stems, and roots, including flavonoids, tannins, alkaloids, glycosides, and steroidal lactones. The withanolides, which have been referred to as the primary secondary metabolites in charge of this plant's beneficial characteristics, are among them. They are steroidal lactones.

This plant has unique properties since it contains the greatest and most structurally diverse variety of phytochemicals withanolides (i.e., modified steroidal molecules based on ergostane skeleton) with glycowithanolides (a major bioactive constituent). As a result of the plant's herbal extract, anti-sedative, and anti-convulsant characteristics, it can treat a variety of neurological illnesses, geriatric disabilities, arthritis, anxiety, and problems with behaviour (Bhattacharya et al., 1987; Dhuley 2001; Kulkarni et al., 1998; Ray and Gupta., 1994; Schliebs et al., 1973).In various forms (decoctions, infusions, ointments, powder, and syrup), *Withania somnifera* has been used for a very long time as a herbal therapy around the world for patients of all ages, of both sexes, and even during pregnancy without any harmful side effects (Archana and Namasivayam, 1999; Davis and Kuttan, 2001; Kumar et al., 2007). (1985; Sharma et al.). In healthy males and females, ashwagandha administration was more effective than a placebo at enhancing physical performance-related factors. Recent systematic studies have shown its promise and safety for treating anxiety, delaying the deterioration of cognitive function, treating male infertility, increasing the function of the reproductive system, and treating diabetes adjuvantly. Some of the secondary metabolites of ashwagandha may have some potential to improve physical performance through the regulation of particular anti-inflammatory and anti-oxidative pathways, as they are responsible for a variety of physiological and metabolic effects. Some people have argued that ashwagandha may have ergonomic advantages for sportsmen and active people because nutrition is one of the essential pillars of maximising sports performance. According to a recent study by Perez-Gomez et al., consuming this natural herbal extract substantially enhances maximal oxygen consumption (VO2max), muscle strength, muscle fatigue, and sleepiness in healthy people as well as their physical recovery (pain, inflammation state, and sleep

quality). The upper and lower limbs' strength and muscular power are improved when ashwagandha is administered during a resistance training programme.

Botany:

The genus *Withania* contains species that are woody herbs, sub-shrubs, or shrubs that grow to a height of 120-150 cm and have long tuberous roots. It is a perennial plant that grows in India, Africa, and the Mediterranean region. Simple, 2–7 cm wide, petiolate leaves measure 4–10 cm long. Depending on their shape, leaf blades might be elliptic-ovate or widely ovate, whole along the margins, acute to obtuse at the apex, and cuneate or oblique at the base. The leaves on the vegetative shoot are broad and alternate, while on the flowering branches, the leaves are opposite, arranged a little laterally in pairs of one large and one little leaf, and each leaf has a leaf axil that is home to a cymose cluster of five to twenty-five delicate pale green bisexual flowers. The opposite of the oval, glabrous leaves in the floral zone is smaller and less numerous. Small, globular, greenish or lurid-yellow blooms grow inconspicuously in axillary, umbellate cymes; mature berries are encased in the persistent calyx. The plant's roots, which constitute its principal component, are substantial, meaty, pale brown, and frequently used medicinally. The seeds are dried for sowing in the spring after the fruit, which is a bright red colors collected in the late fall. It has a peak flowering period between March and July and blooms constantly throughout the year.

Cytology:

This species exhibits polysomatomy (2n=12, 2n=18, 2n=24, 2n=36, 2n=48, 2n=72), as well as diploid (2n=24), tetraploid (2n=48), and hexaploid (2n=72) cytotype variation. The 2n=48 type predominates (Iqbal&dutta, 2007). Because of the intense pollen competition within the flower and the heavy pollen load on the stigma, this plant favours self-pollination (Mir et al., 2012).).

Ethnobotany:

Withania somnifera has several characteristics. In ayurveda, several portions of the plant are utilised for a variety of functions, such as aphrodisiac, sedative, rejuvenative, and life extension. For instance, an ointment made from leaves and berries helps with inflammation, abscesses, and wound healing. Rheumatism and haemorrhoids are both treated with a leaf decoction (Idowu and Wilfred 2018). The plant root is a well-known dietary supplement used in traditional medicine, with claims that it can reduce tension and anxiety (Vijay et al. 2018). The ingestion of the roots enhances cardiovascular health, strengthens heart muscles, lessens stress and swelling, controls cholesterol, and decreases hair loss in humans addition to its high antioxidant content (Mamta and Vijaya (2018). However, the roots have also been used to treat cattle in veterinary treatment. When the roasted root and leaves are decocted, cows, lambs, and buffalo produce milk; it is also used as an antipyretic and a sexual tonic (Aziz et al. 2018). Ashwagandha root extracts are frequently used in cosmetics and personal care items such skin conditioners, shampoos, and anti-wrinkle agents (Sakamoto et al. 2017). Additionally, it is applied to geriatric issues and as a learning and memory-

enhancing energy tonic called Medharasayana (Nadkarni, 1976). This plant has been used for millennia to improve youth, stamina, strength, and health as well as increase the body's production of cells, essential fluids, muscle fat, blood, lymph, and semen (Williamson, 2020). Additionally, it is used to treat muscle tension, impotence, premature ageing, emaciation, debility, and chronic weariness as well as weakness, dehydration, weak bones and loose teeth. It is typical to use leaves as an antihelmintic. The fruit also has sedative, emetic, and stomachic effects that can be used as an alternative diuretic and bitter tonic for dyspepsia, as well as a growth promoter in young children. For localised treatment of tumours, tubercular glands, carbuncles, and ulcers, crushed fruit is applied (Nandkarni, 1976; Kapoor, 2001). The fruit helps the milk coagulate. (Atal and Sethi 1963). Constipation, senile debility, rheumatism, general debility, nervous tiredness, memory loss, muscle energy, and spermatorrhoea are among the conditions for which roots are utilised (Watt, 1972). Recent studies have shown effects that are immunomodulatory and anticancer (Sharad et al, 1996). Plant extracts have been shown to have antioxidant, antiderotogenic, and anticancerous properties (Asthane, 1989). Iron, magnesium, phosphorus, copper, zinc, and other macro- and micronutrients are all abundant in this plant (Sangita and Alka 2016). Additionally, this plant has antifungal and antibacterial properties that can be used to treat murine aspergillosis (Dhuley et al., 1998). Ayurveda medicine considers *Withania* to be one of the most significant ethnomedicinal herbs due to its wide range of therapeutic properties (Singh et al. 2011). This plant also eases loose stools and gastrointestinal discomfort. Hallucinogens, nasal congestion (rhinitis), coughing, colds, decreased appetite, nausea, constipation, dry mouth, hyperactivity, nocturnal cramps, impaired vision, hyperacidity, skin rashes, and weight gain are possible adverse effects as well, though they are less common (Tandom and Yadav 2020). The plant is frequently used in Egypt, Djibouti, and Ethiopia in conjunction to other herbs to treat malaria, bronchitis, and Alzheimer's disease. (Hassan-Abdallah et al. 2013, Rahma et al. 2017, Alebie et al. 2017).

Cultivation:

In India, it is grown on roughly 10,780 hectares and produced in 8,429 tonnes (Kubsad et al., 2009). Ashwagandha thrives best at a temperature range of 20–32 °C, red soil (slightly basic), 500–750 mm of rainfall per year, and a pH of 7.5–8.0. The plant is harvested 180–210 days after it was planted (Rajeshwara et al., 2012).

Marketing:

Withania somnifera is one of 32 prioritised medicinal plants in India, where it is projected that more than 1500 tonnes of roots are produced year and that 7,000 tonnes are needed, making further cultivation and higher output necessary. The greatest way to improve Ashwagandha output and production in India will be to apply inorganic fertilisers.

Biochemical properties:

Due to the presence of its key biochemical components, steroidal alkaloids, steroidal lactones, triterpenoids (root and leaves), and withanolides for thousands of years, *Withania somnifera* has been utilised in traditional medicine (Elaskka et al. 1990). Twelve alkaloids, forty withanolides, sitoindosides (VII, VIII, IX, X), and Ashwagandhanolide active markers are shown in the chemical analysis of roots. The root of *Withania somnifera* has approximately 35 different chemical components (Rastogi & Mehrotra 1998) in which Alkaloids (Isopellertierine, Anaferien) are the biologically active chemical component present in *Withania*. There are also more alkaloids, such as somnine, tropine, 3-a-gloyloxytropane, choline, cuscohygrine, isopelletierine, anhydride, and somniferine (Elaskka et al. 1996). Recent studies also revealed the presence of Nicotine, Somniferine, Somniferinine, Withanine, Withananine, Pseudowithanine, 3-alpha-Tigloxytropane, dl-iso-pellectierine and new alkaloid Anaferin & Anhygrine in *Withania somnifera* (Gupta &Rana 2007). Unsaturated lactone-ring present in withaferin A is the region for antibiotic activity.

Withanolides

A class of naturally occurring polyoxygenated steroids with a 28-C ergostane backbone are known as withanolides. The kind, quantity, and degree of ring saturation at which C-22 and C-26 are correctly oxidised to form a six-membered lactone ring all contribute to the structural variability of withanolides. Th ese compounds can be classified into two major categories based on the C17 side chain: those that frequently form a -lactone between C23 and C26 and those that frequently produce a -lactone between C22 and C26. First-class withanolides include those with an unaltered (withaferin) and altered (fisalin C) backbone, respectively. At the moment, withanolides with unaltered skeletons have been found frequently in nature; among them, about 580 have been found in the Solanaceae family. In terms of structure and activity, it resembles Asian ginseng (ginsenosides) to some extent. The withanolide skeleton's primary structural unit is a 22-hydroxyergostan-26-oic acid-26, 22-lactone. The numerous biological effects of ashwagandha, including its antibacterial, anti-inflammatory, immunomodulatory, neuroprotective, cytotoxic, and antioxidant properties, may be connected to the extensive structural variation of withanolides (Alfonso et al. 1993; Glotter1991). Typically, the amount of withanolides in roots and leaves ranges from 0.001% to 0.5% dry weight (DW). Numerous withanolides that have had their carboxylic skeleton or side chain altered are connected to withanolides and are referred to as ergon-type steroids (polyoxygenated). The distinguishing feature of withanolides and ergosane-type steroids is one C8 or C9 side with a lactone or lactone ring that may be connected with the carboxycyclic component of the molecule through a carbon-carbon bond or through an oxygen bridge. Because of the creation of new bonds and the aromatization of rings from the root of *W. somnifera*, Zhao et al. and this chemical has novel properties (2002) extracted five novel withanolides compounds based on spectroscopic and physiochemical studies -3a,6a-epoxy-4b,5b,27-trihydroxy-1-oxowitha-24-enolide (20S,22R), Withanoside VIII, 9 and 27-O-b-D-

glucopyranosylpubesenolide-3-O-D-glucopyranoside provide the substance's 27-O-b-D-glucopranosyl. Withanolide IX, 10, Withanoside X, 11, and (20R, 22R)-Ia,3b,20,27-tetrahydroxywitha-5,24-dienolide are examples of compounds that include -b-D-glucopyranosylpubesenolide. 3-O-b-D-glucopyranoside (withanoside XI, 12). (withanoside XI, 12). Only five substances—withanolide A, (20S,22R), 27-tetrahydroxy-1-oxowitha-2,24,-dienolide, withanoside IV, withanoside VI, and coagulin Q—have neurite outgrowth activity in a human neuroblastoma SH-SY5Y Cell line at doses of 1 mM. The biological effects of various withanolide and withanoside extraction methods from Ashwagandha leaf and root extracts were assessed by Nile et al. in 2019. They showed that, in contrast to other extraction methods like maceration, soxhlet extraction, and microwave-assisted extraction, which require a lengthy period of time and the use of organic solvent, subcritical water extraction allowed for a higher yield in solubilization of these compounds, primarily in root extract, while maintaining their biological properties. Withaferin A, withanolideA, withanoside IV and VI, withanolide D, dihydro-withanolide D, and withanolide sulfoxide were among the 43 withanolides that Trivedi et al. (2017) discovered using LC/MS, GC/MS, and NMR. These withaferins A and withanolide A have therapeutic benefits that include the treatment of cancer and neurological diseases including Parkinson's and Alzheimer's. Gupta et al. (1996) discovered that among leaves, roots, and fruits, leaves had the highest concentration of alkaloids. Subaraju et al. discovered ashwagandhanolide, a new dimeric thiowithanolide, in the root in 2006. Although the yield of *W. somnifera* is significantly larger (up to 4.3% of region/countries), the total alkaloid concentration in the root varies between 0.13 and 0.31%. These plants also contain a substantial quantity of iron, aspartic acid, cysteine, proline, tyrosine, alanine, glycine, glutamic acid, cysteine, and tryptophan, among other amino acids (Gupta and Rana 2007). Images of stem and root

Metabolic profiling of *Withania:*

Leaves contain a total of 62 major, minor, primary, and secondary metabolites.Total of 48 major and minor primary and secondary metabolites from roots. Roots and leaves contain a total of 29 major, minor, primary, and secondary metabolites.

Table: Distribution of pharmaceutically important secondary metabolites among different plant parts of *Withania.*

Plant parts	Major	Minor
Leaf	Withaferin A	Withanolide D
	Withanone	Withanolide D
Root	Withanolide A	Withaferine A
	Withanolide D	Withanone

Economic importance:

Roots that are claimed to improve immune function, slow down the ageing process, revitalise the body in weakened states, boost resistance to environmental toxins, and promote mental wellbeing are said to promote health and longevity during pregnancy. *W. somnifera* leaves have antibacterial, antifungal, and anticancer qualities. Ashwagandha is used as a tonic for life and health to soothe the mind, diminish weakness and nervous tiredness, boost sexual vigour, and promote peaceful sleep. One of the tranquillizers most regularly used in India is this one. because It is used to boost vitality and speed up the recovery from chronic illnesses since it has an impact on the neurological and reproductive systems, revitalising the body. Prolonged stress can cause immune system suppression, sexual dysfunction, stomach ulcers, anomalies in glucose homeostasis, and alterations in plasma corticosterone levels, among other health problems. Osteoarthritis, inflammation, stroke, and tardive dyskinesia can all be treated with ashwagandha. When used against staphylococcus aureus and pseudomonas aeruginosa bacterial strains, ashwagandha has demonstrated potential as a microbial agent with antifungal and mild antibacterial effect.

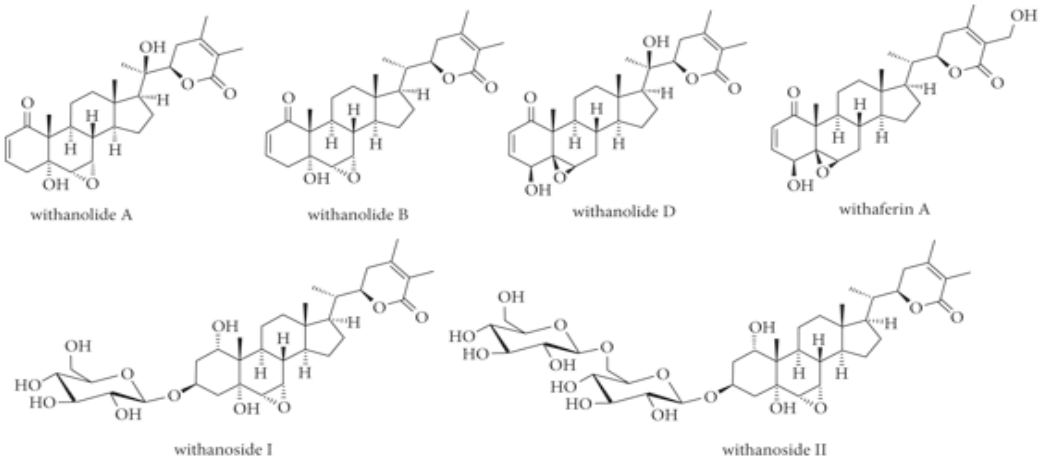
Pharmacological Activity:

Withania somnifera has pharmacological relevance as an adaptogen, an abortifacient, an antibacterial, an aphrodisiac, an astringent, an anti-inflammatory, a diuretic, a narcotic, a sedative, and a tonic. It's been proven that ashwagandha offers strong antioxidant defence. Activate the immune system's phagocytes and lymphocytes by stimulating them. reduce the effects of stress while enhancing overall wellness.

Distribution of *Withania somnifera* yellow dots showing plant distribution

Map Of India showing collection of germplasm of *Withania somnifera*

Strucutes of Bioactive Compounds:



Chemistry:

Table: Power and Salway (1911) extracted an amorphous alkaloid (C12 H16 N2) from a south strain of *W. somnifera.*

Plants part	Class	Chemical constituent	Biological activity/Reference
Root	Acylsteryl-glucoside Glycowithanolide	Sitoindosides VII, Sitoindosides VIII Sitoindosides IX, Sitoindosides X	Immunomodulatory, CNS effect, antioxidant, antistressor. (Bhattacharya et al., 1987) Immunomodulatory, CNS effect, antioxidant, antistressor. Ghosal et al., (1988)

Alkaloid	Withananine	Majumdar (1955)
Alkaloid	Withanine	Majumdar (1955)
Ashwagandhanolide		Subaraju et al (2006), Mirjalili et al., 2009
Steroidal lactone	Withaferin	Majumdar (1955)
Steroidal lactone	Somniferine	Majumdar (1955)
Steroidal lactone	Visamine	Antibacterial anti fungal Antibiotic & antimitotic Antitumour&radiosensitizer Cytotoxic, anti-inflammatory Antiaethritic, Alzhiemers, immunosuppressant. Kirsonet al.(1970) lavie et al. (1966)
Steroidal lactone	Withaferin A	Antibacterial anti fungal Antibiotic & antimitotic Antitumour&radiosensitizer Cytotoxic, anti-inflammatory Antiaethritic, Alzhiemers, immunosuppressant. Kirsonet al.(1970) lavie et al. (1966)
Steroidal lactone	Withnolide D	Antitumour
Steroidal lactone	Withanolie E	Antibacterial, Immunosuppresive, Insectantifeedant. Glotter et al (1977)
	Withanone	Dhalla et al (1961b), kirson et al (1971)
Novel	Withanolide Z	Pramanick et al (2008)
	Withanolide B	Pramanick et al (2008)
	7- hydroxywithanolide	Pramanick et al (2008) Anjancyulu and satyanarayanarao (1997)
	3$^{\alpha}$-methoxy-2, 3-dihydro	
Steroidal lactone	27-deoxywithaferin A	(Kirson et al., 1970)
	- 4β, 17$^{\alpha}$-dihydroxy-1-loxo-	(Lavie et al.,1965)
	5β, 6β-epoxy-22R-witha	(Lavie et al.,1965)
	2, 24-dienolide	(Glotter et al., 1977)

		4β-dihydroxy-5β, 6β-epoxy	
		1-oxo-22R-witha-2, 14-24-	(Dhalla et al., 1977)
	Steroidal lactone	Trienolide	(Kirson et l., 1971)
	Steroidal lactone	5, 20$^{\alpha}$(R)-dihydroxy-6$^{\alpha}$, 7$^{\alpha}$-epoxy-1-oxo-(5$^{\alpha}$)-with a-2, 24-dienolide	(Menben Von and staple 1973)
		2,3-dihydrowithaferin A-3 beta-O-sulfate	
	Aliphatic ester	Withanolide- WS2	(Xu et al., 2009), (Kundu et al., 1976a,b), (khan et al., 1993)
Seeds	Aliphatic ketone	Withanolide-WS1	

Table: Summary of human trials on ashwagandha:

Active principle	Properties	Form	Effect	Mechanism of action	Reference
Withaferin A Withanolide D	Anticancer activity	Powder	Reduce skin carcinoma Enrlich ascites carcinoma, sarcoma 180, and E0771 mammary adenocarcinoma growth is slowed.	At metaphase, withaferin-A halts cell division in cultured human laryngeal cancer cells. Nuclear factor kappa B levels are decreased by protein kinase C inhibition or caspase-3 activation, This also inhibits intercellular tumour necrosis factor and boosts apoptotic signalling in certain types of cancerous cells.	(Davis and kuttan, 1998)
Withaferin A	Anti-inflammatory	extract	Descresetheglycosaminoglycans content in the granuloma tissue. reduced the ADP/0 ratio in mito, releasing the oxidative phosphorylation. of tissues with granulosa. Increase the MG2+ dependent atpaseenz. Reduction in succinate dehydrogenase activity	lymphocyte growth, delayed type hypersensitivity, and complement inhibition.Its naturally occurring steroidal content is much heigher than that of hydrocortisone sodium succinate a commonly prescribed Anti-inflammatory.	(Begum et al. 1988)
Sitoindosides VII-X Withaferin A, glycowithanolides	Antioxidant effects		Oxidative Free radical accumulation thatdamage in nervous (neural loss) and brain i.e epilepsy, schizophrenia, parkinsonsalzheimers.	Increased levels of endogenous catalase, glutathione peroxidase, ascorbic acid, and superoxide dismutase are associated with decreased levels of lipid peroxidation.	Jayprakasam et al., 2004, Bhatnagar, 2005; Dhuley,

			neurodegenerative effect		1998; Bhattachary a, 2001; Mirjalali et al., 2009;
Withanolide	Anti-microbial activities	Extract			Dhuley, 1998 ziauddin et al., 1996 ; Mishra et al., 2000; pwais., 2005
Sitoindosides VII and VIII	Antistress and aphrodisiac	tonic	Spermatopathia, seminal depletion, diuretic and aphrodidsiac activity, cure sterility in women (decoction of root cooked with milk and ghee)	Antistress activity associated with glycosides. Inhibitory neurotransmitters such as GABA (gamma aminobutyric acid) are found in the brain. Its purpose is to lessen neuron activity and prevent excessive firing of nerve cells. There is a relaxing impact from this action. Insomnia and restlessness can result from excessive neuronal activity, while GABA reduces the number of brain cells that fire, which promotes sleep, improves mood, and lessens anxiety.	Bhattachary a., 1987; dhuley., 2000; nandkarini., 1954; boone., 1998; lohae., 1992; singh and kumar., 1998
Withaferin A	Anti-arthritic	Powder	Reduces the discomfort associated with arthritis. Hypotensive effect. Depressant action on higher cerebral centers Cardio attack.	Autonomic ganglion blocking	Bector., 1968; malhotra., 1981; mohanty et al., 2004; sehgal., 2012.
Ashwagandhol ine	Effects on nervous system	(root extract)	Relaxanat and antiplasmodic effect. Cognition and memory enhancing effects. Improvement in scopolamine-inducedmemory in mice. Due to its powerful antioxidant, antiperoxidative, and free radical quenching characteristics, haloperidol and reserpine have an antiparkinsonian effect on neuroleptic-induced catalepsy by suppressing it.	Sedative action on cns that alters the conc. Of neurotransmitters. influence the cholinergic signalling processes in the cortical and basal regions. Increase the capability of the cortical muscarinic acetylcholine receptors	Malhotra., 1965; Schliebs at al., 1997; Sehgal et al., 2012; Dhuley., 2001; Kumar & Kulkarni (2006), Ahmad et al. (2005), Sehgal et al. (2012).

Withanolide A .	Immunity	Root powder	Immune-potentiating and myeloprotectective effect. Increase Red blood cell count. Activate IgM and IgG and cell-mediated immunity	Enhance the level of interferon-y, interleukin-2, granulocyte macrophages. Boost CD4 and CD 8 counts as well as T-Helper 1 cytokine expression levels. Boost the action of natural killers.	Davis., &Kuttan., 1999; Singh et al. (2008); Bani et al. (2006)
Glycowithanolides, sitoindosides IX and X	Immunomodulator properties	Tablet	Immunomodulator and CNS effects. Antistress activity in albino mice and rats. Increase in hemolytic antibody response towards human erythrocytes (immunostimulator)	Increase WBC count , inhibit delayed type hypersensitivity reaction and enhance phagocytic activity of macrophages. Immunomodulatory effect in three myelosuppression model in mice: cyclophosphamide, azathioprine or prednisolone.	Ghosal et al., 1989; Ziauddin et al., 1996;
Withanolides	Rejuvenating effect	Powdered	Enhance serum iron levels, hand grip, body weight, packed cell volume, mean corpuscle volume, haemoglobin, and total proteins.	growth-enhancing impact useful as a general health tonic in both younger and elderly populations. diuretic and hypoglycemic effects.	Budhiraja& Sudhir, 1987; Kuppurajan et al., 1996; andallu& Radhika, 2000
	Anti-aging activity	Powder	Improvement in sexual performance	Dose of 3 gm daily for 1 year improve in hemoglobin, RBC count, hair melanin etc	
	Hypothyroid activity	Root extract	indirect thyroid stimulation through the cellular antioxidant system.	Significant increase in T4 shows plant has stimulating effect on glandular level.	

Conflict of interest:

There is no conflict of interest.

Conclusion:

The growing demand for this species on both domestic and international markets necessitates the production of high-quality roots on farms. The only way to do this is to produce acceptable high yielding cultivars and technologies. Therefore, the development of dwarf, high-yielding variants of Ashwagandha should be the goal of future breeding efforts.

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