A REVIEW ON WITHANIA SOMNIFERA (L.) DUNAL- AS AN IMPORTANT AYURVEDA PLANT

Dhruv Pandya*, Archana Mankad and Himanshu Pandya

Department of Botany, Bioinformatics & Climate Change Impacts Management, School of Science, Gujarat University, Navrangpura, Ahmedabad, Gujarat.

*E-mail: dhruvpandya1309@gmail.com

ABSTRACT

Withania somnifera (L.) Dunal is a well-known and important medicinal plant widely used in several indigenous systems of medicine for the treatment of various ailments, viz. asthma, bronchitis, inflammatory diseases, ulcer and stomach problems. Steroidal lactones have been reported as the major phytoconstituents of this species. Different pharmacological experiments in a number of in vitro and in vivo models have convincingly demonstrated the ability of W. somnifera to exhibit anti-inflammatory, anti-oxidative, antimicrobial, anti-anxiety, aphrodisiac, immunomodulation, anti-diabetic, anti-ulcer, anticancer, central nervous system depressant and hepatoprotective activities, lending support to the rationale behind several of its traditional uses. The species is also used to treat some neurological disorders like Parkinson’s and Alzheimer’s. The phytochemicals such as withaferin A, withanolide A and withanolide D isolated from this plant are potential bioactive molecules. Due to the remarkable biological activity of W. somnifera and its constituents, it will be appropriate to develop them as a medicine and make them more potent by chemical modifications and biotransformation. This review has covered botany, chemistry and pharmacology of the plant besides its traditional and folkloric uses.

Keywords: Withania somnifera; Steroidal lactones; Withanolides; Ayurveda.

INTRODUCTION

Plants play a dominant role in the discovery of new therapeutics and have been used in traditional medicine for thousands of years (Muthu et al., 2006). They have always been a rich source of a large variety of lead compounds. Pharmacological screening of natural products has led to the discovery of a number of drugs. Among the worldwide list of twenty-six species, the genus Withania is represented in India by Withania somnifera and W. coagulans (Chadha, 1976). Recently we have reported a third species Withania ashwagandha from Indian germplasm using multidisciplinary approaches (Mir et al., 2010; Kumar et al., 2011). Within the family Solanaceae, Withania belongs to subfamily Solanoideae, tribe Physaleae and sub-tribe Withaninae of which it is the type genus (Olsmstead et al., 2008). The generic name Withania commemorates the celebrated English ‘Paleobotanist’, ‘Henry Thomas Maire Witham’ with an orthographic variation of the final ‘m’ into an ‘n’ to which the commemorative termination – ia has been added. The specific epithet somnifera is a compound of two Latin words ‘somnus’ meaning sleep and ‘fero’ (ferere) meaning ‘to bear’. Thus, the specific epithet alludes to sleep inducing properties of the plant.

Withania somnifera is an erect, branched, greyish, stellate-tomentose under-shrub, 30-150 cm high with long tuberous roots. Leaves are simple, petiolate with the leaf blade varying in shape from elliptic-ovate to broadly ovate, entire along margins, acute to obtuse at apex, cuneate or oblique at base, 4-10 cm long and 2-7 cm broad. Flowering is seen between March to July.
Classification of *Withania somnifera* L.:  
**Kingdom:** Plantae  
**Division:** Angiosperms  
**Class:** Dicotyledon  
**Sub-class:** Gamopetalae  
**Series:** Bicarpellatae  
**Order:** Polymoniales  
**Family:** Solanaceae  
**Genus:** *Withania*  
**Species:** *somnifera*  
(According to Bentham and Hooker).

Ethnobotany:  
In Ayurveda, *Withania somnifera* is widely claimed to have aphrodisiac, sedative, rejuvenativeand lifeprolonging properties.

Pharmacological effects of *Withania somnifera* L.:  
**Anti-oxidant effects:**  
Free radical damage of nervous tissue may be responsible for neural loss in cerebral ischemia andmay be involved in aging and neuro-degenerative diseases, e.g., epilepsy, schizophrenia, Parkinson’s, Alzheimer’s and other diseases (Sehgal *et al*, 2012). The active compounds of *Withania somnifera* L., sitoindosides and withaferin A, are reported to increase levels of endogenous superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX), and ascorbic acid, with a concomitant decrease in lipid peroxidation (Mirjalali *et al*, 2009). A decrease in the activity of these enzymes is known to lead accumulation of free radicals and resulting in degenerative effects.

**Anti-microbial activity:**  
The anti-bacterial properties of this plant were reported first time by Kurup (1956) against *Salmonella aurens*.

**Anti-inflammatory property:**  
Ashwagantha act as an anti-inflammatory agent through inhibition of complement, lymphocyteproliferation and delayed type hypersensitivity (Rasool and Varalakshmi, 2006). The extracts of the plant have shown anti-inflammatory effects in a variety of rheumatological conditions (Al- Hindavi *et al*, 1992).

**Anti-stress activity:**  
Anti-stress activity is associated with glycosides (Sitoindosides) present in the plant was reportedby Bhattacharya (2000 and 2003). The studies conducted by (Singh *et al*, 2001) lent...
support to the usefulness of Ashwagantha as an anti-stress adaptogen.

Aphrodisiac activity:
Ashwagantha is also used as a tonic in the treatment of spermatopathia, impotence and seminal depletion (Nadkarni, 2002) and the man who used the herb enjoyed higher vigour performance (Boone, 1998). The higher concentrations of inorganic elements like Fe, Mg, K and Ni in the roots of this plant plays significant role in the diuretic and aphrodisiac activity of the drug (Lohar et al, 1992).

Anti-arthritic activity:
Ashwagantha powder has been found useful in acute rheumatoid arthritis and reduces the discomfort associated with arthritis (Bector et al, 1968). This property has been attributed to the active principle withaferin A.

Anti-neoplastic activity:
Ashwagantha is reported to have anti-carcinogenic effects. Research on animal cell cultures has shown that the herb decreases the level of the nuclear factor kappaB, suppresses the intracellular tumour necrosis factor, and potentiates apoptotic signalling in cancerous cell lines. It works to reduce tumour size.

Different plant part with uses and system of medicine:

| Plant Part | System of medicine | Uses | References |
|------------|--------------------|------|------------|
| Roots      | Ayurveda           | Tonic, Alternative pungent, Astringent, Aphrodisiac, Phthisis | Dutta (1877), Kumar et al (1980). |
|            | Siddha             | Aphrodisiac, Fever, Inflammation. | SPC Chand (1992). |
|            | Unani              | Asthma, Bronchitis, Leukoderma, Arthritis. | Stewart (1869), Mathani (1973). |
|            | Folklore           | Abortifant, Cold, Asthma, Tuberculosis, Fever. | Dutta (1877), Kumar et al., (1980). |
| Leaves     | Ayurveda           | Aphrodisiac, Carbuncle, Ulcers, Painful swelling. | Singh and Kumar (1998), Kumar et al (1980). |
|            | Siddha             | Fever, Chest pain, Sores, Swelling. | SPC Chand (1992). |
|            | Unani              | External pains, Anti-inflammatory. | UPC Chand (1993). |
|            | Folklore           | Cure eyesores, Boils, Narcotic, Syphilis. | Shah and Gopal (1985). |
| Seeds      | Ayurveda           | Diuretic, Narcotic and Hypontic. | Dalzell and Gibson (1861). |
CONCLUSION

The use of herbal drug is increasing worldwide as they have fewer or no side effects as compared with synthetic drugs. Ayurveda claims therapeutic potentials of various plants. A lot of work has been done on this multipurpose drug yielding plant till now. But all this information is fragmented therefore; the present review has been an attempt to compile this available information in a comprehensive manner. An extensive research has been done on this plant in past three decades but still there is an urgent need to carry out investigations on the biological activities, efficacies and modes of action of this traditional drug. In India, three species of the genus *Withania* are found, *Withania somnifera*, *Withania ashwagandha* and *Withania coagulans*. Withanolides are the principal compounds found in all the three species, there are some withanolides specific to each of them. Withaferin A is an important phytochemical found in *W. somnifera* and *Withania ashwagandha*, whereas, coagulin L has been found in major amounts in *Withania coagulans*. A unique thio-dimer of withanolide named Ashwagandhanolide has been found in *Withania somnifera*. The plant has been used as an antioxidant, adaptogen, aphrodisiac, liver tonic, anti-inflammatory agent, anticancer, central nervous system depressant, hepatoprotective and astringent and more recently as an antibacterial, antihyperglycaemic, hypolipidaemic and antitumoral, as well as to treat ulcers, senile dementia, Parkinson’s and Alzheimer’s. It had the greater therapeutic value overall. The variety of activities reported for the extracts, fractions and withanolides isolated from this wonder medicinal plant provide promising evidence for future research. Withanolides could achieve an important place in the world of modern drugs. Isolation on a large scale, chemical transformations and synthesis of the active compounds will definitely enhance their pharmacological value. The pharmacophores of various pharmacologically active withanolides have not yet been identified. All these advantages prove the significance of *W. somnifera* in natural product research. Despite having immense medicinal properties a multipronged strategy is required for making Ashwagandha varieties more competitive. There is need to augment the pharmacological properties by selecting and improving chemotypes producing prodigal amounts of the desired withanolide.

REFERENCES

1) Agarwal R, Diwanay S, Patki P, Patwardhan B (1999) Studies on immunomodulatory activity of *Withania somnifera* (ashwagandha) extracts in experimental immune inflammation. *J Ethnopharmacol*. 67, 27–35.
2) Ahmad M, Saleem S, Ahmad AS, Ansari MA, Youssuf S, Hoda MN, Islam F (2005) Neuroprotective effects of *Withania somnifera* on 6-hydroxydopamine induced Parkinsonism in rats. *Hum. Exp. Toxicol*. 24, 137–147.
3) Al Hindawi MK, Al Khaifiy SH and Abdul-Nabi MH (1992) Anti-granuloma activity of Iraqi *Withania somnifera*. *J. Ethnopharmacol*. 37, 113–116.
4) Anbalagan K and Sadique J (1984) Role of prostaglandins in acute phase proteins in inflammation. *Biochem. Med.*. 31, 236-245.
5) Andulla B and Radhika B (2000) Hypoglycemic, diuretic and hypocholesterolemic effect of winter cherry (*Withania somnifera*) root. *Indian J. Exp. Biol*. 38, 607-609.
6) Anonymous (1976) In: The Wealth of India, (Raw Materials), CSIR: New Delhi. India. 10, 580-585.
7) Anonymous (2004) Monograph: *Withania somnifera*. *Altern. Med. Rev.* 9, 211-214.
8) Archana R and Namavisayan A (1999) Antistressor effect of *Withania somnifera*. *J. Ethnopharmacol*. 64, 91–93.
9) Asthana R and Raina MK (1989) Pharmacology of *Withania somnifera* (L.) Dunal—a review. *Ind. Drugs*. 26, 199-205.
10) Atal CK, Gupta OP, Rangunathan K and Dhar KL (1975) Central Council for Research in Indian Medicine and Homeopathy. New Delhi, India.
11) Atta-ur-Rahman, Abbas S, Jamal AS and Choudhary MI (1993) New withanolides from *Withania* spp. *J. Nat. Prod*. 56, 1000–1006.
12) Atta-ur-Rahman, Jamal AS, Choudhary MI, Asif I (1991) Two withanolides from *Withania* spp.
somnifera. Phytochem. 30, 3824-3825.
14) Bandyopadhyay M, Jha S and Tepfer D (2007) Changes in morphological phenotypes and withanolide composition of Ri-transformed roots of Withania somnifera. Plant cell. Rep.26, 599-609.
15) Bani S, Gautam M, Sheikh FA et al., (2006) Selective Th-1 up-regulating activity of Withania somnifera aqueous extract in an experimental system using flow cytometry. J. Ethnopharmacol. 107:107-115.
16) Bector NP, Puri AS, Sharma D (1968) Role of Withania somnifera (Ashwagandha) in various types of Arthropathies. Ind. J. Med. Res. 56, 1581-1583.
17) Begum VH and Sadique J (1988) Long term effect of herbal drug Withania somnifera on adjuvant induced arthritis in rats. Ind. J. Exp. Biol. 26, 877-882.
18) Bhatnagar M, Sisodia SS and Bhatnagar R (2005) Antiulcer and antioxidant activity of Asparagus racemosus WILD and Withania somnifera DUNAL in Rats. Ann. NY Acad. Sci. 1056, 261-278.
19) Bhattacharya A, Ghosal S and Bhattacharya SK (2001) Antioxidant effect of Withania somnifera glycowithanolides in chronic footshock stress-induced perturbations of oxidative free radical scavenging enzymes and lipid peroxidation in rat frontal cortex and striatum. J. Ethnopharmacol. 74: 1-6.
20) Bhattacharya SK, Bhattacharya A, Sairam K and Ghosal S (2000) Anxiolytic-antidepressant activity of Withania somnifera glycowithanolides: an experimental study. Phytoimed. 7, 463-469.
21) Bhattacharya SK, Goel RK, Kaur R and Ghosal S (1987) Antistress activity of sinesisides VII and VIII, new acylsterylglucosides from Withania somnifera. Phytother. Res. 1, 32-39.
22) Bhattacharya SK and Muruganandam AV (2003) Adaptogenic activity of Withania somnifera: an experimental study using a rat model of chronic stress. Pharmacol. Biochem. Behav. 75, 547-555.
23) Boone K (1998) Withania-The Indian ginseng and anti-aging adaptogen. Nutr. Healing. 5, 5-7.
24) Budhiraja RD and Sudhir S (1987) Review of biological activity of withanolides. J. Sci. Ind. Res. 1987, 46, 488-491.
25) Davis L and Kuttan G (2000) Effect of Withania somnifera on cyclophosphamide induced urotoxicity. Cancer Lett. 148(1), 4–17.
26) Davis L and Kuttan G (1998) Suppressive: Effect of cyclophosphamide-induced toxicity by Withania somnifera extract in mice. J. Ethnopharmacol. 62, 209-214.
27) Devi PU, Sharada AC, Solomon FE and Kamath MS (year?) In vivo growth inhibitory effect of Withania somnifera (Ashwagandha) on a transplantable mouse tumor, Sarcoma 180. Ind. J. Exp. Biol. 30, 169-172.
28) Devi PU, Sharada AC and Solomon FE (1993) Antitumor and radiosensitizing effects of Withania somnifera (ashwagandha) on a transplantable mouse tumor, Sarcoma-180. Ind. J. Exp. Biol. 31, 607-611.
29) Devi PU (1999) Withania somnifera dunal (ashwagandha): Potential plant source of a promising drug for cancer chemotherapy and radiosensitisation. Ind. J. Exp. Biol. 34 (10), 927-932.
30) Dhuley JN (2000) Adaptogenic and cardioprotective action of ashwagandha in rats and frogs. J. Ethnopharmacol. 70 (1),57-63.
31) Dhuley JN (1998) Effect of ashwagandha on lipid peroxidation in stress-induced animals. J Ethnopharmacol. 60, 173-178.
32) Dhuley JN (2001) Nootropic-like effect of Ashwagandha (Withania somnifera L.) in mice. Phytother Res. 15, 524-528.
33) Eastwood FW, Kirson I, Lavie D and Abraham A (1980) New withanolides from a cross of a South African chemotype by chemotype II (Israel) in Withania somnifera. Phytochem.19, 1503-1507.
35) Falsey RR, Marron MT, Gunaherath GM, Shirahatti N, Mahadevan D, Gunatilaka AA and Whitesell L (2006) Actin microfilament aggregation induced by withaferin A is mediated by annexin II. Nat. Chem. Biol. 2, 33-38.
36) Ghosal S, Kaur R and Srivastava RS (1988) Sitosteroids IX and X, new glycowithanolides from Withania somnifera. Phytother. Ind. J. Nat. Prod. 4, 12-13.
37) Ghosal S, Lal J, Srivastava R and et al (1989) Immunomodulatory and CNS effects of sitosteroids IX and X, two new glycowithanolides from Withania somnifera. Phytother.
38) Grandhi A, Mujumdar AM and Patwardhan B (1994) A comparative pharmacological investigation of Ashwagandha and Ginseng. J. Ethnopharmacol. 44, 131-135.
39) Gupta SK, Mohanty I, Talwar KK, Dinda A, Joshi S, Bansal P, Saxena A and Arya DS: Cardioprotection from ischemia and reperfusion injury by Withania somnifera: A hemodynamic, biochemical and histopathological assessment. Mol. Cell Biochem. 260, 39-47.
40) Halliwell B and Gutteridge (1989) JMC Free radicals in biology & medicine. 2nd ed. Oxford: clarendon press.
41) Hunziker AT (2001) Genera Solanacearum: the genera of the Solanaceae illustrated, arranged according to a new system. Gantner Verlag, Ruggell, Liechtenstein.
42) Jayaprakasam B, Strasburg GA and Nair MG (2004) Potent lipid peroxidation inhibitors from Withania somnifera fruits. Tetrahed. 60, 3109-3121.
43) Jayaprakasam B, Zhang Y. Seeram NP and Nair MG (2003) Growth inhibition of human tumor cell lines by withanolides from Withania somnifera leaves. Life Sci. 2003, 74, 125-132.
44) Jayaram S, Walwalkar PP and Rajadhyaksha SS (1993) Evaluation of efficacy of a preparation containing combination of Indian medicinal plants in patients of generalized weakness. Ind. Drugs 30, 498-500.
45) Jesberger JA and Richardson JS (1991) Oxygen free radicals and brain dysfunction. Int. J. Neurosci. 57, 1-17.
46) Kapoor LD (2001) Handbook of ayurvedic medicinal plants, CRC Press: London, UK. 337-338
47) Karkick CR (1992) Clinical observations on the effect of composite herbal drugs of Withania somnifera, Panax ginseng and Tribulus terrestris on psychomotor performance in healthy volunteers. Ind. Med. 4, 1-4.
48) Kaul MK, Kumar A and Sharma A (2005) Reproductive biology of Withania somnifera (L) Dunal. Curr. Sci. 88 (9), 1375-1377.
49) Khan B, Ahmad SF and Bani S et al., (2006) Augmentation and proliferation of T lymphocytes and Th-1 cytokines by Withania somnifera in stressed mice. Int. Immunopharmacol. 6, 1394-1403.
50) Kirson I, Abraham A and Lavie D (1977) Chemical analysis of hybrids of W. somnifera L. (Dunal) chemotype I and III Israel by Indian I (Delhi). Israel. J. Chem. 16, 20-24.
51) Kothari SK, Singh CP, Kumar YV and Singh K (2003) Morphology, yield and quality of ashwagandha (Withania somnifera (L.) Dunal) roots and its cultivation economics as influenced by tillage depth and plant population density. J. Hort. Sci. Biotechnol. 18, 422-425.
53) Kulkurni SK and Ninan I (1997) Inhibition of morphine tolerance and dependence by Withania somnifera in mice. J. Ethnopharmacol. 57, 213-217.
54) Kumar A, Kaul MK, Bhan MK, Khanna PK and Suri KA (2007) Morphological and chemical variation in 25 collections of the Indian medicinal plant, Withania somnifera (L) Dunal (Solanaceae). Genet Resour. Crop Evol. 45, 655-660.
55) Kumar A and Kulkarni SK (2006) Effect of BR-16A (Mentat), a polyherbal formulation on drug-induced catalepsy in mice. Ind. J. Exp. Biol. 44, 45-48.
56) Kumar A, Mir BA, Sehgal D, Kou S, Dar TH, Maharaj KK, Soom NR and Qazi GN (2011) Utility of multidisciplinary approach for genome diagnostics of cultivated and wild germplasm resources of medicinal Withania somnifera, and status of new species, W. ashwagandha, in the cultivated taxon. Plant Sys. Evol. 291, 141-151.
57) Kumar V, Kotamballi N, Chidambaram M, Bhamid S, Sudha CG, Ravishankar GA (2005) Genetically Modified Hair Root of Withania somnifera Dunal: A Potent Source of Rejuvenating Principles. Rejiv Res. 8, 37-45.
58) Kurup PA (1956) Antibiotic principals of the leaves of Withania somnifera. Curr. Sci. 25, 57-60.
59) Kuttan G (year) Use of Withania somnifera Dunal as an adjuvant during radiation therapy. Ind. J. Exp. Biol. 34, 854-856.
60) Leyon PV and Kuttan G (2004) Effect of Withania somnifera on B16F-10 melanoma induced metastasis in mice. Phytother. Res. 18, 118-122.
61) Lohar DR, Chaturvedi D and Varma PN (1992) Mineral elements of a few medicinally important plants. Ind. Drugs. 29, 271-273.
62) Majumdar DN (1955) *Withania somnifera* Dunal, Part II, Alkaloidal constituents and their chemical characterization. *Ind. J. Pharmacol.* 17, 158-161.

63) Malhotra CL, Mehta VL, Das PK and Dhalia NS (1965) Studies on *Withania ashwagandha*, Kaul. V. The effect of total alkaloids (ashwagandholine) on the central nervous system. *Ind. J. Physiol. Pharmacol.* 9, 127-136.

64) Malhotra CL, Mehta VL, Prasad K and Das PK (1965) Studies on *Withania somnifera* Ashwagandha Kaul (Part V). The effect of total alkaloids on the smooth muscles. *Ind. J. Physiol. Pharmacol.* 9, 9-15.

65) Malhotra CL, Das PK, Dhalia NS and Prasad K (year) Studies on *Withania ashwagandha*, Kaul. III. The effect of total alkaloids on the cardiovascular system and respiration. *Ind. J. Med. Res.* 49, 448-460.

66) Marcerosion AD (2001) The review of natural products, facts and comparisons, St. Louis, MI, USA. 630-632.

67) Mathur S, Kaur P and Sharma M et al (2004) The treatment of skin carcinoma induced by UV B radiation, using 1-oxo-5beta, 6beta-epoxy-with-a-2-enolide, isolated from the roots of *Withania somnifera*, in a rat model. *Phytoemed.* 11, 452-460.

68) Menon LG, Kuttan R and Kuttan G (1997) Effect of rasayanas in the inhabitation of lung metastasis induced by B16F-10 melanoma cells. *J. Exp. Clin. Cancer Res.* 16, 365-368.

69) Mir BA, Koul S, Kumar A, Kaul MK, Soodan AS and Raina SN (2010) Intraspecific variation in the Internal Transcribed Spacer (ITS) Regions of rDNA in *Withania somnifera* (L.) Dunal. *Ind. J. Biotech.* 9(3), 325-328.

70) Mir BA, Koul S, Kumar A, Sushant S, Kaul MK and Soodan AS (2012) Reproductive behaviour and breeding system of wild and cultivated types of *Withania somnifera* (L.) Dunal. *J. Med. Plants Res.* 6 (5), 754-762.

71) Mir BA, Kumar A, Koul S, Kaul MK, Raina SN and Soodan AS (2011) Assessment and characterization of genetic diversity in *Withania somnifera* (L.) Dunal using RAPD and AFLP markers. *Afr. J. Biotech.* 10(66), 14746-14756.

72) https://www.tradeindia.com/fp2076129/Ashwagandha-Withania-somnifera-.html