Comprehensive Report on Phytochemistry and Pharmacological Prominence of Withania somnifera

Kalpana Gavande¹, Dr. Kirti Jain², Dr. Bharti Jain¹, Rakesh Mehta³

¹Sarojini Naidu Govt Girls PG Autonomous College, Bhopal (M.P.)-462016, India
²Govt. Science and Commerce College, Benazir, Bhopal (M.P.)-4620008, India
³Govt. MGM PG college, Itarsi (M.P.)-461111, India

Abstract

Medicinal plants have been one of the prominent sources of remedies since the inception of human civilization. In rural area herbal medicines are considered to be best healthcare products due to its easily availability. A large proportion of the world population, especially in the developing countries relies mainly on the traditional system of medicine. Withania somnifera is known as Ashwagandha belonging to the Solanaceae family. W. somnifera is used as adaptogen, antiarthritic, antispasmodic, anti-inflammatory, nerve tonic, nerve soothing, sedative, hypotensive, antioxidant, immunomodulator, free radical scavenger, anti-stress and anti-cancer agent. From chemistry point of view, the drug contains group of biologically active constituents known as withanolides. The major active constituents of W. somnifera root are steroidal alkaloids and steroidal lactones in a class of constituents called withanolides. The present review is therefore, an effort to give a detailed overview of the published writings on phytochemistry and pharmacological activities of W. somnifera; this information will be beneficial in developing new formulations, which are more effective and have more therapeutic values.

Keywords: Withania somnifera, Solanaceae, Pharmacological activity, Phytochemistry

1 Introduction

Human beings always made use of plants to alleviate suffering and diseases. From thousands of years nature has been a source of medicinal agents. Those plants that have pharmacological activity are termed as medicinal plants or herbs. Medicinal plants offer alternative remedies with tremendous opportunities. Many traditional healing herbs and plant parts have been shown to have medicinal value especially in the rural areas and that these can be used to prevent and cure several human diseases. In addition, plant based drugs remain an important source of therapeutic agents because of their availability, relatively cheaper cost and non-toxic nature, when compared to modern medicine. Plants have the ability to synthesize a wide variety of chemical compounds that are used to perform important biological functions, and to defend against attack from predators such as insects, fungi and herbivorous mammals. Many of these phytochemical have beneficial effects on long-term health when consumed by humans, and can be used to effectively treat human diseases¹,².

Since ancient times medicinal plants are utilized for the ailment of human disease. The resurgence of interest in natural drugs pioneered at last a decade, mostly because of the wide-spread persuasion that natural medicine is safer than the synthetic product³. It has been estimated that about 75,000 species of higher plants exist on the earth. A reasonable estimate of about 10% has been used in traditional medicine. However, perhaps only about 1% of these are acknowledged through scientific studies to have therapeutic value when used in extract form by human⁴.

Withania somnifera usually known in Sanskrit as Ashwagandha, is a perennial plant belonging to the family Solanaceae. The name “somnifera” in Latin means “sleep-inducer” which probably refers to its general use as a remedy against stress⁵.

W. somnifera is one of the major herbal components of geriatric tonics mentioned in Indian systems of medicine. W. somnifera is a main ingredient of many marketed formulations used for a variety of clinical conditions like arthritis and rheumatism and as a general tonic to improve health of the elderly and during pregnancy in
women. *W. somnifera* also helps in conditions like chronic fatigue, weakness, dehydration, bone weakness, loose teeth, thirst, impotency, premature ageing and emaciation. It is an imperative herb in traditional medicine systems for over 3000 years. Traditionally, plant was used as aphrodisiac, anti-inflammatory agent, as an ingredient of liver tonic, rejuvenating agent and to treat insomnia. Its leaves are used in Ayurvedic and Unani systems for treatment of tumors and tubercular glands. *W. somnifera* is considered to promote youthful vigor, endurance, strength and general health. It is widely claimed to produce mild sedation, an effect potentially useful for those troubled by anxiety. The leaves of *W. somnifera* are bitter in taste and used as an anthelmintic. Bruised leaves and fruits are locally applied to tumors and tubercular glands, carbuncles and ulcers. The roots are used in constipation, loss of memory, loss of muscular energy and spermatorrhoe. The medicinal properties of *W. somnifera* is attributed to several classes of withanolides, a group of naturally occurring C-28 steroidal lactone triterpenoids, in which C-22 and C-26 are suitably oxidized to form a six-membered lactone ring. The purpose of this article is to review recent literature regarding *W. somnifera* in an attempt to establish a scientific basis for therapeutic use of *W. somnifera*. Hence this review accomplishes to contribute an overview of the pharmacological importance of the *W. somnifera* and phytoconstituents present in its various parts to establish a scientific basis for the therapeutic use of *W. somnifera*.

### 2 Phytochemistry

*W. somnifera* comprising of various chemical constituents such as steroidal lactones, alkaloids, flavonoids, tannin etc. are identified, extracted and isolated. Currently more than 12 alkaloids, 40 withanolides and several sitoindosides (a withanolide containing a glucose molecule at C-27) are reported from aerial parts, roots and berries of *W. somnifera*. The chief chemical constituents of *W. somnifera* are mainly contained in leaves. Withanolides are a group of naturally occurring C-28 steroidal lactones built on an intact ergostane structure, in which C-22 and C-26 are oxidized to form a six-membered lactone ring. Withaferin A was the first member of withanolides, isolated from *W. somnifera*. Withanolides are main chemical constituents responsible for multiple medicinal applications of ashwagandha. It stimulates activation of immune system cells such a lymphocytes. It inhibits inflammation and restores memory. Leaves are reported to contain five unidentified alkaloids (0.09%), chlorogenic acid, calystegines, withanine, tannin and flavonoids. Four types of peroxidases is purified and characterized from *W. somnifera* roots. The various chemical constituents present in *W. somnifera* are anafarine, anahygrine, β-Sitosterol, chlorogenic acid, cysteine, cuscohygrine, iron, pseudotropine, scopoletin, somniferinine, somniferiene, tropanol, withanine, withananine and withanolides A-Y (steroidal lactones). The structures of various active chemical constituents are exhibited in figure 1.

### 3 Pharmacological activities

#### 3.1 Anti-inflammatory activity

The anti-inflammatory activity of *Withania somnifera* on carrageenin-induced paw oedema in rats was evaluated. The sequential role of inflammatory mediators is proposed through inhibition of histamine, 5-hydroxytryptamine and prostaglandins as the antagonists. The time course of release of inflammatory mediators in the anti-inflammatory activity of *Withania somnifera* is further proposed through inhibition of histamine and 5-HT (0–2 hours) in early phase and prostaglandins (2–4 hours) in delayed phase of inflammatory reaction in rats. Sharma et al. (2014) investigated the antioxidant potential by 1,1-Diphenyl-2-picylhydrazyl and nitric oxide radical scavenging assays, anti-inflammatory activity by HRBC membrane stabilization method and albumin denaturation assay and anti-microbial activities of hydro-alcoholic extract of roots of *Withania somnifera*. Antibacterial activity against test organisms E. coli and S. aureus was evaluated. Results suggested that *Withania somnifera* extract possesses potent antioxidant activity, significant anti-inflammatory activity and noteworthy anti-microbial activity against E. coli and S. aureus.

Rasool and Varalakshmi (2006) reported the effect of *Withania somnifera* root powder on paw volume and serum lysosomal enzyme activities in monosodium urate crystal-induced rats and also measured. The levels of beta-glucuronidase and lactate dehydrogenase in monosodium urate crystal incubated polymorphonuclear leucocytes. A significant increase in the level of paw volume and serum lysosomal enzymes was observed in monosodium urate crystal-induced rats. The increased beta-glucuronidase and lactate dehydrogenase level were observed in untreated monosodium urate crystal incubated polymorphonuclear leucocytes. Administration of *W. somnifera* also showed potent analgesic and antipyretic effect with the absence of gastric damage at different dose levels. This indicates the suppressive effect of root powder on the gout arthritis of experimental animal.

#### 3.2 Antidiabetic activity

The roots of *W. somnifera* were tested for hypoglycemic, diuretic and hypcholesterolemic effects on human subjects. Significant increase in urine sodium, urine volume, significant decrease in serum cholesterol, triglycerides, low density lipoproteins and very low density lipoproteins, cholesterol were observed indicating that root of *W. somnifera* is a potential source of hypoglycemic, diuretic and hypocholesterolemic agents.
Anandh Babu and Gokulakrishnan (2007) evaluated the effect of *W. somnifera* ethanolic extract on glucose-mediated collagen glycation (a diabetic complication and age related disease) and cross-linking in vitro. Extent of glycation, viscosity, collagen-linked fluorescence and pepsin solubility were assessed in different experimental procedures to investigate the effect of *W. somnifera*. The activity of ethanolic extract of *W. somnifera* is comparable to metformin, a known antihyperglycemic agent and it could be have therapeutic role in the prevention of glycation induced pathogenesis in diabetes mellitus and aging.

The hypoglycaemic and hypolipidaemic effect of *W. somnifera* root and leaf extracts on alloxan-induced was investigated in diabetic rats. The levels of urine sugar, blood glucose, HbA1C, G6P, AST, ALT, ACP, ALP, serum lipids except high density lipoprotein-bound cholesterol (HDL-c) and tissues like liver, kidney and heart lipids were significantly increased, however hemoglobin Hb, total protein, albumin, albumin:globulin (A:G) ratio, tissues protein and glycogen were significantly decreased in alloxaninduced diabetic rats. Result indicated that *W. somnifera* root and leaf extracts possess hypoglycaemic and hypolipidaemic activities in alloxan-induced diabetes mellitus rats.

Jatwa R et al (2009) investigated possible ameliorative role of two plant extracts (*W. somnifera* and Bauhinia purpurea) on an antidiabetic drug-induced hypothyroidism in type-2 diabetic animals. Dexamethasone administration caused hyperglycemia. Administration with metformin (orally) to diabetic animals further reduced circulating T4 level and caused severe hypothyroidism. While oral administration with either Withania somnifera or Bauhinia purpurea extract along with dexamethasone and metformin elevated the concentrations of circulating T3 and T4 to euthyroid level. The findings of study revealed that evaluated plant extracts have a potential to ameliorate metformin-induced hypothyroidism in type-2 diabetic subjects.

Udayakumar R et al (2010) determined orally administrated phenolic and flavonoid compounds from extracts of *Withania somnifera* root and leaf extracts to reduce levels of urine sugar, blood glucose and liver glycogen in diabetic rats for 8 weeks. After the treatment, the levels of urine sugar, blood glucose, liver glycogen, and antioxidants like vitamin C and E in plasma and superoxide dismutase (SOD), catalase (CAT), thiobarbituric acid reactive substances (TBARS), glutathione peroxidase (GPx), glutathione-S-transferase (GST) and reduced glutathione (GSH) in liver, kidney and heart were determined. Diabetic rats showed a significant (p < 0.05) elevation in glucose and TBARS and a significant (p < 0.05) reduction in glycogen, vitamin C and E, SOD, CAT, GPx, GST, and GSH levels when compared to normal control rats. Study revealed that *Withania somnifera* root and leaf extracts and their antioxidant activity may play a vital role in reduction of blood glucose level in alloxan-induced diabetic rats.

Pradeep S et al (2010) investigated the antinociceptive effect of root extract of *Withania somnifera* in Streptozotocin (STZ) induced diabetic peripheral neuropathic rat models. Result indicated antinociceptive activity of *W. somnifera* was reversed by prior administration of naloxone. It was concluded that antidepressant and antioxidant effect may be responsible for observed antinociceptive effect of *W. somnifera* in STZ induced diabetic peripheral neuropathic rat models.

Sarangi A et al (2013) examined anti-diabetic effects of root and leaf extracts of *Withania somnifera* on streptozotocin induced diabetic rats. The levels of blood glucose, AST, ALT, ALP, LDH, serum lipids except high density lipoprotein-bound cholesterol (HDL-c) were significantly increased, but total protein albumin, albumin : globulin (A : G) ratio, were significantly decreased in streptozotocin-induced diabetic rats, indicating that the extracts possess hypoglycaemic and hypolipidaemic properties, hence useful in diabetes mellitus.

Kyathanahalli et al (2014) tested attenuating effects of *Withania somnifera* root extract on diabetes induced testicular oxidative disturbances in prepubertal rats. Diabetes was induced by a single intraperitoneal injection of STZ. Result showed partial restoration of glucose-6-phosphate dehydrogenase, lactate dehydrogenase, and 3-beta hydroxysteroid dehydrogenase activities in testis of diabetic prepubertal rats administered with *W. somnifera*. Data suggested that the *Withania somnifera* have potential to improve diabetes induced testicular dysfunctions in prepubertal rats.

3.3 Adaptogenic activity

Bhattacharya and Muruganandam (2003) studied antistress adaptogenic activity of *W. somnifera* roots using administration of chronic stress induced adult male Wistar rats. The stress procedure was mild, unpredictable footshock, administered once daily for 21 days. The stress induced rats showed symptoms of hyperglycaemia, glucose intolerance, gastric ulcer, male sexual dysfunction, cognitive deficits and mental suppression. The stress induced perturbations were controlled by root extract along with *Panax ginseng*. The results indicate that *W. somnifera* has significant antistress adaptogenic activity confirming the clinical use of the plant in Ayurveda.

3.4 Antitumor activity

Christina et al (2004) evaluated the effect of ethanolic extract of the root of *Withania somnifera* against Dalton's Ascitic Lymphoma in Swiss albino mice. A significant increase in the life span and a decrease in the cancer cell number and tumour weight were noted in the tumour-induced mice after treatment with root extracts of *W. somnifera*. The hematological parameters were also corrected by

UK J Pharm & Biosci, 2015: 3(2); 17

Jain et al. Comprehensive Report of *Withania somnifera*

Withanolide

Withanolide A

Withanolide D

Withanolide E

Withanolide M

Withanolide N

Withanolide O

Withanolide R

Withanolide P

Withanolide Q
Panjamurthy SMK et al (2009) investigated the protective effect of Withaferin-A on red blood cell integrity during 7, 12-dimethylbenz[a]anthracene (DMBA) induced oral carcinogenesis. The protective effect of Withaferin-A was assessed by measuring the status of glycoconjugates, membrane bound enzyme activity and red blood cell osmotic fragility. Oral administration of withaferin-A (20 mg/kg b.w) along with DMBA (7, 12-dimethyl benzanthracene a carcinogen which can induce oral cancer) for 14 week, completely prevented the tumour incidence in golden hamster. This shows its anti-lipid peroxidative and antioxidant properties.

Yadav B et al (2010) evaluated in vitro cytotoxicity in 50% ethanol extract of root, stem and leaves of Withania Somnifera against five human cancer cell lines of four different tissues i.e. of prostrate, colon, lung and neuroblastoma. Root, stem and leaves extracts showed cytotoxicity activity depending on the cell lines but maximum activity was found in 50% ethanol extract of leaves of Withania Somnifera. Ethanol extract of leaves obtained from treatments T2, T3, T4 and T5 showed strong activity against prostrate and T3 treatment showed a maximum of 98% growth inhibition against colon.

3.5 Antioxidant activity

Misra et al (2005) tested co-administration of methanolic extract of W. somnifera (root), Ocimum sanctum (leaf) and Zingiber officinale (rhizome) will protect the health disorders in connection to strenuous physical exercise, and on swimming-induced oxidative damage in rats. Stress in rats, resulted in a significant elevation in the level of products of free radicals, and reduced activity of catalase, superoxide dismutase, glutathione-S-transferase in testis, prostrate and seminal vesicle which were protected significantly after co-administration of methanolic extract of the said plant parts. This herbal extracts had no toxic effects on metabolic organs that had been proved by the measurement of glutamate oxaloacetate transaminase and glutamate pyruvate transaminase activities in liver and kidney.

Visavadiya and Narasimhacharya (2007) investigated the hypocholesteremic and antioxidant effects of W. somnifera root powder in male albino rats. Administration of root powder (0.75 and 1.5 gm/rat/day) in the diet of the hypercholesteremic animals registered significant decreases in total lipids, cholesterol, and triglycerides in plasma and further a significant decrease in lipid-peroxidation occurred in W. somnifera administered hypercholesteremic animals when compared to their normal counterparts. On the other hand, significant increases in plasma HDL-cholesterol levels, HMG-CoA reductase activity and bile acid content of liver were noted in these animals.

3.6 Diuretic activity

The aqueous extract of leaves of W. Somnifera was evaluated for diuretic activity in albino rats after defatting and detoxification with petroleum ether and chloroform respectively. Frusemide was used as standard drug. Thus, W. Somnifera significantly showed diuretic activity, which may be due to presence of polar compounds in it.
Tiwari and Patel (2011) investigated the diuretic effect of Ashwagandharishta-T and Ashwagandharishta-M prepared by traditional and modern methods respectively in experimental rats using Furosemide (10 mg/kg p.o) as a standard diuretic drug. Oral administration of Ashwagandharishta-T, Ashwagandharishta-M showed a significant increase in urine volume as compared to control group. All the test formulations of Ashwagandharishta as Ashwagandharishta-T, Ashwagandharishta-M and its marketed formulation showed significant rise in sodium, potassium and chloride level in urine sample as compared to control group. The maximum diuretic effect was produced by Furosemide. Thus, both types of Ashwagandharishta as Ashwagandharishta-T and Ashwagandharishta-M showed significant diuretic, natriuretic and kaliuretic effects.

3.7 Antianxiety activity
Kumar and Kalonia (2007) evaluated the protective effect of W. somnifera in sleep disturbed mice. Pretreatment with W. somnifera root extract (100, 200 mg/kg) and diazepam (0.5 mg/kg) significantly protected reduction in body weight, reduced the anxiety levels in animals and improved locomotor activity. Similarly, biochemical studies showed a significant decrease in lipid peroxidation glutathione levels and improved catalase activity. Preliminary results suggest that W. somnifera root extract can be used in the management sleep loss and associated oxidative stress.

3.8 Hepatoprotective activity
Harikrishnan et al (2008) investigated the influence of W. somnifera root powder on the levels of circulatory ammonia, urea, lipid peroxidation products, and liver marker enzymes for its hepatoprotective effect in ammonium chloride induced hyperammonemia. Treatment of ammonium chloride showed a significant increase in the levels of circulatory ammonia, urea, aspartate transaminase, alanine transaminase, alkaline phosphatase, thioharbituric acid and reactive substances and hydroperoxides in experimental rats. These changes were significantly decreased in rats treated with W. somnifera root powder and ammonium chloride which indicates W. somnifera offers hepatoprotection by influencing the levels of lipid peroxidation by the presence of alkaloids, withanolides, flavonoids etc.

Sabina et al (2013) evaluated the hepatoprotective and antioxidant effects of Withania somnifera against Paracetamol-induced liver injury in rats. Liver marker enzymes (Aspartate Transaminase, Alanine Transaminase and Alkaline Phosphatase), Total Protein content, Bilirubin, Antioxidant status (Reduced Glutathione, Superoxide Dismutase, Catalase and Glutathione-S-Transferase) were evaluated and histopathological analysis was done for the control and experimental rats. The results demonstrated that

Withania somnifera possesses promising hepatoprotective effects through its antioxidant activity and hence suggests its use as a potential therapeutic agent for protection from paracetamol overdose.

3.9 Anticonvulsant activity
Kulkarni SK et al. (2008) studied effect of W. somnifera root extract alone and in combination with exogenous GABA or with diazepam against pentylentetrazol induced seizure threshold in mice. The result suggested that the GABAergic modulation was thought to be involved in anticonvulsant effect of W. somnifera.

3.10 Cardioprotective activity
Mohanty IR et al (2009) described cardioprotective effect of withania somnifera in setting of ischemia and reperfusion (IR) injury in Wistar rats. Post-ischemic reperfusion injury resulted in significant cardiac necrosis, apoptosis, decline in antioxidant status and elevation in lipid peroxidation in the IR control group as compared to sham. Ws prior-treatment favorably restored the myocardial oxidant-antioxidant balance, exerted marked anti-apoptotic effects and reduced myocardial damage as evidenced by histopathologic evaluation. The Antioxidant and anti-apoptotic properties of W. somnifera contributed to cardioprotective effects of W. somnifera.

Hina S et al (2010) evaluated the preventive and curative cardioprotective potential of gemmotherapeutically treated on the basis of biochemical, histopathological and antioxidant parameters in the salbutamol on W. somnifera against chemically induced myocardial injury in rabbits. Result showed that, W. somnifera significantly increases the antioxidant enzymes; superoxide dismutase, catalase and glutathione peroxidase. Protective actions of W. somnifera on heart have also been confirmed. No significant change was observed in the activity of cardiac enzymes in baseline groups.

3.11 Antifertility activity
The role of stress in male fertility and the ability of W. somnifera to combat stress induced male infertility was studied. Administration of root powder at a rate of 5 g/day for 3 months to test patients. Result revealed that W. somnifera decreased the stress, improved the level of antioxidants and improved overall semen quality in a significant number of individuals. The treatment resulted in pregnancy in the partners of 14% of the patients.

3.12 Immunomodulatory activity
Yadav CS et al (2010) studied anti-stress and immunomodulatory properties of W. somnifera on propoxur-induced acetylcholine esterase inhibition and impairment of cognitive function in rats. A significant prolongation of the acquisition as well as retention transfer
latency was observed in propoxur-treated rats. The authors suggested that oral administration of *W. somnifera* exerts protective effect and attenuates AChE inhibition and cognitive impairment caused by sub-chronic exposure to propoxur.\(^{38}\)

Muralikrishnan G *et al* (2010) reported efficacy of *W. somnifera* on immunomodulation in experimental azoxymethane induced colon cancer in Swiss albino mice. Azoxymethane induced colon cancer animals were treated with 400 mg/kg body weight of *W. somnifera* extract once a week for four weeks orally. *W. somnifera* significantly altered the level of leucocytes, lymphocytes, neutrophils, immune complexes and immunoglobulins (Ig) A, G and M. The azoxymethane induced colon cancer and immune dysfunction was better controlled by *W. somnifera*. Results revealed that the immunomodulatory effects of *W. somnifera* could be useful in the treatment of colon cancer.\(^{39}\)

### 3.13 Antibacterial activity

Alam *et al* (2012) evaluated the antioxidant and antibacterial activities of an 80% aqueous methanolic extract of *W. somnifera* roots, fruits and leaves. Result indicated that particularly the leaves of *Withania somnifera*, possesses significant antioxidant properties. Antibacterial activities were measured using the agar well diffusion method. The leaf extracts displayed the highest activity against *S. typhi*, whereas the lowest activity was against *K. pneumoniae*. *W. somnifera* exhibited significant antibacterial activities against Gram-negative bacteria, particularly *S. typhi*.\(^{40}\)

### 3.14 Miscellaneous

Rehman *et al* (2013) tested the effects of different levels of water based infusion of *Allium sativum* and *W. somnifera* mixture in 1:6 respectively on lipid profile of broiler chicks. Water based infusion of *A. sativum* and *W. somnifera* at the rate of 10 mL\(^{-1}\) in broiler chicks reduced total cholesterol, triglycerides, low density lipoproteins while increased high density lipoproteins level. It revealed that water based infusion of *A. sativum* and *W. somnifera* in 1:6 at rate of 10 mL\(^{-1}\) of drinking water improved the lipid profile of broiler chicks.\(^{41}\)

Bhattarai and han (2014) applied methanolic extract of *W. somnifera* (mWS) on mice hippocampal CA1 neurons to identify the receptors activated by the *Withania somnifera*. The application of mWS induced remarkable inward currents on the CA1 pyramidal neurons. These inward currents were not only reproducible but also concentration dependent. mWS-induced inward currents remained persistent in the presence of amino acid receptor blocking cocktail (AARBC) containing blockers for the ionotropic glutamate receptors, glycine receptors and voltage-gated Na\(^+\)-channel suggesting that most of the responses by mWS are postsynaptic events. These results suggest that *W. somnifera* acts on synaptic/extrasynaptic GABA\(_A\) receptors and may play an important role in the process of memory and neuroprotection via activation of synaptic and extrasynaptic GABA\(_A\) receptors.\(^{42}\)

### 4 Conclusions

*W. somnifera* is used for centuries in Ayurvedic medicine to increase longevity and vitality. *W. somnifera* is the most important medicinal plant, extensively used in herbal formulations. Although the results from this review are quite promising for the use of ashwagandha as a multi-purpose medicinal agent, several limitations currently exist in the current literature. It is also important to recognize that *W. somnifera* may be effective not only in isolation, but may actually have a potentiating effect when given in combination with other herbs or drugs. More clinical trials require to be carried out to support its therapeutic potential as multipurpose medicinal agent.

### 5 Competing interest

None

### 6 Author's contributions

KJ and KG carried out literature review and draft the manuscript. BJ and RM participated in collection of data. All authors read and approved the final manuscript.

### 7 References


6. Verma SK, Kumar A. Therapeutic uses of *Withania somnifera* (Ashwagandha) with a note on withanolides and

UK J Pharm & Biosci, 2015: 3(2); 21


