Withania somnifera (L.) Dunal

Scientific Name: Withania somnifera (L.) Dunal
Family: Solanaceae
Genus: Withania
Species: somnifera
Parts used: Root, leaf
Common Name: Ashwagandha, Indian ginseng, poison gooseberry, winter cherry.

Plant Description: W. somnifera is an erect, greyish, slightly hairy evergreen shrub that grows to about 1.5 m in height and has fairly long tuberous roots. The small and greenish-yellow flowers can be single or in clusters. The fruit is smooth, round, and fleshy, with many seeds; it is orange-red when ripe and enclosed in a membranous covering.

Chemical Constituents:
The principal bioactive compounds of W. somnifera are withanolides, which are triterpene lactones. More than 40 withanolides and approximately 12 alkaloids and several sitoindosides have been isolated and identified from W. somnifera. Withanine, somniferine, somnine, somniferinine, withananine, pseudo-withanine tropane, pseudotropine, choline, anaferine, anahydrine, isopelletierine.

Isolated chemical constituents of Withania somnifera (L.) Dunal

Withaferin A
Withanone
Withanolide A
Withanoside IV
Sominone
Ashwagandhanolide
Sitoindoside
**Actions of Herb:** Abortifacient, adaptogen, antibiotic, aphrodisiac, astringent, anti-stress, deobstruent, diuretic, narcotic, sedative, tonic, anti-inflammatory, anti-arthritic.

**Medicinal Uses:** *W. somnifera* is used for arthritis, anxiety, trouble sleeping (insomnia), tumors, tuberculosis, asthma, a skin condition marked by white patchiness (leucoderma), bronchitis, backache, fibromyalgia, menstrual problems, hiccups, and chronic liver disease. *W. somnifera* is also used as an “adaptogen” to help the body cope with daily stress, and as a general tonic. *W. somnifera* is also used for improving thinking ability, decreasing pain and swelling (inflammation), and preventing the effects of aging. It is also used for fertility problems in men and women and also to increase sexual desire. *W. somnifera* is applied to the skin for treating wounds, backache, and one-sided paralysis (hemiplegia).

**Dosage:** *W. somnifera* root powder has generally been used at dosages of 450 mg to 2 g in combination with other preparations.

In a study in which a polyherbal mixture was used for arthritis, *W. somnifera* 450 mg root powder was administered 4 times per day.

In a sleep study with elderly subjects, *Withania* 2 g root powder was administered with other ingredients twice daily for up to 3 months.

In elderly patients with long-term progressive degenerative ataxia, *ashwagandha* 500 mg tablets were administered 3 times a day for 1 month (in combination).

**Drug Interactions:** Medications that decrease the immune system (Immunosuppressants) interacts with *W. somnifera*: *W. somnifera* seems to increase the immune system. Taking *W. somnifera* along with medications that decrease the immune system might decrease the effectiveness of medications that decrease the immune system. Some medications that decrease the immune system include azathioprine (Imuran), basiliximab (Simulect), cyclosporine (Neoral, Sandimmune), daclizumab (Zenapax), muromonab-CD3 (OKT3, Orthoclone OKT3), mycophenolate (CellCept), tacrolimus (FK506, Prograf), sirolimus (Rapamune), prednisone (Deltasone, Orasone), corticosteroids (glucocorticoids), and others.

Sedative medications (Benzodiazepines) interact with *W. somnifera*: It may cause sleepiness and drowsiness. Drugs that cause sleepiness and drowsiness are called sedatives. Taking it along with sedative medications might too much sleepiness. Some of these sedative medications include clonazepam (Klonopin), diazepam (Valium), lorazepam (Ativan), phenobarbital (Donnatal), zolpidem (Ambien), and others.

**Powder microscopic study of *W. somnifera***
Nasreen and Radha (2011) carried out the microscopic studies of root and observed following tissue systems: Cork exfoliated or crushed, when present iso-diametric and non-lignified, Cork
cambium of 2-4 diffused rows of cells, Secondary cortex about twenty layers of compact parenchymatous cells, Phloem consists of sieve tubes, companion cells, phloem parenchyma, Cambium 4-5 rows of tangentially elongated cells, Secondary xylem hard forming a closed vascular ring separated by multi-seriate medullary rays, a few xylem parenchyma, Vessels with bordered pits and horizontal perforations. Fibers are aseptate with pointed ends. Starch grains abundant, simple, mostly spherical, reniform – oval with central hilum. Microcrystals in parenchyma cells.

Figure: A Cork; B Cortex; C Endodermis; D Pericycle; E Phloem; F Medullary ray; G Pith

Photomicrographs of the microscopic characteristic of roots of *Withania somnifera* DUNAL. in different views


**Physico-chemical Parameters of *W. somnifera***

Nasreen and Radha (2011) carried out evaluation of physico-chemical parameters of *W. somnifera*. 

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Figure: Evaluation of physico-chemical parameters of *W. somnifera*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Physicochemical standards</th>
<th>Results % w/w</th>
<th>Standard value % w/w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Total Ash</td>
<td>5.1</td>
<td>NMT 7 %</td>
</tr>
<tr>
<td>2.</td>
<td>Acid Insoluble ash</td>
<td>0.24</td>
<td>NMT 1 %</td>
</tr>
<tr>
<td>3.</td>
<td>Water soluble extractive value</td>
<td>15.53</td>
<td>NLT 15 %</td>
</tr>
<tr>
<td>4.</td>
<td>Alcohol soluble extractive value</td>
<td>16.8</td>
<td>NLT 15 %</td>
</tr>
<tr>
<td>5.</td>
<td>Loss on drying</td>
<td>2.31</td>
<td>NMT 8 %</td>
</tr>
</tbody>
</table>


**Phytochemical studies on *W. somnifera***

Nasreen and Radha (2011) carried out phytochemical studies on *W. somnifera*. See the table below.

Table: Phyto-chemical screening of *W. somnifera*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Constituents</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Steroids</td>
<td>+</td>
</tr>
<tr>
<td>2.</td>
<td>Flavones</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td>Alkaloids</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td>Carbohydrates</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>Glycosides</td>
<td>+</td>
</tr>
<tr>
<td>6.</td>
<td>Bitters</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Phenols</td>
<td>-</td>
</tr>
<tr>
<td>8.</td>
<td>Proteins</td>
<td>-</td>
</tr>
<tr>
<td>9.</td>
<td>Resins</td>
<td>-</td>
</tr>
<tr>
<td>10.</td>
<td>Saponins</td>
<td>+</td>
</tr>
<tr>
<td>11.</td>
<td>Tannins</td>
<td>+</td>
</tr>
<tr>
<td>12.</td>
<td>Terpenoids</td>
<td>+</td>
</tr>
<tr>
<td>13.</td>
<td>Anthraquinones</td>
<td>-</td>
</tr>
<tr>
<td>14.</td>
<td>Gums</td>
<td>-</td>
</tr>
</tbody>
</table>


**Thin-layer chromatography of *W. somnifera***

Thin-layer chromatography of *W. somnifera* was reported by Rani et al. (2012).

Table: Rf values of *W. somnifera* extract

<table>
<thead>
<tr>
<th>Developing solvent</th>
<th>Extract</th>
<th>No. of spots</th>
<th>Rf value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n hexane : isopropanol (8.5 : 1.5)</td>
<td>Methanol</td>
<td>03</td>
<td>0.58, 0.63, 0.8</td>
</tr>
<tr>
<td></td>
<td>Ethanol</td>
<td>04</td>
<td>0.26, 0.58, 0.65, 0.8</td>
</tr>
<tr>
<td></td>
<td>Chloroform</td>
<td>02</td>
<td>0.22, 0.52</td>
</tr>
</tbody>
</table>

FT-IR spectroscopy of *W. somnifera*

Nema et al. (2012) carried out FT-IR spectroscopy of *W. somnifera*.

![FT-IR spectra of *W. somnifera*](image)

**Figure:** FT-IR spectra of *W. somnifera*


**Anti-oxidant activity of *W. somnifera***

Chaudhuri et al. (2012) carried out anti-oxidant activity of *W. somnifera* 70% methanolic extract by using different tests including total antioxidant activity; efficiencies for scavenging of hydroxyl, superoxide, nitric oxide, singlet oxygen radicals, hypochlorous acid and inhibition of lipid peroxidation. The results revealed significant anti-oxidant activity.

Table: Comparison of the antioxidant and free radical scavenging capacities of 70% methanolic crudes of *W. somnifera* and standard reference compounds

<table>
<thead>
<tr>
<th>NAME OF ASSAY</th>
<th><em>W. WHITANIA SOMNIFERA</em> ROOT</th>
<th>STANDARD</th>
<th>VALUES OF STANDARD COMPOUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEAC Values</td>
<td>0.033 ± 0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ω IC50 values of the extracts for free radical scavenging capacity for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPPH</td>
<td>650.37 ±</td>
<td>Ascorbic acid 5.29 ± 0.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>107.18&quot;&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydroxyl radical (OH) scavenging</td>
<td>1808.69 ± 391.16&quot;&quot;</td>
<td>Mannitol 571.45 ± 20.12</td>
<td></td>
</tr>
<tr>
<td>Nitric oxide radical (NO) scavenging</td>
<td>405.91 ± 145.84&quot;&quot;</td>
<td>Curcumin 90.82 ± 4.75</td>
<td></td>
</tr>
<tr>
<td>Peroxynitrite (ONOO) scavenging</td>
<td>3427.18 ± 1212.68&quot;&quot;</td>
<td>Gallic acid 876.24 ± 56.96</td>
<td></td>
</tr>
<tr>
<td>Singlet oxygen (O2) scavenging</td>
<td>234.49 ± 37.69&quot;&quot;</td>
<td>Lipoic acid 46.15 ± 1.16</td>
<td></td>
</tr>
<tr>
<td>Hypochlorous acid (HOCI) scavenging</td>
<td>328.99 ± 35.92&quot;&quot;</td>
<td>Ascorbic acid 735.96 ± 5.75</td>
<td></td>
</tr>
<tr>
<td>Lipid peroxidation</td>
<td>284.13 ± 146.66&quot;&quot;</td>
<td>Trolox 6.76 ± 0.17</td>
<td></td>
</tr>
</tbody>
</table>

Ω Unit of IC50 for all activities is µg/ml. Data are expressed as mean ± S.D. (n=6), where - ** p< 0.01.

Anti-neoplastic effect of *W. somnifera*
In vitro research has been conducted primarily using powdered *W. somnifera* leaf extract. In a study by Kaur et al. (2004) osteogenic sarcoma and breast carcinoma cell lines were treated with 3-24 µg/mL aqueous leaf powder extract of *W. somnifera*. Cells treated with *W. somnifera* showed reduced proliferation compared to controls and assumed morphology more closely related to senescent cells confirms its usefulness in slowing tumor growth and increasing survival time.
Christina et al. (2004) inoculated Swiss albino mice with Dalton’s ascitic leukemia, followed by an intra-peritoneal dose of 20 mg/kg of powdered aqueous root extract of *W. somnifera*. Animals given *W. somnifera* demonstrated a cancer cell number of 0.92±0.12 x 10^6 cells, compared to 1.35±0.08 x 10^6 cells in the control group. The *W. somnifera* extract also significantly reduced packed cell volume and tumor weight, while increasing lifespan by 27.5%.

Anti-stress effect of *W. somnifera*
Singh et al. (1982) evaluated the anti-stress effect of *W. somnifera*, alcoholic extract from defatted seeds of *W. somnifera* dissolved in normal saline was given (100 mg/ kg intra-peritoneally as a single dose) to 20-25 g mice in a swimming performance test in water at 28º-30ºC. Controls were given saline. The extracts approximately doubled the swimming time when compared to controls.

Effectiveness of *W. somnifera* for the treatment of rheumatoid arthritis
Ghawte et al. (2014) reported the randomized clinical trial to evaluate the safety and efficacy of *W. somnifera* in 60 patients between the age group 20-40 years. The results of the study revealed significant results favoring the use of *W. somnifera* in the treatment of rheumatoid arthritis.

Effectiveness of *W. somnifera* in the treatment of Sarcopenia
Mishra and Trikamji (2013) conducted a clinical trial with *W. somnifera* extract on 35 individuals (55-75 years) for the management of sarcopenia for three months. The results of the trial exhibited significant results revealing therapeutic efficacy of *W. somnifera* in improving muscle strength and functioning.

Hepato-protective activity of *W. somnifera*
Khare 2007, Rastogi et al. (1998) carried out hepato-protective activity of *W. somnifera*. Withaferin A at 10mg/kg dose showed significantly protective effect against CCl4-induced hepatotoxicity in rats.

Anti-ageing effect of *W. somnifera*
Rastogi and Mehrotra (1998) mentioned in “Compendium of Indian Medicinal Plant” the double-blind clinical trial carried out to study the effect of plant on prevention of ageing in 101 normal healthy males in 50-59 years age group. Root powder (0.5 g) was given orally three times a day for 1 year. Results showed statistically significant increase in Hb, RBC, hair melanin, and seated stature in treated group in comparison to placebo group. Decrease in serum cholesterol was more in treated group than in placebo group (Rastogi et al. 1998).

Anti-convulsant activity of *W. somnifera*
Kulkarni and George (1996) carried out anti-convulsant activity by administration of *W. somnifera* root extract and found that the extract reduced jerks and clonus in 70% and 10% animals respectively with dose of 100mg/kg and reduction in the severity of pentylenetetrazole (PTZ)-induced convulsions was evident from EEG wave pattern (Kulkarni et al., 1996).

Anti-inflammatory properties of *W. somnifera*
Rasool and Varalakshmi (2006) explored in an *in vivo* and *in vitro* study on immunomodulatory action of *W. somnifera* and found that it acts as an anti-inflammatory agent through inhibition of
complement, lymphocyte proliferation, and delayed-type hypersensitivity. According to the researches carried out by Anbalagan et al. (1984) and Al-Hindawi et al. (1992), it can be concluded that the extracts of *W. somnifera* have shown anti-inflammatory effects in a variety of rheumatological conditions.

**Anti-depression and anti-anxiety activity of *W. somnifera***

In a study carried out by Jayanthi et al. (2012), it was found that *W. somnifera* at 40 mg/kg significantly reduces the depression in various experimental models. Pingali et al. (2014) carried out clinical trials with healthy volunteers that also showed that aqueous extracts of *W. somnifera* improve the psychomotor performances in anxiety and depression.

**Antimicrobial activity of *W. somnifera***

Alam et al. (2012) carried out anti-microbial activity of the leaves and roots of *W. somnifera* and reported that the extract exhibited significant anti-microbial activity. Leaf extracts at concentrations 6.25 mg/ml and 12.5 mg/ml inhibited the growth of five Gram-negative pathogenic bacteria (*Escherichia coli, Salmonella typhi, Citrobacter freundii, Pseudomonas aeruginosa* and *Klebsiella pneumonia*). Isolated flavonoids and alkaloids from *W. somnifera* displayed growth inhibitory activity against *Enterobacter aerogenes, Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus subtilis, Klebsiella pneumoniae, Raoulletta planticola* and *Agrobacterium tumefaciens* at concentration 0.039 mg/ml in the research work carried out by Singh and Kumar (2011 and 2012).

**Hypothyroid activity of *W. somnifera***

Panda and Kar (1998 and 1999) carried out animal studies on *W. somnifera* that may have an effect on thyroid activity. An aqueous extract of dried *W. somnifera* root was given to mice daily for 20 days. Significant increases in serum T4 were observed, indicating the plant has a stimulating effect at the glandular level. *W. somnifera* may also stimulate thyroid activity indirectly, via its effect on cellular antioxidant systems. The results of researches carried out indicated that *W. somnifera* may be a useful botanical in treating hypothyroidism.

**Antibiotic activity of *W. somnifera***

Dhuley (1998) evaluated antibiotic effect of *W. somnifera* against systemic Aspergillus infection. This protective activity was probably related to the activation of the macrophage function revealed by the observed increases in phagocytosis and intracellular killing of peritoneal macrophages induced by Ashwagandha treatment in mice.

**Cardio-protective effect of *W. somnifera***

Cardioprotective effect of hydroalcoholic extract of *W. somnifera* was studied by Mohanty et al. (2004) on the basis of haemodynamic, histopathological and biochemical parameters in the isoprenaline, (isoproterenol), induced myocardial necrosis in rats and was compared with vitamin E, a known cardio-protective antioxidant. Both the drugs restore the myocardial antioxidant status and maintain membrane integrity by evidently reducing the malonyldialdehyde levels. Cardioprotective effect of these drugs was also confirmed by histopathological examinations. *W. somnifera* at 50 mg/kg dose shows maximum cardio-protective effect.

**Neuro-protective activity of *W. somnifera***

According to the neuro-protective studies carried out by Schliebs et al. (1997), Abbas et al. (2004), Abbas et al. (2005) and Ahmed et al. (2005); *W. somnifera* may be used for the treatment of neurodegenerative disorders like Alzheimer, Parkinson, Huntington and other neurodegenerative disorders at any stage of disease because it can significantly reverse then neurotic atrophy, synaptic loss, along with GABA mimetic effect and promotes formation of
dendrites due to therapeutic activity of glycowithanolides, withaferin A VII-X present in roots of *W. somnifera*

**Anti-diabetic effect of W. somnifera**
Sarangi et al. (2013) conducted an investigation to explore the possibilities of using leaf and root extracts of *W. somnifera* against diabetes mellitus and also to examine their hypoglycaemic and hypolipidaemic effects on streptozotocin-induced diabetic rat. The extract was found to possess hypoglycaemic and hypolipidaemic properties and hence useful in diabetes mellitus. Another study carried out by Navinder et al. (2013) showed significant positive anti-diabetic activity of *W. somnifera* on diabetic rats when compared with Glibenclamide standard drug. Anti-diabetic activity may be due to increase in hepatic metabolism, increased insulin release from pancreatic β-cells or insulin sparing effect.

**Anthelmintic activity of W. somnifera**
The hydroalcoholic extracts of *W. somnifera* and *Ocimum sanctum* at a dose of 40 mg/ml were given to adult earthworm in research work carried out by Kirtiman (2012). Piperazine citrate (10 mg/ml) was used as a reference standard. The time of paralysis was 2.5±0.6 and 2.8±0.8 whereas the time of death was 6.5±0.7 and 7.1±0.9 in the case of *O. sanctum* and *W. somnifera* respectively. *W. somnifera* was found to possess anthelmintic activity as comparable with *O. sanctum*.

**Anti-malarial activity of W. somnifera**
Dikasso et al. (2006) studied the anti-malarial activity of *W. somnifera* extracts in mice. *W. somnifera* extracts were administered by intra-tube daily for four days starting from the day of *Plasmodium berghei*, 0.2 ml of x10 (7) parasites inoculation with positive controls were given chloroquine. Parasitemia percent inhibition of *W. somnifera* roots and root barks were 50.43% and 29.13% respectively, with 600 mg/kg dose. Extracts of the leaves and root barks of *W. somnifera* exhibited parasite suppressive effect and a protective effect on packed cell volume (PCV) drop.

**Clinical evaluation of the spermatogenic activity of W. somnifera**
Ambiye et al. (2013) conducted pilot study to investigate spermatogenic activity of *W. somnifera* root extract in forty-six oligospermic patients. The results of the study exhibited significantly greater improvement and regulation were observed in serum hormone levels with the *W. somnifera* treatment as compared to the placebo.

**Diuretic activity of W. somnifera**
The aqueous extract of leaves of *W. somnifera* was evaluated by Deb (2006) for diuretic activity in albino rats after defatting and detoxification with petroleum ether and chloroform respectively. Frusemide was used as standard drug. *W. somnifera* significantly showed diuretic activity that may be due to presence of polar compounds in it.

**Immunomodulatory activity of W. somnifera**
Yadav 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 transferlatency 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.
References
Abbas SS, Bhalla M, Singh N. 2005. A clinical study of organic Ashwagandha in some cases of uterine tumors (fibroids) and dermatofibrosarcoma. Proceedings of the workshop on essential medicines, Adverse Drug Reactions and Therapeutic Drug Monitoring, Lucknow;143-144.


