



MORPHOLOGY OF *WITHANIA SOMNIFERA* (Distribution, Morphology, Phytosociology of *Withania somnifera* L. Dunal)

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Abstract

Withania somnifera (L.) Dunal (Family: Solanaceae, commonly known as Ashwagandha, English name: Winter cherry) is an important perennial plant species with immense therapeutic uses in traditional as well as modern system of medicine (Datta *et al* 2010). Due to restorative property of roots, the species is also known as 'Winter cherry' (Tripathi *et al* 1996; Andallu & Radhika 2000, Winters 2006). The Indian Himalayan region (BHR), one of the richest reservoirs of biological diversity in the world, is undergoing irrational extraction of wild, medicinal herbs, thus endangering many of its high value gene stock. *Withania somnifera* L. (Dunal) is a member of solanaceae, also known for thousands of years by Ayurvedic practitioners. *Withania somnifera* root contains flavonoids, alkaloids, steroid and many active functional ingredients (Kumar *et al* 2015). *Withania somnifera* having small white flowers mainly in rainy and winter seasons that can be develop into fruit during the winter seasons. Plants products can be obtained from the roots, leaves, and branches, by using many different biological techniques. *Withania* which is also known as Ashwagandha having effective

property can also used in blends and supplements which are designed to show many multiple effects. It is described as an herbal tonic and health food in Vedas and considered as ‘Indian Ginseng’ in traditional Indian system of medicine (Singh *et al* 2001).

Key words: Winter cherry, perennial plant, flavonoids, alkaloids, steroid, herbal tonic, biological diversity.

Introduction

The meaning and origin of the word *Withania* is doubtful, whereas *somnifera* refers to the narcotic property of the leaves of plant. *Withania somnifera* is an erect, evergreen (green in whole year), branching, tomentose shrub of 30 to 150 cm in height. Leafs are simple, petiolate with the leaf blade varying in shape from elliptic-ovate to broadly ovate, entire along margins, acute to obtuse at apex, oblique at base, clothed with a persistent grayish tomentum on sides, 4-10cm long and 2-7cm broad. Leaves on vegetative shoots are alternate and large and those on floral branches are opposite, arranged somewhat laterally in pairs of one small leaf and one large leaf, bearing in their axil a cymose cluster of 4-25 inconspicuous pale green monoceous flowers. It produces flowers indeterminately round the year with a peak of flowering between March and July (Mirjalili *et al* 2009).

In Sanskrit it is called shvagandha (asva_‘horse’, gandha_‘smell’) which means ‘smell of the horse’, because the root of the infected plant has the smell of the horse urine, but in general the meaning of the name is: ‘what gives the energy and the sexual vitality of a horse’. Other synonymous are: Varada (vara_‘choosing’, ‘desiring’, ‘offering’, ‘producing’) that means ‘granting wishes’, ‘conferring a ‘a; Vajigandha (vaji_‘strength’, ‘vigour’, gandha_‘smell’) i.e. ‘smell of the strength’; Vajikari (kari_‘causing’, ‘accomplishing’) that means strengthening’, ‘producing virility’; Vajiini (_‘a mare’) i.e. ‘what promotes pregnancy’; Palashparni (palasa_‘cruel’, ‘toxic’; parna_‘leaf’) with reference to the poisoning leaves. In Ayurveda *Withania* is used as tonic, aphrodisiac, sedative, as Medharasayana (Nadkarni 1993; Monier-Williams 1997).

Vernacular names Sanskrit, Ashvagandha, Ashvakandika, Balada, Balaja, Gandhapatri, Vajigandha, Vajikari, Vajiini, Palashaparni; Hindi, Asgandh; English, Winter cherry; Italian, Falso Alchechengi; Japanese, Ashwagandha; Aasoganda

Nepalese; Singalese, Amukkara; Arabic, Bahman; Tibetan, Ba-dzigandha (Kirtikar *et al* 1993).

Distribution and Habitat

The genus *Withania* is restricted and related to the old World; rather it closely belongs to the genus *Physalis*, the gooseberries. *Withania* possesses a natural occurrence, most probably in the drier and humid areas, spread from the Mediterranean region to throughout tropical region of Africa to South Africa and also from the Cape Verde Islands and Canary region to the Arabia and Middle East region like India, southern China and Sri Lanka. Ashwagandha is propagated and cultivated in gardens in the warmer and drier regions of Europe and became a natural herb in New South Wales and South Australia. Generally it is cultivated in India and in many other places as a medicinal crop (Govindaraju *et al* 2003), most probably for its fleshy roots.

Ashwagandha is globally known but is not so common in all regions of South Africa, Botswana, Namibia, Lesotho and Swaziland. It is total absent in the western half of the Western and Northern Cape regions. It develops and cultivated in a wide range of vegetation types in dry and warm areas to areas with usually high humid region with high rainfall like coastal vegetation, savanna, grassland, scrubland, karoo, woodland, and mostly in margins of forests and thickets, besides water also, as on the river banks. Its presence is also observed in light shaded dark places as well as in full sun places, mostly among rocks where the roots are being kept cool.

Habitat

Ashwagandha grows in dry areas in India, on the Himalayas under 1600m, Beluchistan, Sri Lanka and in the Mediterranean area: spontaneous in Sicily and Sardinia (Kapoor 1990d; Kirtikar *et al* 1993). Used parts root, leaf, seed (Kapoor 1990d). *Withania somnifera* L. Dunal is a common herbaceous evergreen shrub of 30-150cm height. It grows as a weed along road sides and in open waste places. It is distributed throughout the drier parts of India. It is now cultivated at different parts of the country due to its medicinal importance. The plant is usually clothed with minutely stellate tomentum. The leaves are 5-10 cm long, simple alternate,

ovate, entire, thin with cuneate/connate base and are densely hairy with reticulate venation. However, near the inflorescence leaves are opposite with adnate.

Morphological characteristics

Withania is a small or medium undershrub, 30-150cm height, erect, grayish, branching perennial, with strong disagreeable odour like horse's urine. *Withania somnifera* is a small shrub of 1m to 2m height across. Almost the complete plant is covered and surrounded with very short, small, fine, branched hairs and silver-grey in colour. The stems of *Withania* are brownish dark colour and erect, sometimes leaves are absent or less on lower part of stem. The leaves are in an alternate manner (opposite on flowering shoots), simple, possessing margins are slightly wavy, narrowed into the 5–20mm long petioles, normally broadly ovate or oblong, 29–80mm long and 21–50mm broad. It is generally referred to as stellate-tomentose, grayish, under shrub of 30-150cm high with long woody tuberous roots. Flowers are generally small, greenish, axillary, monoecious or bisexual and solitary or in few-flowered cymes. Seeds are normally many, discoid, reniform and yellow. The number of chromosome is $2n = 48$ (Schonbeck 1972; Hepper 1991; Mozaffarian 2003).

The corolla is 5-lobed, constrictly campanulate, 5–8mm long and light yellow to yellow-green in colour. Ashwagandha fruit is usually a round hairless berry, 5–8mm across, orange-red to red in ripped condition and is enveloped by the enlarged calyx. Most of the seeds are very pale brown, 2.5mm across, sometimes kidney-shaped and squeezed with a rough surface and netted surface. In *Withania* flowering time is generally from October to June, whereas the fruiting time is usually from October to July. *Withania somnifera* can be identified by the red fruit enclosed by the brownish, papery, turgid calyx. Collectors have mentioned it as a bad-smelling bush with generally strong-smelling roots and have also described that the leaves have a strong smell of green tomatoes (Mirjalili *et al* 2009).

Material and Methods

Seeds

Numerous, yellow-white, reniform, laterally compressed, poisonous (Kapoor 1990d; Kirtikar *et al* 1993).

Stems

Branches ligneous, tomentose at the apex covered with minute stellately hairs.

Leaves

Leaves simple, 2–6cm wide, 3–8cm long, alternate, petiole 1–2cm long. Leaves are ovate, glabrous, simple more than 10cm long.

Flowers

Flowers sessile, axillary clusters, 1cm long, it blossoms nearly throughout the year. Corolla greenish or yellow or white-yellowish, 5mm long, lobes lanceolate, acute and thin, calyx is visibly expanded around the fruit. The flowers appear in a bright-yellow or greenish and it carries small berries which are orange-red in color. Fruits are orange-red, carrying numerous seeds. Florescence appears and falls in spring season (Davis & Kuttan 2000).

The stamet or filament base is appeared to the ovary and a groove between every stamet helps to allows the nectar to flow upward from the nectary at the ovary base (Kothari *et al* 2003). There are large numbers of trichomes present in stamet which also secrete some amount of nectar. Trichomes are also present on outer surface of calyx and corolla. Nectaries on different floral parts attract insects. There are 3200-4000 pollen/anther and 16,250- 20,000 pollen/flower. Each ovary contains 26-32 ovules. Thus, the pollen ovule ratio is 625:1 indicating facultative xenogamy (Cruden 1977).

Roots

The roots of Ashwagandha are fleshy when dry, they are straight, cylindrical, tapering down, gradually unbranched of about 10-17.5cm long and 6-12millimeter diameter in thick. The main roots are brownish outer and creamy interior and bear fiber similar secondary roots having acrid taste and bitter (Anonymous 1982). Roots are stout, fleshy and whitish brown in colour. Leaves simple, petiolate, elliptic-ovate to broadly ovate, entire, exstipulate, cunate or oblique, glabrous, up to 10cm long, those in the floral region are smaller and opposite. Single layered epidermis present in young root with a 4-5 layers of cells of parenchymatous cortex whiles the endodermis being present as casparian stripes. Outer most layer of cortex consists of cork cambium. The endodermis is always persists even after the secondary growth has taken place. Measurement of cells of roots is given in (Table 1).

Table. 1: Measurement of cells (in microns) through ocular lens

Cork	35-72 × 20-42
Phelloderm	32-52-165 × 25-35-70
Xylem vessels	240-295-390× 40-50-70
Tracheids	160-280-470×26-40-50
Fibre tracheids	190-325-525 × 15-22-29
Fibres	220-400-650× 13-20-25
Starch grains	11-24-40×9-20-30

One or more roots, tuberous, some long. A transversal section shows thin cork, light brown, and cortex has a thick central woody region parenchymatous with a storage function. Cork has 12 to 16 rows of thin walled cubical or slightly tangentially elongated cells. Around the phellogen there are one or two rows of cork cells yellow coloured. Most of the cortical cells are rich of large starch grains. These having two to five components almost rounded with a diameter of 15–30mm. The different components are much smaller than starch grains with a diameter of 9mm.

The woody part of the root is 12–15mm in diameter. It is composed of secondary xylema and woody rays. The outside part of the wood is composed of thick walled fibers, wherein lie small patches of thin walled parenchyma as well as scattered or radically arranged rows of small groups of vessels and tracheids, all forming a circular zone or band of thick walled tissue. The cells of parenchyma are thin walled, rather large, rectangular, and most of them loaded with starch grains like cortical cells.

Pollination

Pollen transfer experiments were done to examine and depend on number of seeds and fruits, effect of pollen/another source on fruit set and as well as on the germination of seeds. Pollination is normally takes placed during April to May 2003 (period of high stigma receptivity). In all these cases, once the requisite time had glided away, fruit set and seed set were recorded. The species exhibits stigma-anther proximity caused by elongation of filaments to cover the bilobed stigmatic surface with dehiscing anthers (Kaul *et al* 2005).

Result and Discussion

Table. 2: Morphology of qualitative traits of *Withania somnifera* in natural habitat

S. No.	Days	Cultivated Variety			Wild Variety		
		Growth of shoots (cms)	Growth of roots (cms)	Size of leafs (cms)	Growth of shoots (cms)	Growth of roots (cms)	Size of leafs (cms)
1.	15	5.2 ±0.06	2.6 ±0.029	0.5 ±0.006	6.4 ±0.09	3.1 ±0.043	1.1 ±0.015
2.	25	8.3 ±0.13	4.2 ±0.067	1.4 ±0.022	10.6 ±0.19	5.4 ±0.097	2.2 ±0.040
3.	35	16.2 ±0.34	6.1 ±0.128	2.7 ±0.057	20.8 ±0.48	7.7 ±0.177	3.4 ±0.078
4.	45	44.1 ±1.10	8.3 ±0.208	3.9 ±0.098	50.5 ±1.41	10.9 ±0.305	4.8 ±0.134

± STANDARD DEVIATION

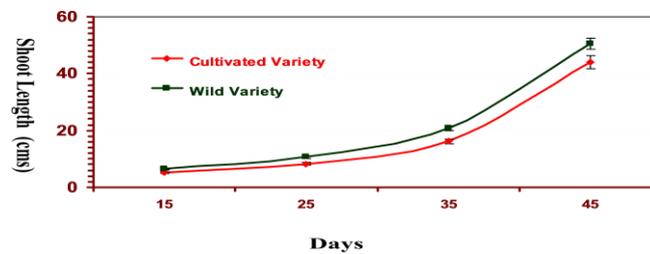


Fig-(Table-2)
Line diagram showing growth of shoots (cms) of Cultivated & Wild variety of *Withania somnifera* in natural habitat

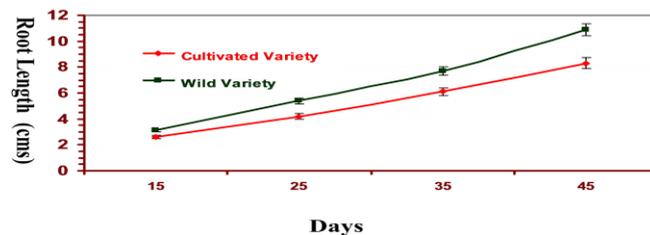


Fig-(Table-2)
Line diagram showing growth of root (cms) of Cultivated & Wild variety of *Withania somnifera* in natural habitat

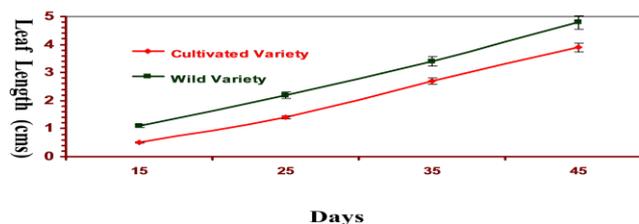


Fig-(Table-2)
Line diagram showing growth of leaves (cms) of Cultivated & Wild variety of *Withania somnifera* in natural habitat

During February-June, cowbugs were found to infect the normally aerial apical portion of *Withania somnifera* (Ashwagandha) plants in the Amritsar region of Punjab of India. The pest cowbugs generally used to feed on apical portions of the stem, giving them a rough and woody appearance, it becomes brown in colour that progressively dried the apical parts and were cause shed off the apical leaves. These cowbugs belong to Hemiptera: Membracidae were identified as *Oxyrachis tarandus*. Of our best knowledge it is proved that *Withania somnifera* (L.) Dunal act as a new host for cowbugs (*Oxyrachis tarandus*) in Punjab of Northern India (Sharm & Pati 2011).

References

- Andallu B and Radhika B 2000 Hypoglycemic diuretic and hypocholesterolemic effect of winter cherry (*Withania somnifera* Dunal) root. Ind. J. Exp. Bio. 38: 607-609
- Anonymous 1982 The Wealth of India. Vol. X (Sp-W), Publications and Information Directorate, Council of Scientific and Industrial Research (CSIR), New Delhi (1982) 580-585
- Cruden R W 1977 Pollen-ovule ratio: A conservative indicator of breeding system in plants. Evolution 31: 32-46
- Datta A K; Das A; Bhattacharya A; Mukherjee S; Ghosh B K 2010 An Overview on *Withania somnifera* (L.) Dunal – The ‘Indian ginseng’. Med Aro Pl Sci Biotech. 5: 1-15

- Davis L and Kuttan G 2000 Effect of *Withania somnifera* on cell mediated immune responses in mice. J. Exp Clin Cancer Res. 21(4): 585-590
- Govindaraju B; Rao S R; Venugopal R B; Kiran S G; Kaviraj C P and Rao S 2003 High frequency plant regeneration in ashwagandha (*Withania somnifera* (L.) Dunal): An important medicinal plant. Pl Cell Biotech. Mol. Bio. 4: 49-56
- Hepper F N; Hawkes J G; Lester R N; Nee M and Estrada E 1991 In Solanaceae III: taxonomy, chemistry, evolution; Eds.; Royal Botanic Gardens, Kew: UK. pp 211-227
- Kapoor L D 1990 Handbook of Ayurvedic Medicinal Plants. CRC, Press, Boca Raton
- Kaul M K; Kumar A and Sharma A 2005 Reproductive biology of *Withania somnifera* (L.) Dunal. Curr. Sci. 88 (9): 1375-1377
- Kirtikar K R; Basu B D; Blatter E; Caius J F and Mhaskar K S 1993 Indian Medicinal Plants, Vol. IV. Lalit Mohan Basu, Allahabad, India
- Kothari S K; Singh C P; Kumar Y V 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. Hortic Sci. Biotechnol. 78(3): 422-425
- Kumar P K Praveen; Swarnalakshmi M and Sivanandham M 2015 Phytochemical Analysis of *Boerhaavia Diffusa*, *Emblica officinalis*, *Terminalia Chebula*, *Terminalia Bellirica*, *Withania Somnifera*. World J. Pharmaceutical Res. 4(5): 1747-1756
- Mirjalili M H; Mayano E; Mercedes B and Cusido R M 2009 Palazón. Steroidal lactones from *Withania somnifera*, an ancient plant for novel medicine. Mol 2009; 14: 2373-2393
- Mirjalili; Seyyed M Fakhr-Tabatabaei; Mercedes Bonfill; Houshang Alizadeh; Rosa M Cusido; Alireza Ghassempour and Javier Palazon 2009 Morphology and withanolide production of *Withania coagulans* hairy root cultures. Engineering in Life Sci. 9(3): 197-204
- Monier-Williams M 1997 A Sanskrit-English Dictionary. Motilal Banarsidass Publishers Pvt., New Delhi
- Mozaffarian V 2003 Trees and shrubs of Iran; Farhange Moaser: Tehran, Iran. pp 874-877
- Nadkarni K M 1993 Indian Materia Medica. Popular Prakashan Private, Bombay

- Schonbeck-Temesy E; In Flora Iranica; Rechinger K H Ed and Akademische Druck-u 1972 Verlagsanstalt: Graz, Austria, 1972; No. 100 pp 26-29
- Sharma A and Pati P K 2011 First Record of 28-Spotted Ladybird Beetle, *Henosepilachna vigintioctopunctata* (F.) infesting *Withania somnifera* (L.) Dunal in Punjab Province of Northern India. Pest technol. 5(1): 91-92
- Singh B; Saxena A K; Chandan B K; Gupta D K; Bhutani K K and Anand 2001 Adaptogenic activity of a novel withanolide-free aqueous fraction from the roots of *Withania somnifera*. Dun Phytother Res. 15(4): 311-318
- Tripathi A K; Shukla Y N; Kumar S and Kumar S 1996 Ashwagandha (*Withania somnifera*) Dunal (Solanaceae): a status report. J. Med Aromat. Pl Sci. 18: 46-62
- Winters M 2006 Ancient medicine, modern use: *Withania somnifera* and its potential role in integrative oncology. Altern. Med. Rev. 11(4): 269-277

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