INTRODUCTION

Medicinal plants are rich in secondary metabolites and essential oils of therapeutic importance. The important advantages claimed for therapeutic uses of medicinal plants in various ailments include their safety, economic feasibility, effectiveness, and ease of availability (Atal and Kapoor, 1989; Siddiqui, 1993). Ashwagandha (Withania somnifera) is a perennial plant belonging to the family Solanaceae. Ashwagandha, a popular Ayurvedic herb, is commonly known as “Indian winter cherry.” The root smells like a horse (“ashwa”), and that is why it is named Ashwagandha (on consuming it gives the power of a horse). The species name somnifera means “sleep-inducing” in Latin, indicating its sedating properties. Some herbalists refer to Ashwagandha as Indian ginseng, because it is used in Ayurvedic medicine in a way similar to Chinese ginseng (Panax ginseng) in traditional Chinese medicine (TCM). It has been used as an antibacterial, antioxidant, adaptogen, aphrodisiac, liver tonic, and anti-inflammatory agent (Mehrotra et al., 2011). W. somnifera has been used in different medicinal systems for centuries. Writings indicate that the therapeutic use of plants is as old as 4000–5000 BC and the Chinese used the first natural herbal preparations as medicines. In India, however, earliest references to the use of plants as medicine appear in Rigveda, which is said to have been written between 3500 and 1600 BC. Later, the properties and therapeutic uses of medicinal plants were studied in detail and recorded empirically by the ancient physicians in Ayurveda, which is a basic foundation of ancient medical science in India (Sirkar, 1989). This chapter describes various aspects of Ashwagandha, including its multiple health effects.

BOTANY OF W. SOMNIFERA

W. somnifera, commonly known as Ashwagandha, is an important medicinal plant that has been used in Ayurvedic and indigenous medicine for more than 3,000 years. Ashwagandha (W. somnifera) belongs to the genus Withania and family Solanaceae. Two species, such as, Withania coagulans Dunal and W. somnifera Dunal, are found in India. W. coagulans is a rigid gray under shrub 60–120 cm high. W. somnifera is an erect, evergreen, tomentose shrub 30–75 cm in height. Its roots are stout, fleshy, cylindrical, 1–2 cm in diameter, and whitish brown in color. Leaves are simple, ovate, glabrous, and opposite. Flowers are bisexual, inconspicuous, greenish or dull yellow in color, born on axillary umbellate cymes, and comprise five sepals, petals, and stamens each; the two-celled ovary has a single style and a bilobed stigma. The petals are united and tubular. The stamens are attached to the corolla tube and bear erect anthers that form a close column or cone around the style. Pollen production is poor. The fruit is a small, globose, orange-red berry when mature and is enclosed in a persistent calyx. The seeds are small, flat, yellow, and reniform in shape and very light in weight. The cultivated plants have sizeable differences from the wild forms not only in their morphological characteristics but also in their therapeutic action, although the alkaloids present are the same in both (Kaul, 1957; Atal and Schwarting, 1961; Schonbeck-Temesy, 1972; The Ayurvedic Pharmacopoeia of India, 1990a,b,c; Hepper, 1991; Mozaffarian, 2003).

The 23 known Withania species are widely distributed in the drier parts of tropical and subtropical zones, ranging from the Canary Islands, the Mediterranean region, Northern Africa, India, Sri Lanka, Afghanistan, Baluchistan, and Sindh (Schonbeck-Temesy, 1972;
saponins containing an additional acyl group (sitoindoside VII and VIII), and withanoloides with a glucose at carbon 27 (sitonidoside XI and X). *W. somnifera* is also rich in iron. The roots of *W. somnifera* consist primarily of withanolides, which are believed to account for its extraordinary medicinal properties. Withanolides are steroidal and bear a resemblance, both in their action and appearance, to the active constituents ginsenosides present in Asian ginseng (*Panax ginseng*). Ashwagandha’s withanolides have been researched in a variety of animal studies examining their effect on numerous conditions, including immune function and even cancer (*Grandhi et al.*, 1994). Chemical analysis of Ashwagandha shows its main constituents to be alkaloids and steroidal lactones. Among the various alkaloids, withanine is the main constituent. The other alkaloids are somniferine, somnine, somniferinine, withananine, pseudo-withanine, tropine, pseudo-tropine, 3-a-gloyloxytropine, choline, cuscohygrine, isopelletierine, anaferine, and anahydrine. The withanolides within the leaves have C28 steroidal nucleus with C9 side chain and a six-member lactone ring. Twelve alkaloids, 35 withanolides, and several sitoindosides from *W. somnifera* have been isolated and studied. A sitoindoside is a withanolide containing a glucose molecule at carbon 27. Much of Ashwagandha’s pharmacological activity has been attributed to two

**IMPORTANT BIOACTIVE MOLECULES PRESENT IN W. SOMNIFERA**

The pharmacological effects of the roots of *W. somnifera* are attributed to the presence of withanolides, a group of steroidal lactones (*Budhiraja et al.*, 1987). This plant is commonly used in formulations for its wide range of health benefits. In Ayurveda, *Withania* is widely claimed to be a potent aphrodisiac, sedative, and rejuvenative, and to have life-prolonging properties. It is also used as a general energy-enhancing tonic known as Medharasayana, which means that “it promotes learning and a good memory” (*Nadkarni*, 1976; *Williamson*, 2002).

Laboratory analysis has revealed more than 35 chemical constituents contained in the roots of *W. somnifera* (*Rastogi and Mehrotra*, 1998). The biologically active chemical constituents are alkaloids (isopellertierine, anaferine), steroidal lactones (withanolides, withaferins),
MAJOR MEDICINAL VALUE IN ANIMALS AND HUMANS

Withaferin A and withanolide D are the two main withanolides that contribute to most of the biological actions of *Withania* (Matsuda et al., 2001; Sharma et al., 2011). The active ingredients of WS are alkaloids (isopelletierine, anaferine, cuscohygrine, anahygrine, etc.), steroidal lactones (withanolides and withaferins), and saponins (Mishra et al., 2000). Sitoindosides and acylsitosides in Ashwagandha are antistress agents. Active principles of Ashwagandha, for instance, sitoindosides VII–X and Withaferin A, have been shown to have significant antistress activity against acute models of experimental stress (Bhattacharya et al., 1987). The arial parts of WS yield 5-dehydroxy withanolide-R and withasominiferin-A (Rahman et al., 1991).

The biological activities of *W. somnifera* are anti-inflammatory, antioxidant, antifungal (Bhattacharya et al., 2000b), antimicrobial (Girish et al., 2006), antimalarial (Dikasso et al., 2006), apoptotic (Senthil et al., 2007), cardiotonic (Sumantran et al., 2007), cardioprotective (Girish et al., 2006), antitumor, antistress, anti-inflammatory, immunomodulatory, hematopoietic, antiaging, anti-inflammatory, antidepressant, antifungal, and neuroprotective (Sankar et al., 2007), promote inhibition of COX-2 enzyme (Jayaprakasam et al., 2003), and promote learning and memory in Alzheimer’s disease (AD) (Bhattacharya et al., 1995). Numerous studies indicated that Ashwagandha possesses antioxidant, antitumor, antistress, anti-inflammator, immunomodulatory, hematopoietic, antiaging, anti-inflammatory, antidepressant, and rejuvenating properties, and that it also influences various neurotransmitter receptors in the central nervous system (CNS) (Pattipati et al., 2003).

**Animals**

Use of medicinal plants for the treatment of various diseases has been a part of human culture since ancient times. Medicinal properties of plants were mostly discerned through trial and error, but they were also influenced by the belief systems of the people involved and often became entangled with religious and mythical practices (Mathias et al., 1996). Medicinal plant use evolved into an art and a science practiced according to the experience, traditions, and disease theory of the healer.

NUTRACEUTICALS
<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Type of bioactive molecules</th>
<th>Bioactive molecules</th>
<th>Plants parts</th>
<th>Medicinal value of the bioactive molecules</th>
<th>Benefited/experimented animals</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Steroidal lactones</td>
<td>Withanolides</td>
<td>Leaves (Atta-ur-Rahman et al., 1991; Choudhary et al., 1996; Bandyopadhyay et al., 2007)</td>
<td>Antioxidant activity</td>
<td>Rat</td>
<td>Bhattacharya et al. (1997a,b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Atta-ur-Rahman et al., 1991; Choudhary et al., 1996; Bandyopadhyay et al., 2007)</td>
<td>Anxiolytic and antidepressant actions</td>
<td>Rat</td>
<td>Bhattacharya et al. (2000b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Atta-ur-Rahman et al., 1991; Choudhary et al., 1996; Bandyopadhyay et al., 2007)</td>
<td>Treat Alzheimer’s disease (AD) and associated problems</td>
<td>Isolated rabbit jejunum</td>
<td>Choudhary et al. (2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Atta-ur-Rahman et al., 1991; Choudhary et al., 1996; Bandyopadhyay et al., 2007)</td>
<td>Antimicrobial activities</td>
<td>Balb/C mice</td>
<td>Owais et al. (2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Stimulating tumor cell apoptosis</td>
<td>MCF-7 breast cancer cells</td>
<td>Zhang et al. (2011, 2012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Causes G2 and M phase cell cycle arrest</td>
<td>Human breast cancer cell linesMDA-MB-231 and MCF-7</td>
<td>Stan et al. (2008)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Withaferin A</td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Chemosensitization</td>
<td>Nu/nu mice</td>
<td>Fong et al. (2012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Radiosensitization</td>
<td>Swiss albino mice</td>
<td>Ganasoundari et al. (1997)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Chemo therapeutic</td>
<td>Nu/nu mice, Balb/c mice, SCID mice.</td>
<td>Samadi et al. (2010), Thaiparambil et al. (2011), and Lahat et al. (2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Antiangiogenesis</td>
<td>Human umbilical vein endothelial cells</td>
<td>Mohan et al. (2004)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>Anti-inflammation</td>
<td>Swiss albino mice</td>
<td>Sabina et al. (2008)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>NF-kB inhibiting activity cell line</td>
<td>Spinal cord tissue</td>
<td>Swarup et al. (2011)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>NF-kB inhibiting activity cell line (A549)</td>
<td>Lung epithelial cell line (A549)</td>
<td>Oh and Kwon (2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaves (Jayaprakasam et al., 2003)</td>
<td>NF-kB inhibiting activity cell line (RAW 264.7)</td>
<td>Macrophage cell line (RAW 264.7)</td>
<td>Oh et al. (2008b)</td>
</tr>
</tbody>
</table>
### TABLE 52.1

**Sources of Bioactive Molecules from different parts of *Withania Somnifera* and their pharmacological importance on Animals**

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Type of bioactive molecules</th>
<th>Medicinal value of the bioactive molecules</th>
<th>Benefited/experimented animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Treat Alzheimer’s disease (AD) and associated problems</td>
</tr>
<tr>
<td>2.</td>
<td>Atta-ur-Rahman et al., 1991; Choudary et al., 1996; Bandyopadhyay et al., 2007</td>
<td>Antimicrobial activities</td>
<td>Isolated rabbit jejunum and associated problems</td>
</tr>
<tr>
<td>4.</td>
<td>Withaferin A</td>
<td>Stimulating tumor cell apoptosis</td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
<tr>
<td>5.</td>
<td>Withaferin A</td>
<td>Chemosensitization</td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
<tr>
<td>6.</td>
<td>Withaferin A</td>
<td>Radiosensitization</td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
<tr>
<td>7.</td>
<td>Withaferin A</td>
<td>Antiangiogenesis</td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
<tr>
<td>8.</td>
<td>Withaferin A</td>
<td>Anti-inflammation</td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
<tr>
<td>9.</td>
<td>Withaferin A</td>
<td>NF-kB inhibiting activity</td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
<tr>
<td>10.</td>
<td>Withaferin A</td>
<td></td>
<td>Human breast cancer cell lines MDA-MB-231 and MCF-7</td>
</tr>
</tbody>
</table>

**Continued**
<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Type of bioactive molecules</th>
<th>Bioactive molecules</th>
<th>Plants parts</th>
<th>Medicinal value of the bioactive molecules</th>
<th>Benefited/experimented animals</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Withanolides</td>
<td>Withanolide A, withanoside IV, and withanoside VI</td>
<td>Leaves (Chaurasiya et al., 2008)</td>
<td>Anticarcinogenic effect</td>
<td>Human BJ-5ta fibroblasts, MCF-7 cells</td>
<td>Grin et al. (2012)</td>
</tr>
<tr>
<td></td>
<td>Ashwagandhanolide</td>
<td>Roots (Subaraju et al., 2006; Mirjalili et al., 2009)</td>
<td></td>
<td>Abrogation of TNF-induced NF-κB activation</td>
<td>Human tumor cells</td>
<td>Mulabagal et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Withanoside</td>
<td>Root (Jeyanthi and Subramanian, 2009)</td>
<td></td>
<td>Improved memory deficits in β amyloid-injected mice (to induce dendritic and axonal atrophy) and prevented loss of axons, dendrites, and synapses in the cerebral cortex and hippocampus</td>
<td>Mice</td>
<td>Kuboyama et al. (2005, 2006)</td>
</tr>
<tr>
<td></td>
<td>Withanolide sulfoxide</td>
<td>Roots (Mulabagal et al., 2009)</td>
<td></td>
<td>Inhibit COX-2 enzyme and to suppress human tumor cell proliferation</td>
<td>Human tumor cells</td>
<td>Mulabagal et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>L-asparaginase</td>
<td>Fruits (Oza et al., 2010)</td>
<td></td>
<td>Inhibitory effect against lymphoblastic leukemia</td>
<td>Human leukemia cells</td>
<td>Oza et al. (2010)</td>
</tr>
<tr>
<td>6.</td>
<td>Withanolides</td>
<td>Withanolide A</td>
<td>Root (Bani et al., 2006)</td>
<td>Increases the expression levels of T-helper 1 (Th1) cytokines, as well as CD4 and CD8 counts, enhances natural killer (NK) cell activity</td>
<td>Mice</td>
<td>Bani et al. (2006)</td>
</tr>
<tr>
<td></td>
<td>Withanoside IV</td>
<td>Root (Kuboyama et al., 2006)</td>
<td></td>
<td>Attenuated the axonal, dendritic, and synaptic losses and memory deficits induced by amyloid peptide Aβ(25–35)</td>
<td>Mice</td>
<td>Kuboyama et al. (2006)</td>
</tr>
<tr>
<td></td>
<td>Withanolide A, withanoside IV, and withanoside VI</td>
<td>Whole plants (Zhao et al., 2002)</td>
<td></td>
<td>Induce neurite outgrowth in human neuroblastome SHSY5Y</td>
<td>Human</td>
<td>Zhao et al. (2002)</td>
</tr>
</tbody>
</table>
Treatment of animal diseases developed in parallel with the treatment of human diseases. This knowledge was passed on verbally, by example, and sometimes through writing (Mathias et al., 1996). Ethnoveterinary medicine (EVM) is important in animal health care in developing countries (Cunningham and Zondi, 1991). It has become a recognized field of research that includes traditional veterinary theory, medicines, surgical methods, diagnostic procedures, and animal husbandry practices (Mathias et al., 1996). Veterinary aspects of ethnobotany are included in the field of EVM.

Humans

Withania roots are astringent, bitter, acrid, somniferous, thermogenic, stimulant, aphrodisiac, diuretic, and tonic. The leaves contain antibiotic, antitumorous, antihepatotoxic, and anti-inflamatory properties. The seed contains milk-coagulating, hypnotic, and diuretic properties.

*W. somnifera* has been used as an antibacterial, antioxidant, adaptogen, aphrodisiac, liver tonic, and anti-inflammatory agent (Mehrotra et al., 2011). It is a reputed health food and herbal tonic that is used for cardiovascular diseases in ethnomedicine. It is available for human use either as a single herb or an ingredient of polyherbal or herbomineral formulations. The human doses of *Ashwa* *gan* *dh* *a* are generally in the range of 4–6 g/day and are expected to be safe and nontoxic. Stress, as a major cardiovascular risk factor, leads to activation of sympathoadrenal and hypothalamic pituitary adrenal (HPA) axis and causes oxidative stress. Ashwagandha possesses a potent antistressor effect and is reported to alleviate stress-induced changes and provide cardioprotection in ischemic rats similar to the properties ascribed to adaptogens such as *Panax ginseng*. It also increases heart weight and glycogen in the myocardium and liver, indicating intensification of the anabolic process, and enhances the duration of contractility as well as coagulation time (Dhuley, 1998, 2000).

**EXPERIMENTAL STUDIES SUPPORTING MEDICINAL VALUE OF W. SOMNIFERA**

The leaves and roots of this plant are used as an abortifacient, aphrodisiac, diuretic, nerve tonic, narcotic, sedative, astringent, growth promoter, and anthelmintic. It has antiarthritic, antibacterial, antistress, antitumor, and anticancer activities. It is an antidote for scorpion stings. It is used for toning the uterus, consumption, dropsy, leucoderma, impotence, rheumatism, debility from old age, ulcer, sexual and genital weakness, assumption, rheumatic swelling, loss of memory, loss of muscular energy, spermatorrhea, syphilis, sterility of women, blood discharge, leucorrhea, anemia with emaciation, multiple sclerosis, neoplasia, cancer, and fatigue. Fruits and seeds are diuretics and are used in the coagulation of milk (Nadkarni, 1954).


**POTENTIAL MEDICINAL APPLICATION IN AMELIORATING HIGH-ALTITUDE STRESS**

Administration of the active principles of *W. somnifera* at equimolar concentrations of sitoindosides VII–X and withaferin A was found to increase superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) activity in rat brain frontal cortex and striatum. The antioxidant effect of active glycowithanolides of *W. somnifera* (WSG) may explain, at least in part, the reported anti-inflammatory, immunomodulatory, antistress, antiaging, and cognition-facilitating effects produced in experimental animals and in clinical situations (Bhattacharaya et al., 1997a,b).

Another study reported by Bhattacharya et al. (2000a,b, 2001) investigated the antioxidant activity of WSG in chronic foot shock stress-induced changes in rat brain frontal cortex and striatum. The stress procedure, administered once daily for 21 days, induced an increase in SOD and lipid peroxidation (LPO) activity, with concomitant decrease in CAT, and GPx activities in both the brain regions. WSG administered orally 1 h prior to the stress procedure for 21 days (10, 20, and 50 mg/kg) induced a dose-related reversal of the stress effects. Thus, they concluded that WSG tended to normalize the augmented SOD and LPO activities and enhance the activities of CAT and GPx. Their results indicate that at least part of the chronic stress-induced pathology may be due to oxidative stress, which is mitigated by WSG, lending support to the clinical use of the plant as an antistress adaptogen (Bhattacharya et al., 2000b).

The brain is relatively more susceptible to free radical damage than other tissues because it is rich in lipids and iron, both of which are known to be important in...
<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Extract name</th>
<th>Dosages</th>
<th>Route of Dosages</th>
<th>Duration</th>
<th>Experimental Animals</th>
<th>Pharmacological Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Glycowithanolides</td>
<td>20 and 50 mg/kg</td>
<td>Oral</td>
<td>5 days</td>
<td>Wistar rats</td>
<td>Antidepressant effect, induced an anxiolytic effect, antianxiety effects</td>
<td>Bhattacharya et al. (2000b)</td>
</tr>
<tr>
<td>2.</td>
<td>Glycowithanolides</td>
<td>10, 20, and 50 mg/kg</td>
<td>Oral</td>
<td>10 days</td>
<td>Wistar rats</td>
<td>Antioxidative effect</td>
<td>Bhattacharya et al. (2000a)</td>
</tr>
<tr>
<td>5.</td>
<td>Withaferin A</td>
<td>2–4 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>10 days</td>
<td>Mice</td>
<td>Prolonged survival of S-180 ascites</td>
<td>Lahat et al. (2010)</td>
</tr>
<tr>
<td>6.</td>
<td>Withaferin A</td>
<td>10–60 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>24h</td>
<td>Swiss albino mice</td>
<td>Inhibited growth of mouse Ehrlich ascites carcinoma cells and increased tumor-free survival</td>
<td>Byun et al. (2001)</td>
</tr>
<tr>
<td>7.</td>
<td><em>W. somnifera</em> root extract</td>
<td>100 mg/kg</td>
<td>Oral</td>
<td>28 days</td>
<td>Mice</td>
<td>Improves catecholamines and physiological abnormalities seen in Parkinson’s disease (PD)</td>
<td>RajaSankar et al. (2009)</td>
</tr>
<tr>
<td>8.</td>
<td><em>W. somnifera</em> root extract</td>
<td>100 and 200 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>14 days</td>
<td>Rat</td>
<td>Improves Huntington’s disease (HD)</td>
<td>Kumar and Kumar (2009)</td>
</tr>
<tr>
<td>9.</td>
<td><em>W. somnifera</em> leaf extract</td>
<td>100 mg/kg</td>
<td>Oral administration</td>
<td>7 days</td>
<td>Balb/C mice</td>
<td>Antimicrobial activities</td>
<td>Owais et al. (2005)</td>
</tr>
<tr>
<td>Sl. no.</td>
<td>Extract name</td>
<td>Dosages</td>
<td>Route of Dosages</td>
<td>Duration</td>
<td>Experimental Animals</td>
<td>Pharmacological Effects</td>
<td>References</td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
<td>---------</td>
<td>------------------</td>
<td>----------</td>
<td>-----------------------</td>
<td>------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>1.</td>
<td>Glycowithanolides</td>
<td>20 and 50 mg/kg</td>
<td>Oral</td>
<td>5 days</td>
<td>Wistar rats</td>
<td>Antidepressant effect, induced anxiolytic effect, antianxiety effects</td>
<td>Bhattacharya et al. (2000b)</td>
</tr>
<tr>
<td>2.</td>
<td>Glycowithanolides</td>
<td>10, 20, and 50 mg/kg</td>
<td>Oral</td>
<td>10 days</td>
<td>Wistar rats</td>
<td>Antioxidative effect</td>
<td>Bhattacharya et al. (2000a)</td>
</tr>
<tr>
<td>4.</td>
<td>W. somnifera root extract</td>
<td>250, 500, and 750 mg/kg</td>
<td>Oral</td>
<td>14 days</td>
<td>Rats</td>
<td>Nephroprotective effect</td>
<td>Jeyanthi and Subramanian (2009)</td>
</tr>
<tr>
<td>5.</td>
<td>Withaferin A</td>
<td>2–4 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>10 days</td>
<td>Mice</td>
<td>Prolonged survival of S-180 ascites</td>
<td>Lahat et al. (2010)</td>
</tr>
<tr>
<td>6.</td>
<td>Withaferin A</td>
<td>10–60 mg/kg</td>
<td>24 h</td>
<td>Swiss albino mice</td>
<td>Inhibited growth of mouse Ehrlich ascites carcinoma cells and increased tumor-free survival</td>
<td>Byun et al. (2001)</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>W. somnifera root extract</td>
<td>100 mg/kg</td>
<td>Oral</td>
<td>28 days</td>
<td>Mice</td>
<td>Improves catecholamines and physiological abnormalities seen in Parkinson's disease (PD)</td>
<td>RajaSankar et al. (2009)</td>
</tr>
<tr>
<td>8.</td>
<td>W. somnifera root extract</td>
<td>100 and 200 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>14 days</td>
<td>Rat</td>
<td>Improves Huntington's disease (HD)</td>
<td>Kumar and Kumar (2009)</td>
</tr>
<tr>
<td>9.</td>
<td>W. somnifera leaf extract</td>
<td>100 mg/kg</td>
<td>Oral administration</td>
<td>7 days</td>
<td>Balb/C mice</td>
<td>Antimicrobial activities</td>
<td>Owais et al. (2005)</td>
</tr>
<tr>
<td>10.</td>
<td>Withaferin A</td>
<td>1, 2, 4, 8 mg/kg body weight</td>
<td>Oral administration</td>
<td>7 days</td>
<td>Balb/C mice</td>
<td>WA reduces macrophage production of pro-inflammatory cytokines, withaferin A reduces MDSC accumulation in tumor-bearing mice, WA minimizes MDSC production of the pro-tumor cytokine IL-10</td>
<td>Sinha and Ostrand-Rosenberg (2013)</td>
</tr>
<tr>
<td>11.</td>
<td>Sitoindosides VII and VIII</td>
<td>25 and 50 mg/kg</td>
<td>Oral administration</td>
<td>21 days</td>
<td>Wistar rats</td>
<td>Antistress and antistress adaptogenic activity</td>
<td>Bhattacharya and Muruganandam (2003)</td>
</tr>
<tr>
<td>12.</td>
<td>Withaferin A</td>
<td>4 or 8 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>24 days</td>
<td>PC-3 (prostate)</td>
<td>↓Tumor growth</td>
<td>Yang et al. (2007)</td>
</tr>
<tr>
<td>13.</td>
<td>Withaferin A</td>
<td>8 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>21 days</td>
<td>DRO81-1 (medullary thyroid)</td>
<td>↓Tumor growth</td>
<td>Samadi et al. (2010)</td>
</tr>
<tr>
<td>14.</td>
<td>Withaferin A</td>
<td>2 and 4 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>30 days</td>
<td>4T1 (mouse breast)</td>
<td>↓Tumor growth</td>
<td>Thaiparambil et al. (2011)</td>
</tr>
<tr>
<td>15.</td>
<td>Withaferin A</td>
<td>5 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>17 days</td>
<td>ABI2 (mesothelioma)</td>
<td>↓Tumor growth</td>
<td>Yang et al. (2012)</td>
</tr>
<tr>
<td>16.</td>
<td>Withaferin A</td>
<td>3 and 6 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>28 days</td>
<td>Panc-1 (pancreatic)</td>
<td>↓Tumor growth</td>
<td>Yu et al. (2010)</td>
</tr>
<tr>
<td>17.</td>
<td>Withaferin A</td>
<td>20 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>105 days</td>
<td>DMBA (oral)</td>
<td>↓Oral cancer (100%)</td>
<td>Manoharan et al. (2009)</td>
</tr>
<tr>
<td>18.</td>
<td>Withaferin A</td>
<td>100 μg/mouse</td>
<td>Intraperitoneal (IP)</td>
<td>196 days</td>
<td>MMTV-neu (breast)</td>
<td>↓Macroscopic and ↓microscopic tumor burden</td>
<td>Hahm et al. (2014)</td>
</tr>
<tr>
<td>19.</td>
<td>Glycowithanolides</td>
<td>1 mL/kg</td>
<td>Intraperitoneal (IP)</td>
<td>21 days</td>
<td>Rat</td>
<td>Increase the antioxidant activity</td>
<td>Bhattacharya et al. (1997a,b)</td>
</tr>
<tr>
<td>20.</td>
<td>Leaf powder</td>
<td>1.1 μg/mL</td>
<td>Oral</td>
<td>20 days</td>
<td>Mice</td>
<td>↓Tumor growth</td>
<td>Widodo et al. (2008)</td>
</tr>
<tr>
<td>21.</td>
<td>Leaf extract</td>
<td>0.3 mL of 24μg/mL leaf extract</td>
<td>Subcutaneous</td>
<td>20 days</td>
<td>BALB/c nude mice</td>
<td>↓Tumor growth</td>
<td>Widodo et al. (2007)</td>
</tr>
<tr>
<td>22.</td>
<td>Withaferin A</td>
<td>10–60 mg/kg</td>
<td>Intraperitoneal (IP)</td>
<td>120 days</td>
<td>Mice</td>
<td>↓Tumor growth</td>
<td>Devi et al. (1992)</td>
</tr>
<tr>
<td>23.</td>
<td>Sitoindosides IX and X</td>
<td>50–200 mg/kg</td>
<td>Oral and intraperitoneal</td>
<td>4 days</td>
<td>Mice</td>
<td>↑Immunomodulatory and CNS effects</td>
<td>Ghosal et al. (1989)</td>
</tr>
<tr>
<td>24.</td>
<td>Root extract of W. somnifera</td>
<td>20 mg/kg</td>
<td>Intragastric</td>
<td>45 days</td>
<td>Mice</td>
<td>Antioxidative effect</td>
<td>Hussain et al. (2013)</td>
</tr>
</tbody>
</table>
### TABLE 52.3  In vitro Study of Different Bioactive Molecules of *Withania Somnifera* with Their Special Medicinal Value

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Extract name</th>
<th>Dosages</th>
<th>Duration</th>
<th>Experimental cell lines</th>
<th>Pharmacological effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>27-acetoxy-4b, 6a-dihydroxy-5b-chloro-1-oxowitha-2, 24-dienolide. 5b,6b,14a,15a-diepoxy-4b,27-dihydroxy-1-oxowitha-2,24-dienolide &amp; Withaferin A</td>
<td>40mg/mL, 9.4mg/mL</td>
<td>4 days</td>
<td>Human lung cancer cell line (NCI-H460)</td>
<td>Growth inhibition and cytotoxic activity against human lung cancer cell line</td>
<td>Choudhary et al. (2010)</td>
</tr>
<tr>
<td>2.</td>
<td>L-asparaginase</td>
<td>0.01, 0.05, 0.1, 0.2, 0.5, 1, 2, 3, and 5 IU</td>
<td>3 days</td>
<td>Human leukemia cells</td>
<td>Inhibitory effect against lymphoblastic leukemia</td>
<td>Oza et al. (2010)</td>
</tr>
<tr>
<td>3.</td>
<td>Withanolides</td>
<td>0.003–1.01g/mL</td>
<td>3h</td>
<td>Isolated rabbit jejunum</td>
<td>Treat Alzheimer’s disease (AD) and associated problems</td>
<td>Choudhary et al. (2005)</td>
</tr>
<tr>
<td>4.</td>
<td>Withanolides</td>
<td>200μg/mL</td>
<td>3h</td>
<td>Isolated human neutrophils</td>
<td>Treat Alzheimer’s disease (AD) and associated problems</td>
<td>Choudhary et al. (2005)</td>
</tr>
<tr>
<td>5.</td>
<td>Withaferin A</td>
<td>0, 0.156, 0.313, 0.625, 1.25, 2.5, 5μM.</td>
<td>72h</td>
<td>MCF-7 breast cancer cells</td>
<td>Stimulating tumor cell apoptosis</td>
<td>Zhang et al. (2011, 2012)</td>
</tr>
<tr>
<td>7.</td>
<td>Withaferin A</td>
<td>0.25, 0.5, 1.0, 1.5, 2.0μM</td>
<td>24h</td>
<td>Human leukemia U937 cells</td>
<td>Activation of caspase-3, increase translocation of cytochrome C from mitochondria to cytosol</td>
<td>Oh et al. (2008a)</td>
</tr>
<tr>
<td>8.</td>
<td>Withaferin A</td>
<td>0.5μM</td>
<td>24h</td>
<td>Human STS cell lines</td>
<td>Anticancerous effect</td>
<td>Lahat et al. (2010)</td>
</tr>
<tr>
<td>9.</td>
<td>Withaferin A</td>
<td>2mg/kg</td>
<td>24h</td>
<td>HT-1080, SKLMS-1 (soft tissue sarcoma)</td>
<td>↓Tumor growth</td>
<td>Lahat et al. (2010)</td>
</tr>
<tr>
<td>10.</td>
<td>Withaferin A</td>
<td>8mg/kg</td>
<td>48h</td>
<td>CaSki (cervical)</td>
<td>↓Tumor growth</td>
<td>Munagala et al. (2011)</td>
</tr>
<tr>
<td>Sl. no.</td>
<td>Extract name</td>
<td>Dosages</td>
<td>Duration</td>
<td>Experimental cell lines</td>
<td>Pharmacological effects</td>
<td>References</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>---------</td>
<td>----------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>1.</td>
<td>27-acetoxy-4b, 6a-dihydroxy-5b-chloro-1-oxowitha-2, 24-dienolide. Withaferin A 40 mg/mL, 9.4 mg/mL</td>
<td>4 days</td>
<td>Human lung cancer cell line (NCI-H460)</td>
<td>Growth inhibition and cytotoxic activity against human lung cancer cell line</td>
<td>Choudhary et al. (2010)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>L-asparaginase</td>
<td>0.01, 0.05, 0.1, 0.2, 0.5, 1, 2, 3, and 5 IU</td>
<td>3 days</td>
<td>Human leukemia cells</td>
<td>Inhibitory effect against lymphoblastic leukemia</td>
<td>Oza et al. (2010)</td>
</tr>
<tr>
<td>3.</td>
<td>Withanolides</td>
<td>0.003–1.0 lg/mL</td>
<td>3 h</td>
<td>Isolated rabbit jejunum</td>
<td>Treat Alzheimer's disease (AD) and associated problems</td>
<td>Choudhary et al. (2005)</td>
</tr>
<tr>
<td>4.</td>
<td>Withanolides</td>
<td>200 μg/mL</td>
<td>3 h</td>
<td>Isolated human neutrophils</td>
<td>Treat Alzheimer's disease (AD) and associated problems</td>
<td>Choudhary et al. (2005)</td>
</tr>
<tr>
<td>5.</td>
<td>Withaferin A</td>
<td>0, 0.156, 0.313, 0.625, 1.25, 2.5, 5 μM.</td>
<td>72 h</td>
<td>MCF-7 breast cancer cells</td>
<td>Stimulating tumor cell apoptosis</td>
<td>Zhang et al. (2011, 2012)</td>
</tr>
<tr>
<td>7.</td>
<td>Withaferin A</td>
<td>0.25, 0.5, 1.0, 1.5, 2.0 μM</td>
<td>24 h</td>
<td>Human leukemia U937 cells</td>
<td>Activation of caspase-3, increase translocation of cytochrome C from mitochondria to cytosol</td>
<td>Oh et al. (2008a)</td>
</tr>
<tr>
<td>8.</td>
<td>Withaferin A</td>
<td>0.5 μM</td>
<td>24 h</td>
<td>Human STS cell lines</td>
<td>Anticancerous effect</td>
<td>Lahat et al. (2010)</td>
</tr>
<tr>
<td>9.</td>
<td>Withaferin A</td>
<td>2 mg/kg</td>
<td>24 h</td>
<td>HT-1080, SKLMS-1 (soft tissue sarcoma)</td>
<td>↓ Tumor growth</td>
<td>Lahat et al. (2010)</td>
</tr>
<tr>
<td>10.</td>
<td>Withaferin A</td>
<td>8 or 12 mg/kg</td>
<td>24 h</td>
<td>CaSki (cervical)</td>
<td>↓ Tumor growth</td>
<td>Munagala et al. (2011)</td>
</tr>
<tr>
<td>11.</td>
<td>Withaferin A</td>
<td>8 or 12 mg/kg</td>
<td>72 h</td>
<td>Human uveal melanoma cell lines</td>
<td>Induce apoptosis</td>
<td>Samadi et al. (2012)</td>
</tr>
<tr>
<td>13.</td>
<td>Withaferin A</td>
<td>1.5 μM</td>
<td>48 h</td>
<td>Osteogenic sarcoma (U2OS) and fibrosarcoma (HT1080) cells</td>
<td>Anticancerous effect</td>
<td>Widodo et al. (2008)</td>
</tr>
<tr>
<td>14.</td>
<td>Leaf extract, withaferin A, Withanone, Withanolide A</td>
<td>(0.8–5.0 μg/mL), (0.1–0.5 μM), (5–10 μg/mL), (5–10 μg/mL)</td>
<td>48–72 h</td>
<td>Glioma cell lines C6 (rat) and YKG1 (human)</td>
<td>Effective glioma therapy</td>
<td>Shah et al. (2009)</td>
</tr>
<tr>
<td>15.</td>
<td>Withaferin A</td>
<td>4.0 and 5.0 μM</td>
<td>3 h</td>
<td>Human lung cancer cells, A549</td>
<td>Alters intermediate filament organization, cell shape and behavior</td>
<td>Grin et al. (2012)</td>
</tr>
<tr>
<td>16.</td>
<td>Withaferin A</td>
<td>1.0 to 4.0 μM</td>
<td>3 h</td>
<td>MCF-7 cells</td>
<td>Induce apoptosis</td>
<td>Hahm et al. (2014)</td>
</tr>
<tr>
<td>17.</td>
<td>Withaferin A</td>
<td>2 μM</td>
<td>24 h</td>
<td>BJ-5ta cells</td>
<td>Induce the apoptotic process</td>
<td>Hahm et al. (2014)</td>
</tr>
<tr>
<td>18.</td>
<td>Withaferin A</td>
<td>2.5 and 5.0 μM</td>
<td>16 h</td>
<td>Human breast cancer cells (MCF-7 and SUM159 cells)</td>
<td>Induce the apoptotic process</td>
<td>Hahm et al. (2014)</td>
</tr>
<tr>
<td>19.</td>
<td>Withaferin A</td>
<td>5 and 10 μM</td>
<td>48 h</td>
<td>Leukocyte-depleted erythrocytes</td>
<td>Induce the apoptotic process</td>
<td>Hahm et al. (2014)</td>
</tr>
<tr>
<td>20.</td>
<td>Water extract of W. somnifera leaves</td>
<td>0.1–2.5% of the crude extract</td>
<td>72 h</td>
<td>Rat C6 glioma cell line</td>
<td>Induce the apoptotic process</td>
<td>Kataria et al. (2011)</td>
</tr>
<tr>
<td>21.</td>
<td>Ashwagandha leaf extracts</td>
<td>0.3 μg/mL</td>
<td>24 h</td>
<td>Human neuroblastoma (IMR32) and rat glioblastoma (C6) cells</td>
<td>Protect brain-derived cells against oxidative stress and induce differentiation</td>
<td>Shah et al. (2015)</td>
</tr>
</tbody>
</table>
### TABLE 52.4 Different Types of Curable Disease After Application of Different Bioactive Molecules of *Withania Somnifera*

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Curable disease</th>
<th>Bioactive molecules</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Oxidative stress</td>
<td>Withanolides</td>
<td>Bhattacharya et al. (1997a,b)</td>
</tr>
<tr>
<td>4.</td>
<td>Microbial disease</td>
<td>Withanolides</td>
<td>Owais et al. (2005)</td>
</tr>
<tr>
<td>5.</td>
<td>Cancer</td>
<td>Withaferin A</td>
<td>Zhang et al. (2011, 2012), Stan et al. (2008), Fong et al. (2012), Panjamurthy et al. (2009), Samadi et al. (2010), Thaiparambil et al. (2011), and Labat et al. (2010)</td>
</tr>
<tr>
<td>7.</td>
<td>Stress relief</td>
<td>Sitoindosides VII and VIII, Glycowithanolides and sitoindosides IX and X</td>
<td>Bhattacharya and Muruganandam (2003), Dhuley et al. (2000), and Singh et al. (2001)</td>
</tr>
<tr>
<td>9.</td>
<td>Lymphoblastic leukemia</td>
<td>L-asparaginase</td>
<td>Oza et al. (2010)</td>
</tr>
<tr>
<td>10.</td>
<td>Poor immunity</td>
<td>Withanolide A</td>
<td>Bani et al. (2006)</td>
</tr>
</tbody>
</table>

Generating reactive oxygen species (ROS). The brain also uses nearly 20% of the total oxygen supply. Free radical damage to the brain may contribute to neuronal loss in cerebral ischemia and may be involved in normal aging and neurodegenerative diseases (epilepsy, schizophrenia, PD, AD, and others). Because traditional Ayurvedic use of WS has included many diseases associated with free radical oxidative damage, it has been considered likely that the effects may be due to a certain degree of antioxidant activity. Decreased activity of these enzymes leads to accumulation of toxic oxidative free radicals and resulting degenerative effects. An increase in these enzymes would represent increased antioxidant activity and a protective effect on neuronal tissue. Active WSG (10 or 20 mg/kg, intraperitoneal) was given once daily for 21 days to groups of six rats. Dose-related increases in all enzymes were observed; the increases comparable to those seen with deprenyl (a known antioxidant) administration (2 g/kg/day, intraperitoneal). This implies that WS does have an antioxidant effect in the brain that may be responsible for its diverse pharmacological properties. Further studies on other parts of the brain (e.g., cerebellum, medulla, and hypothalamus) may provide information with respect to the effects of WS on cognitive behavior and other functions of the brain in both healthy and diseased individuals.

In another study, an aqueous suspension of WS root extract was evaluated for its effect on stress-induced lipid peroxidation (LPO) in mice and rabbits (Dhuley, 1998). LPO blood levels were increased by...
intravenous administration of 0.2 mg/kg of lipopolysaccharides (LPS) from *Klebsiella pneumoniae* and 100 mg/kg of peptidoglycans (PGN) from *Staphylococcus aureus*. Simultaneous oral administration of WS extract (100 mg/kg) prevented an increase in LPO. The authors indicated that the almost innocuous doses of LPS and PGN used in this study were comparable to a mild bacteremia that may follow tooth extraction or streptococcal angina.

Antistressor effects of Asgand were investigated in rats using a cold water swimming stress test. The treated animals showed better stress tolerance (Archana and Namasivayam, 1999). A withanolide-free aqueous fraction isolated from the roots of *W. somnifera* exhibited antistress activity in a dose-dependent manner in mice (Khare, 2007). Asgand has been evaluated for its adaptogenic activity. Administration of Asgand with other drugs in experimental animals exposed to a variety of biological, physical, and chemical stressors was found to offer protection against these stressors (Bhattacharya, 1992; Rege et al., 1999).

**AVAILABLE DRUG FORMULATION USING W. SOMNIFERA**

*Ashwagandha* is advocated as a protective drug against atherosclerosis, hypertension, and coronary heart diseases (Mehra et al., 2009). It reduces the sensitivity of the heart to adrenergic stimulation and thereby protects the heart against sympathetic outbursts. Moharana (2008) reported that the roots and leaves of *Ashwagandha* are traditionally used in the form of powder, decoction, or oil. These have been used in folk medicine against general disability, hypertension, inflammation, and wounds. Thirunavukkarasu et al. (2006) found *Ashwagandha* to have energy boosting properties and recommended its use as a dietary supplement for cardioprotection. The effect of *Ashwagandha* root was evaluated for lipid peroxidation in stress. The herb was found to have very good antioxidant activity, which may partly explain the antistress, congestion-facilitating, anti-inflammatory, and antiaging effects of this herb (Moharana, 2008; Table 52.5).

### TABLE 52.5 List of Some Available Drug Formulated by *Withania Somnifera*

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Product name</th>
<th>Manufacturer</th>
<th>Utility of the product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Stresswin</td>
<td>Baidynath Ayurved Bhawan</td>
<td>→ Combating exertion, reduction in anxiety, strain, and stress, improvement of stamina, relaxation from disturbed sleep, mental alertness</td>
</tr>
<tr>
<td>2.</td>
<td>Stresscom</td>
<td>Dabur India Ltd.</td>
<td>→ Relieves anxiety neurosis, physical and mental stress, and relieves general debility and depression</td>
</tr>
<tr>
<td>4.</td>
<td>Ashwagandha</td>
<td>Morpheme Remedies</td>
<td>→ Combating stress</td>
</tr>
<tr>
<td>5.</td>
<td>Dabur Ashwagandha Churna</td>
<td>Dabur</td>
<td>→ Combating stress</td>
</tr>
<tr>
<td>6.</td>
<td>Ashwagandha</td>
<td>Ayurceutics</td>
<td>→ Stress reliever</td>
</tr>
<tr>
<td>7.</td>
<td>Himalaya Massage oil</td>
<td>The Himalaya Drug Co.</td>
<td>→ Stress relief and relief from insomnia</td>
</tr>
<tr>
<td>8.</td>
<td>Ashwagandharista</td>
<td>Baidynath Ayurved Bhawan</td>
<td>→ Nerve tonic, memory and cognition improvement, better power of concentration, relieves mental tension, natural sleep induction, and recovery from nervous and general debility</td>
</tr>
<tr>
<td>9.</td>
<td>Arshadi pills</td>
<td>Dehlvi Remedies</td>
<td>→ Stress, depression, cardiac tonic</td>
</tr>
<tr>
<td>10.</td>
<td>Ashwagandha extract</td>
<td>Nanjing Zelang Medical Technology Co., Ltd.</td>
<td>→ It is called “Indian ginseng” and contains alkaloids, steroidal lactones, withanoids, and iron; it has antiallergy, antihistamine, antibacterial, local anaesthetic, antipyretic, and pain-relieving functions → Alkaloids could be used in sedative and pain relief, lowering blood pressure. The function of anti-inflammation of withanolides can inhibit cancer cell growth, treat chronic inflammation, such as lupus and rheumatoid arthritis, reduce vaginal discharge, improve sexual function, etc.</td>
</tr>
</tbody>
</table>

(Continued)
TABLE 52.5  Continued

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Product name</th>
<th>Manufacturer</th>
<th>Utility of the product</th>
</tr>
</thead>
</table>
| 11.    | Ashwagandha/W. somnifera extract withanolides | Wuxi Gorunjie Natural-Pharma Co., Ltd. | → Ashwagandha extract can treat different diseases like inflammation, arthritis, stress and anxiety, and even mental disorders  
→ Improves the white blood cell in the body in a way that increases the phagocytosis or the process of removing dead cells  
→ Enhances the results of radiation and chemotherapy  
→ Regulates the nerve signals and makes sure that it is balanced  
→ A great source of energy; it develops stamina by managing the process of metabolism  
→ Best source for antioxidants and hormonal forerunners  
→ Maintains necessary bodily functions  
→ Protects the immunity cells that are subjected to chemicals that may prevent the cells to work properly |
| 12.    | Nutramax-AE (100%)                          | Hunan Nutramax Inc.              | → Antiallergy  
→ Antihistamine  
→ Antipyretic and pain-relieving  
→ Local anesthetic  
→ Antibacterial |
| 13.    | Nutramax W. somnifera extract (10:1)        | Hunan Nutramax Inc.              | → Winter cherry medicinally works as an adaptogen, antistress agent, aphrodisiac, and in all cases of general debility  
→ Ashwagandha extract is traditionally used in case of spermatorrhoeas, loss of strength, seminal debility, and as a growth promoter  
→ The root extracts exhibits antistress, hypotensive, antispasmodic, bradicardic, and respiratory stimulant activities  
→ The herb promotes sound sleep, provides protection against environmental free radicals, nourishment of the cells, and works as rejuvenate |
| 14.    | Natural 80 mesh American ginseng root extract | Qingdao Fraken International Trading Co., Ltd. | → Withanolides possess remarkable antibacterial, antitumor, antiarthritic, anti-inflammatory, and immunosuppressive properties |
| 15.    | 100% Natural W. somnifera extract Alkaloids, Withanolides Ashwagandha extract | Xi’an Saina Biological Technology Co., Ltd | → Antiallery, antihistamine, antipyretic, pain-relieving, local anesthetic, antibacterial |

CONCLUDING REMARKS AND FUTURE DIRECTIONS

In Ayurveda, the use of medicinal plants for better health management has been performed up to the present time, and its utility has increased across the globe. Medicinal plants contain several types of medicinally and pharmacologically important bioactive molecules that maintain the health and vitality of individuals and also cure disease. Several studies on W. somnifera have indicated its use as an aphrodisiac, liver tonic, anti-inflammatory agent, and astringent, and to treat bronchitis, asthma, ulcers, emaciation, insomnia, and senile dementia. Clinical trials and animal research support the use of Ashwagandha for anxiety, immunomodulation, hematopoiesis, cognitive and neurological disorders, inflammation, tumors, and PD. This plant is also responsible for the exertion of an influence on the endocrine, nervous, and cardiopulmonary systems. The most well-known bioactive molecules of W. somnifera are withaferins and sitoindosides, which reduce the oxidative damage of the cells and help in the prevention of several diseases. Studies on W. somnifera have indicated that supplementing with this plant can reduce lipid peroxidation, possibly by scavenging free radicals, and can help to build up a potent antioxidant defense system. This chapter describes that W. somnifera contains several bioactive molecules that are important for good health and for maintaining life at high altitudes, because it is responsible for the reduction of oxidative stress. This plant can also be used as a multipurpose medicinal agent. More research is needed to determine a potential dosage range for achieving its multipurpose drug properties.

Acknowledgments

The authors thank Ms. Robin B. Doss and Ms. Michelle A. Lasher for their technical assistance, and Mr. Arup Giri for his help in the preparation of this chapter.
References


NUTRACEUTICALS


Oza, V.P., Parmar, P.P., Kumar, S., et al., 2010. Anticancer properties of highly puriﬁed L-asparaginase from Withania somnifera L. against NUTRACEUTICALS


