

# The Role of Adaptogenic Herbs in Combating Stress: A Review of Scientific Evidence

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**Abstract:** *Adaptogens are bioactive compounds which allow the body to cope with stress, to be on homeostasis again. Its history dates back thousands of years, when Ayurvedic and Traditional Chinese Medicine developed knowledge on adaptogenic compounds and functions, specifically on modulatory aspects of the hypothalamic-pituitary-adrenal axis and of cortisol regulatory pathways. The present review explores the history and classification of adaptogens as well as the underlying mechanisms, including hormone modulation, neurobiological pathways, and antioxidant activity. Botanical examples are Withaniasomnifera and Rhodiolarosea, as well as some non-botanical adaptogens including fungi and nutraceuticals. Preclinical and clinical evidence is presented as proof of the efficacy of the substances in diminishing stress, augmenting cognitive ability, and promoting physical endurance.*

*Discussions on modern trends of formulations like teas, capsules, and functional foods in relation to practical uses regarding stress management and maintenance of psychological well-being and avoidance of burnout will be covered. Although generally safe, adaptogen risks include high dose toxicity and inter-medication interactions. Current challenges include variability in standardization of preparations and limitations in understanding long-term effects and associated molecular mechanisms. This review draws attention to the potential therapeutic role of adaptogens in modern life, provides insights into their safe and effective use, and points out areas for further work. Specific practical recommendations are given for how to select and combine adaptogens tailored to individual stress profiles, thus paving the way for their further integration into health care and wellness practice.*

**Keywords:** Adaptogens, Stress management, HPA axis, Cognitive resilience, Herbal medicine

## I. INTRODUCTION

**Definition and Concept of Adaptogens:** Adaptogens are natural substances that improve the nonspecific resistance of living organisms to physical, chemical, and biological stressors. The term "adaptogen" was invented in 1947 by Soviet scientist Nikolai Lazarev who described a substance that helps the body get homeostasis through improving its nonspecific resistance to stress. Later, Brekhman and Dardymov established criteria for adaptogens, stating that they should [1] exhibit nonspecific resistance to various stressors, [2] have a normalizing effect irrespective of the type of pathological state, and [3] be safe and non-toxic.

**Historical Background:** Adaptogens find their basis in traditional medical systems, including Traditional Chinese Medicine and Ayurveda. For centuries, ginseng [*Panax ginseng*] and schisandra [*Schisandrachinensis*] have been used in TCM to enhance vitality and stress resilience. In Ayurvedic medicine, adaptogenic herbs like ashwagandha [*Withaniasomnifera*] and holy basil [*Ocimum sanctum*] are also used to help bring balance and well-being to the body.

### General Characteristics

Adaptogens are defined by the capacity to ameliorate the adaptive capacity of the body, especially when a person is stressed. They involve:

1. Maintenance of Homeostasis: In this regard, Adaptogens facilitate the body in maintaining a balance under stress conditions by regulating the hypothalamic-pituitary-adrenal axis.
2. They boost up mental and physical force and reduce fatigue, enhancing endurance.
3. They show dual action: Adaptogens stimulate or relax the body depending on the body's requirement.
4. Enhance the body's resistance to infection and inflammation: Adaptogens modulate the immune system of the body.

### **Role in Traditional Medicine**

**Traditional Chinese Medicine [TCM]:** Adaptogens are classified as "tonic herbs" in TCM. They enhance Qi, or the vital energy, promoting well-being and balance. Some commonly used herbs in this category are ginseng, astragalus[Astragalusmembranaceus], and licorice[Glycyrrhizaglabra], which restore equilibrium and vitality in the body. Ginseng is actually called the "king of herbs" because of its ability to enhance the human body's overall performance physically as well as mentally. Schisandra is also one of the main adaptogens in TCM because of its ability to boost the function of the liver and endurance.

**Ayurvedic Medicine:** In Ayurveda, adaptogenic herbs are classified as "Rasayanas," substances that rejuvenate and enhance longevity. The most prominent of these are ashwagandha and holy basil, used to reduce stress, improve cognitive function, and enhance immunity. Ashwagandha is referred to as "Indian ginseng" and has been well studied for its stress-reducing properties. Holy basil is often referred to as "Tulsi," an elixir of life in Ayurveda, capable of reducing inflammation and supporting respiratory health.

**Siberian and Native Practices:** Plants such as rhodiola[Rhodiolarosea] have been in the cultures of Siberia and others for centuries to heighten the endurance of the body and the mind. Rhodiola is famous for being referred to as the "golden root" and has always been part of the mainstream in fighting against fatigue and the improvement of one's ability to survive hostile climates. This practice underlines the role of adaptogens in increasing survival and adaptation to extreme environments.

### **Mechanisms of Action**

Mainly, the adaptogens are effectors of the modulators in HPA axis. It is considered to be at the centre of the body's stress response. Other than this, they also have control over cortisol, neurotransmitters, and other physiological systems. All these reasons give birth to many of its benefits.

### **Modification of HPA Axis**

The central system for the response to stress is the HPA axis. This includes

1. Hypothalamus: Response to stress, there is the release of CRH.
2. Pituitary Gland: Responses to CRH it produces ACTH.
3. Adrenal Glands: Produce cortisol, the primary stress hormone.

Adaptogens function to regulate HPA axis activity, thus preventing over-activation and maintaining normal levels of cortisol. Ashwagandha has been shown to normalize cortisol levels and reduce stress [1]. Rhodiola and schisandra also regulate HPA axis activity and stabilize responses to stress [2].

### **Regulation of Cortisol**

Cortisol is the body's regulator of acute stress but becomes injurious when levels are chronically elevated. Such chronic elevation impairs metabolic, immune, and cognitive functions since the cortisol secreted due to stress overshadows normal functions in the body. Rhodiola and schisandraadaptogenic effects inhibit the production of a lot of cortisol secretions, as a safeguarding mechanism that limits the effects caused by the action of the stressor on the HPA axis, and it is due to such mechanisms, feedback inhibition would increase in the process [2] .

### **Neurotransmitter Modulation**

Adaptogens also modulate neurotransmitter systems: dopamine, serotonin, and norepinephrine, important for mood and cognitive function. Rhodiola, for example, enhances activity of serotonin; it improves mood and reduces fatigue [3].

Ashwagandha has been proven to influence GABAergic activity, which helps in relaxation and reduces anxiety. Schisandra supports dopaminergic and cholinergic systems; it enhances the cognitive function and focus.

#### **Antioxidant and Anti-inflammatory Actions**

Many adaptogens are antioxidants that guard against oxidative stress, a side effect of chronic stress. Oxidative stress causes cellular damage and speeds up the aging process. Adaptogens such as holy basil and ashwagandha scavenge free radicals, which decrease oxidative damage [4]. Holy basil, for example, contains eugenol and other phenolic compounds that have very strong antioxidant activity. In addition, adaptogens possess anti-inflammatory activity that counters chronic inflammation, which is a hallmark of stress-related disorders.

#### **Immune System Modification**

Adaptogens include substances like astragalus and ginseng, which encourage immune function by stimulating the proliferation of white blood cells and enhancing overall resistance to infections. One such crucial herb used in TCM is astragalus; it acts as a potent activator of T-cell function, which enhances host defenses[5]. Moreover, ginseng also modulates cytokine production, decreases excessive pro-inflammatory responses, and enhances anti-inflammatory cytokines. Such immunomodulating activity might be especially useful in the context of chronic stress, which may compromise immune function.

### **1.1. Physiological and Psychological Effects of Stress**

#### **Impact of Stress on the Body**

Stress is the physiological and psychological response to a change in internal or external conditions, disrupting homeostasis. Even though stress is an adaptive response, chronic or exaggerated stress affects both physical and mental health. The following sections examine the acute and chronic stress impacts on the body's different physiological systems.

#### **Acute Stress**

Acute stress refers to a response that is time limited and to an immediate danger; it's known as the "fight-or-flight" response. Physiological responses in acute stress include:

1. Activation of the SNS: SNS causes adrenaline and norepinephrine to be released from the adrenal medulla. These cause the heart rate and blood pressure and breathing to rise.
2. HPA Axis Stimulation: Activation of the HPA axis triggers increased release of cortisol from the adrenal cortex to fuel mobilization of energy and elevation of arousal [6].

#### **Chronic Stress**

Long-term exposure to stressors causes chronic stress and maintains the activation of the SNS and HPA axis. Such a stress state affects most of the physiological systems:

1. Immune Function: Chronic stress suppresses immune function because of decreased proliferation of lymphocytes and blunted cytokine signaling and thus makes them even more susceptible to infections and slows down the healing of wounds [8]
2. Metabolic Health: Exposure to chronically elevated cortisol increases the risk for insulin resistance, central adiposity, and dyslipidemia, and therefore places someone at a highly increased risk for metabolic syndrome and type 2 diabetes [9].
3. Cardiovascular Health: Stress-induced hypertension and endothelial dysfunction increase the risk of atherosclerosis and coronary artery disease. The inflammation and oxidative stress that stress elicits are additive cardiovascular risks [10].
4. Mental Health and Cognitive Decline: Chronic stress reorganizes the neural circuits of the brain, especially in the hippocampus and prefrontal cortex that impact memory, learning, and emotional regulation [11].

### System-Specific Impact

1. Immune response: Acute stress induces the immune response transiently; however, chronic stress tends to shift the immune response in a pro-inflammatory direction. Dysregulation has been implicated with autoimmune diseases, chronic inflammation, and increased susceptibility to infections [8].
2. Metabolism Cortisol stimulates gluconeogenesis and lipolysis and suppresses anabolic processes. Cortisol elevation to the chronic range disrupts glucose metabolism, and there is an increased risk of obesity and diabetes [9].
3. Cardiovascular System: The chronic elevation of stress raises heart rate and blood pressure, thereby causing vascular damage and atherosclerosis. There is also increased platelet aggregation, which elevates the risk of thrombosis and myocardial infarction [10].
4. Mental Health Chronic stress triggers structural and functional changes in the brain, which include:
  - Hippocampus: Neurogenesis and atrophy cause impaired memory and learning.
  - Amygdala: Hyperactivity increases emotional responses and anxiety.
  - Prefrontal Cortex: Reduced connectivity impairs decision-making and self-regulation [11].

### Role of Stress in Mental Health Disorders

Chronic stress is one of the root risk factors that lead to various mental health disorders. Its effect on the brain and body would be pervasive and create a vicious cycle of worsening psychological and physiological health.

Anxiety Disorders: The amygdala gets hyperactivated and suppressed prefrontal cortex are somehow causing an imbalance in the human emotional processing and regulation in chronic stress. Dysregulation results in increased levels of anxiety, fear, and hypervigilance. Stress also keeps fueling anxiety by maintaining higher-than-normal levels of cortisol, which increases the arousal state of the body [12].

Depression: Stress is the core of pathophysiology of depression.

Mechanisms include:

- HPA Axis Dysregulation: Chronic stress causes hypercortisolemia, which interferes with the balance of neurotransmitters and neuroplasticity.
- Neuro-inflammation: Chronic inflammation caused by stress hampers serotonin synthesis and decreases hippocampal neurogenesis [13].
- Monoamine Imbalance: Stress alters the level of serotonin, dopamine, and norepinephrine and is accountable for the expression of depression [14].
- Burnout: This is a state of physical, emotional, and mental exhaustion caused by chronic stress in the workplace. Some of the manifestations of burnout include, Emotional exhaustion, Depersonalization, Reduced sense of accomplishment [15].
- Burnout has been associated with cortisol dysregulation patterns, reduced autonomic flexibility, and reduced stress resilience. This worsens the effects.
- Cognitive Decline: Chronic stress accelerates cognitive aging and increases susceptibility to neurodegenerative diseases such as Alzheimer's. Some of the mechanisms include;
- Hippocampal Atrophy: Exposure to cortisol for a long period results in a decrease in hippocampal volume that interferes with memory consolidation.
- Oxidative Stress: Stress-generated reactive oxygen species damage neurons and glial cells.
- Neuro-inflammation: Chronic inflammation compromises synaptic integrity and plasticity [16].
- Stress and Comorbidities: Chronic stress is also prevalent in most patients with PTSD and substance use disorders. In such patients, stress maintains these conditions as hyperarousal, negative affect, and poor coping all feed the pathological processes [17].

### Interventions and Mitigation Measures

The stress effects must be managed through a multi-level intervention approach, comprising lifestyle changes, therapeutic interventions, and pharmacologic treatments:

**Lifestyle Changes:**

Exercise habitually because that lowers cortisol but elevates the release of endorphins.  
Meditation and mindfulness help in regulation of emotions as well as decreases the perception of stress.  
Proper sleep helps re-establish the functions of the HPA axis while improving cognitive resilience [18].

**Treatment Interventions:**

Cognitive behavior therapy [CBT] helps the subject identify and transform thought patterns, which trigger stress responses.

Stress management programs boost resilience and coping skills.

Pharmacological Interventions:

Antidepressants and anxiolytics are used for stress-related mood and anxiety disorders.

Neuro-steroids and anti-inflammatory drugs with effects on the neurobiologic alterations caused by stress are novel treatments [19].

**II. CLASSIFICATION OF ADAPTOGENS**

**Botanical Adaptogens:** Common plants that have adaptogenic properties [e.g., *Withaniasomnifera*[Ashwagandha], *Panax ginseng*, *Rhodiolarosea*, *Eleutherococcussenticosus*].

**Pharmacognostic Profiles of Adaptogenic Plants:**

Adaptogenic plants have garnered significant attention for their ability to help the body resist various stressors. This section provides a more in-depth look at the pharmacognostic profiles of four prominent adaptogens: *Withaniasomnifera*[Ashwagandha], *Panax ginseng*, *Rhodiolarosea*, and *Eleutherococcussenticosus*.

**A. *Withaniasomnifera*[Ashwagandha]**

**Botanical Source:**

- Dried roots and leaves of *Withaniasomnifera*[L.] Dunal. belonging to the Solanaceae family.

**Geographical Distribution:**

- Widely distributed throughout India, Africa, and parts of the Middle East, thriving in arid and semi-arid regions.

**Macroscopic Characteristics:**

- *Roots:* Long, cylindrical, and branched with a grayish-brown bark. They exhibit a characteristic woody texture and may have a slightly bitter taste.
- *Leaves:* Simple, ovate-lanceolate, and petiolate. They have a slightly velvety texture due to the presence of fine hairs.

**Microscopic Characteristics:**

*Root:*

- *Cork:* Multiple layers of cork cells, often with suberin deposits, provide protection.
- *Secondary Phloem:* Consists of sieve tubes, companion cells, phloem parenchyma, and fibers.
- *Xylem:* Composed of vessels, tracheids, wood fibers, and xylem parenchyma.
- *Secondary Growth:* Prominent with well-developed secondary xylem and phloem.

*Leaf:*

- *Epidermis:* Presence of unicellular trichomes[hairs], stomata, and cuticular waxes.
- *Mesophyll:* Differentiated into palisade and spongy parenchyma.
- *Veins:* Prominent midrib with vascular bundles containing xylem and phloem.

**Chemical Constituents:**

- *Withanolides:* The most important class of bioactive compounds in Ashwagandha. These are steroidal lactones, with withaferin A and withanone being the most prominent examples. *Withanolides* exhibit a wide range of pharmacological activities, including anti-inflammatory, anti-tumor, and immunomodulatory effects.



- *Alkaloids*: Withanine and somniferine are the major alkaloids present.
- *Flavonoids*: Withaferin A and withanone also possess flavonoid characteristics, contributing to their antioxidant and anti-inflammatory properties.[ 20]



Fig. 1. Image of Ashwagandha

### B. Panaxgnseng

#### Botanical Source:

- Dried roots and rhizomes of *Panax ginseng* C.A. Meyer, belonging to the Araliaceae family.

#### Geographical Distribution:

- Primarily found in Northeastern China, Korea, and Russia, typically in cool, mountainous regions.

#### Macroscopic Characteristics:

- *Roots*: Fusiform or cylindrical, often forked, with a yellowish-brown bark and numerous fine rootlets.
- *Rhizome*: Short and stout, often bearing scars from previous aerial stems.

#### Microscopic Characteristics:

##### Root:

- *Cork*: Multiple layers of cork cells.
- *Secondary Phloem*: Well-developed with sieve tubes, companion cells, and phloem parenchyma.
- *Xylem*: Consists of vessels, tracheids, wood fibers, and xylem parenchyma.
- *Characteristic feature*: Presence of xylem parenchyma cells containing abundant starch grains.

#### Chemical Constituents:

- *Ginsenosides*: The primary active constituents of ginseng. These are triterpene saponins with diverse structures and pharmacological activities. Major ginsenosides include Rb1, Rb2, Rc, Rd, Re, Rg1, and Rg2.
- *Polysaccharides*: Ginsan, a complex polysaccharide, exhibits immunomodulatory and anti-tumor properties.
- *Peptides*: Ginseng peptides have been shown to possess antioxidant and anti-aging properties.[21]



Fig. 2. Image of Panax ginseng

### C. Rhodiolarosea

#### Botanical Source:

- Dried roots and rhizomes of *Rhodiolarosea* L., belonging to the Crassulaceae family.

**Geographical Distribution:**

- Found in cold regions of the Arctic, Europe, and Asia, typically in mountainous areas.

**Macroscopic Characteristics:**

- *Roots:* Fleshy, cylindrical, and often branched, with a reddish-brown bark.
- *Rhizome:* Stout and woody, often bearing scars from previous aerial stems.

**Microscopic Characteristics:**

*Root:*

- *Cork:* Multiple layers of cork cells.
- *Secondary Phloem:* Well-developed with sieve tubes, companion cells, and phloem parenchyma.
- *Xylem:* Consists of vessels, tracheids, wood fibers, and xylem parenchyma.
- *Characteristic feature:* Abundant starch grains are present in parenchyma cells.

**Chemical Constituents:**

- *Phenylethanoid glycosides:* Salidroside, rosavin, and rosarin are the major bioactive compounds. These compounds exhibit adaptogenic, anti-fatigue, and neuroprotective properties.
- *Flavonoids:* Rutin and quercetin are present in smaller amounts.
- *Phenolic acids:* Rosmarinic acid and caffeic acid also contribute to the plant's antioxidant activity.[22]

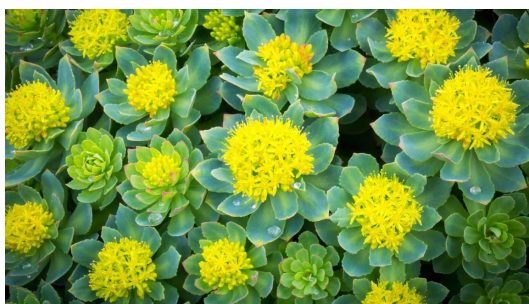


Fig. 3. Image of Rhodiolarosea

**D. Eleutherococcussenticosus**

**Botanical Source:**

- Dried roots and rhizomes of *Eleutherococcussenticosus*[Rupr. & Maxim.] Maxim. belonging to the Araliaceae family.

**Geographical Distribution:**

- Found in Eastern Siberia, North Korea, and Northeast China, typically in mountainous forests.

**Macroscopic Characteristics:**

- *Roots:* Long, cylindrical, and branched, with a grayish-brown bark and numerous fine rootlets.
- *Rhizome:* Stout and woody, often bearing scars from previous aerial stems.

**Microscopic Characteristics:**

*Root:*

- *Cork:* Multiple layers of cork cells.
- *Secondary Phloem:* Well-developed with sieve tubes, companion cells, and phloem parenchyma.
- *Xylem:* Consists of vessels, tracheids, wood fibers, and xylem parenchyma.
- *Characteristic feature:* Presence of starch grains in parenchyma cells.

**Chemical Constituents:**

- *Eleutherosides:* Triterpene glycosides, such as eleutheroside B and eleutheroside E, are the major bioactive compounds. They exhibit adaptogenic, immunomodulatory, and anti-inflammatory properties.
- *Lignans:* Syringaresinol and matairesinol are present in smaller amounts.
- *Polysaccharides:* Eleutherococcus polysaccharides exhibit immunomodulatory and antitumor activities.[23]



Fig. 4. Image of Eleutherococcus senticosus

### III. MECHANISM OF ACTION OF ADAPTOGENS

#### A. Ashwagandha

Ashwagandha [Withaniasomnifera] is an adaptogenic herb traditionally used in Ayurvedic medicine to combat stress. Its potential to influence stress hormones, particularly cortisol, has garnered significant scientific attention.

##### *Impact on Cortisol:*

- **Cortisol Reduction:** Several studies have shown that Ashwagandha supplementation can significantly reduce cortisol levels in individuals experiencing chronic stress.
- **By modulating the hypothalamic-pituitary-adrenal [HPA] axis,** Ashwagandha may help regulate cortisol production and prevent excessive release in response to stressors.
- **HPA Axis Regulation:** Ashwagandha may exert its effects by modulating the activity of key neurotransmitters and hormones involved in the HPA axis, such as GABA, serotonin, and dopamine.

##### *Influence on Adrenaline and Noradrenaline:*

- **Sympathetic Nervous System Modulation:** While the direct impact of Ashwagandha on adrenaline and noradrenaline levels requires further investigation, it may indirectly influence these hormones by modulating the activity of the sympathetic nervous system.
- Ashwagandha may help to downregulate the sympathetic nervous system, which is responsible for the "fight-or-flight" response and the release of adrenaline and noradrenaline.[15]

##### *Reduction of Oxidative Stress and Inflammation:*

Chronic stress can lead to increased oxidative stress and inflammation throughout the body. Ashwagandha may offer protection against these detrimental effects through several mechanisms:

##### *Antioxidant Properties:*

- Ashwagandha contains various compounds, including withanolides and flavonoids, which possess potent antioxidant properties.
- These compounds can neutralize free radicals, reducing oxidative damage to cells and tissues.

##### *Anti-inflammatory Effects:*

- Ashwagandha has been shown to exhibit anti-inflammatory properties by inhibiting the production of pro-inflammatory cytokines such as TNF-alpha and IL-6.
- This can help to reduce inflammation associated with chronic stress, such as inflammation in the cardiovascular system and the brain.[16]

##### **Overall Stress Response:**

By modulating the HPA axis, reducing oxidative stress, and mitigating inflammation, Ashwagandha may help the body adapt more effectively to stressors. This can lead to a more balanced stress response, improved mood, and enhanced overall well-being.



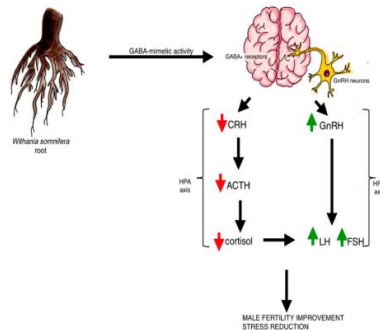


Fig. 5. Image of Stress Reduction through Ashwagandha Root

### B. Panax Ginseng

Panax ginseng, often referred to as "Asian ginseng," is another well-known adaptogen with a long history of use in traditional Chinese medicine. Like Ashwagandha, ginseng has demonstrated potential in modulating the stress response.

#### **Impact on Cortisol**

- **Cortisol Regulation:** Studies have shown that ginseng may help regulate cortisol levels, particularly in response to acute stressors.
- **HPA Axis Modulation:** Ginseng may influence the HPA axis by modulating the release of corticotropin-releasing hormone [ CRH ] from the hypothalamus, thereby regulating cortisol production.[17]

#### **Influence on Adrenaline and Noradrenaline**

- **Sympathetic Nervous System Modulation:** Similar to Ashwagandha, ginseng may indirectly influence adrenaline and noradrenaline levels by modulating the sympathetic nervous system.
- Ginseng may help to downregulate the sympathetic nervous system, reducing the release of these stress hormones.[18]

#### **Reduction of Oxidative Stress and Inflammation**

- **Antioxidant Properties:** Ginseng contains various compounds, including ginsenosides, which possess antioxidant properties. These compounds can help neutralize free radicals, reducing oxidative damage associated with stress.
- **Anti-inflammatory Effects:** Ginseng has been shown to exhibit anti-inflammatory properties by inhibiting the production of pro-inflammatory cytokines. This can help reduce inflammation associated with chronic stress.[19]

#### **Overall Stress Response**

By modulating the HPA axis, reducing oxidative stress, and mitigating inflammation, ginseng may help the body adapt more effectively to stressors. This can lead to a more balanced stress response, improved mood, and enhanced overall well-being.

### C. Rhodiolarosea

Rhodiolarosea, an adaptogenic herb, has gained attention for its potential to modulate the stress response. While research is ongoing, here's what we know about its influence on stress hormones:

#### **Cortisol Regulation:**

- **Reduced Cortisol Levels:** Studies suggest that Rhodiolarosea may help reduce elevated cortisol levels in response to acute and chronic stress.
- **HPA Axis Modulation:** This effect might be due to Rhodiola's ability to modulate the activity of the hypothalamic-pituitary-adrenal [ HPA ] axis, the primary system responsible for regulating the body's stress response.[20]

#### **Influence on Adrenaline and Noradrenaline:**

- *Sympathetic Nervous System Modulation:* Rhodiolarosea may also influence the activity of the sympathetic nervous system, which is responsible for the "fight-or-flight" response and the release of<sup>1</sup> adrenaline and noradrenaline.
- *Reduced Sympathetic Activity:* Some studies suggest that Rhodiola may help downregulate the activity of the sympathetic nervous system, leading to a reduction in the release of these stress hormones.[21]

#### ***Reduction of Oxidative Stress and Inflammation***

- Chronic stress can lead to increased oxidative stress and inflammation throughout the body. Rhodiolarosea may offer protection against these detrimental effects through several mechanisms:
- *Antioxidant Properties:* Rhodiolarosea contains various compounds, including flavonoids and phenolic acids, which possess antioxidant properties. These compounds can help neutralize free radicals, reducing oxidative damage to cells and tissues.
- *Anti-inflammatory Effects:* Rhodiolarosea has been shown to exhibit anti-inflammatory properties by inhibiting the production of pro-inflammatory cytokines such as TNF-alpha and IL-6. This can help to reduce inflammation associated with chronic stress.[22]

#### ***Overall Stress Response***

- By modulating the HPA axis, reducing oxidative stress, and mitigating inflammation, Rhodiolarosea may help the body adapt more effectively to stressors. This can lead to a more balanced stress response, improved mood, and enhanced overall well-being.

#### **D. Eleutherococcus sibiricus**

Eleutherococcus sibiricus, also known as Siberian ginseng, is another adaptogenic herb traditionally used in traditional Chinese medicine to enhance physical and mental performance and reduce stress.

While research on its direct effects on specific stress hormones is limited compared to Ashwagandha, some studies suggest potential mechanisms:

- *HPA Axis Modulation:* Some studies suggest that Eleutherococcus sibiricus may help regulate the HPA axis, although the exact mechanisms are not fully understood. It may influence the release of corticotropin-releasing hormone [CRH] from the hypothalamus, which is a key regulator of the HPA axis.
- *Sympathetic Nervous System Modulation:* Similar to Ashwagandha, Eleutherococcus sibiricus may also influence the sympathetic nervous system, helping to downregulate its activity and reduce the release of adrenaline and noradrenaline.[ 23, 24]

#### ***Reduction of Oxidative Stress and Inflammation***

Like Ashwagandha, Eleutherococcus sibiricus may also help reduce oxidative stress and inflammation, which are closely linked to the stress response:

- *Antioxidant Properties:* Eleutherococcus sibiricus contains various compounds, including eleutherosides and lignans, which possess antioxidant properties. These compounds can help neutralize free radicals, reducing oxidative damage to cells and tissues.
- *Anti-inflammatory Effects:* Studies have shown that Eleutherococcus sibiricus may have anti-inflammatory effects by inhibiting the production of pro-inflammatory cytokines such as TNF-alpha and IL-6. This can help reduce inflammation associated with chronic stress.[ 24]

#### ***Overall Stress Response***

By potentially modulating the HPA axis, reducing oxidative stress, and mitigating inflammation, Eleutherococcus sibiricus may contribute to a more balanced stress response, improved mood, and enhanced overall well-being. However, more research is needed to fully understand its effects on specific stress hormones and the underlying mechanisms.

#### IV. FORMULATION OF ADAPTOGENS

The combination of adaptogens in the preparation of adaptogenic supplements usually follows a synergistic effect, ensuring that the various benefits are maximized. Following is a description of each of the adaptogen formulations and their combinations for enhanced efficacy.

##### A. Ashwagandha [*Withaniasomnifera*] Formulation

###### Formulation Considerations

- Standardized Extract: Standardized Ashwagandha extract is mainly 5% withanolides. This is primarily used for a consistent formulation of the product while maximizing therapeutic potency.
- Capsules/Tablets: Ashwagandha is often taken in capsule or tablet form, with a common dose between 300 mg and 600 mg per day.
- Powder: Ashwagandha powder can be added to smoothies, teas, or health drinks. The powder is less concentrated but still effective.
- Liquid Extract: A tincture form of Ashwagandha is helpful for rapid absorption and can be taken in small doses.

**Recommended Dosage:** For treating stress and maintaining good mental health, a typical recommended dose of standardized extract is in the range of 300 to 600 mg/day.

##### B. Panax Ginseng [*Panax ginseng*] Formulation

###### Formulation Consideration

- Standardized Extract: Panax ginseng is most often standardized to 10-20% ginsenosides, to assure composition and potency.
- Capsules/Tablets: The most popular form of supplementing with Panax ginseng is capsules. The dose is 200 mg to 400 mg a day.
- Powder: Ginseng powder can be added to tea, smoothies, or energy drinks. It is suitable for those looking for natural energy boosters.
- Tincture: A tincture of Panax ginseng offers quick absorption. It is perfect for people requiring rapid mental and physical stimulation.

**Recommended Dosage:** Recommended dosages of Panax ginseng vary between 200 to 400 mg per day. The dosage, however, is contingent upon the concentration of active compounds and specific health goals.

##### C. RhodiolaRosea Formulation

###### Formulation Considerations:

- Standardized Extract: RhodiolaRosea is standardized to 3% rosavins and 1% salidroside.
- Capsules/Tables: Majorly, it is in capsular or in tabular forms that the Rhodiola extracts are found with standardized doses of 200mg to 400mg per day.
- Powder: The Rhodiola powder mostly comes in utilization for smoothies, teas and energy drinks where it may be less concentrated compared to the capsule dosage but will suffice when used persistently.
- Tincture: It is particularly helpful for Rhodiola Tincture persons who are more interested in using fast-absorbing, not-so-hassle types.

**Recommended Dosage:** Typical dosage of RhodiolaRosea is between 200 to 400 mg per day. However, higher doses may be required in clinical studies to address certain health issues.

##### D. EleutherococcusSenticosus[Siberian Ginseng] Formulation

###### Formulation Considerations:

- Extract: Standardized to 0.8-1.2% eleutherosides for efficacy and consistency.
- Capsules/Tablets: The most common form is capsules or tablets, with a dose of 300 mg to 500 mg per day.

- Powder: It can be added to smoothies, teas, or health drinks for convenience. The powder is less potent but can be used for general well-being and energy support.
- Tincture: A liquid extract is also available for the tincture form for those who prefer.

**Recommended Dosage:** The average dosage is between 300 and 500 milligrams per day, although dosages may be higher depending on the health professional.

#### **Combination of Adaptogens: Synergy and Formulation Considerations**

Although the four adaptogens can be used in isolation, formulating them into a multi-adaptogen preparation will enhance the therapeutic effects based on their synergistic properties. The dosing of each herb should be considered in the preparation of a multi-adaptogen supplement to avoid over-burdening the body and potentially causing harm.

Some key considerations for using these four together are:

#### **Synergistic Benefits:**

- Ashwagandha, Panax ginseng, RhodiolaRosea, and EleutherococcusSenticosus all target different aspects of stress, mental clarity, physical performance, and overall vitality. Combining these herbs allows for a comprehensive approach to stress management and energy enhancement.
- Ashwagandha and Rhodiola can help reduce stress and anxiety, while Panax ginseng and EleutherococcusSenticosus improve energy and cognitive function.

#### **Formulation Strategy:**

- Standardized Extracts: Use standardized extracts of each herb to ensure the desired potency. For example, a typical combination might include 300 mg of Ashwagandha[with 5% withanolides], 200 mg of Panax ginseng standardized to 10% ginsenosides, 200 mg of RhodiolaRosea standardized to 3% rosavins, and 300 mg of EleutherococcusSenticosus standardized to 1% eleutherosides.
- Capsules/Tab: Design a capsule of well-balanced formulation. Average dosage might consist of 1-2 capsules administered twice in a day.
- Powder Formulation: Powder formulation may be added to a beverage. Keep the amount per serving appropriate to be within safety dosage range yet not losing the effectiveness.

#### **Target Market:**

- Stress and Anxiety: The combination of Ashwagandha and RhodiolaRosea is best suited for those who experience high stress and anxiety.
- Fatigue and Energy: In the case of fatigue, the addition of Panax ginseng and EleutherococcusSenticosus would help increase energy and endurance as well as support the adrenal glands.
- Cognitive function and mental clarity: The mixture of Panax ginseng and RhodiolaRosea gives a considerable cognitive enhancement.

### **V. APPLICATIONS AND USES IN MODERN LIFE**

#### **Stress and Anxiety Management:**

Workplace stress is steadily on the rise, with millions of employees worldwide affected by it. According to the American Institute of Stress, in a survey conducted in the US, it was found that 83% of its workers were under stress due to their work, while 25% reported their stress level as either "high" or "extremely high" [ 1 ] . Chronic stress at the workplace can lead to:

- Decreased productivity
- Increased absenteeism
- Burnout
- Mental health issues [ e.g., anxiety and depression]

**Adaptogens in Workplace Wellness:** Adaptogens generally come to prosper in workplaces as mechanisms to build resilience in employees, enhance mental clarity, and lower anxiety and fatigue [2,3].

**Enhancing Cognitive Function and Focus:** Various adaptogens, including *Rhodiolarosea* and *Panax ginseng*, have been known to enhance concentration, cognitive function, and overall mental performance [3,4]. In high-stress settings, where getting things done quickly and focusing are important, these adaptogens boost efficiency in workplaces.

**Treating Burnout:** Adaptogens like *Rhodiola* and *Eleutherococcus*[Siberian Ginseng] are renowned for their effectiveness in combating fatigue. They help individuals recover after stressful periods and even decrease burnout potential [4, 5].

**Emotional Clarity:** Adaptogens such as *Ashwagandha* and *Holy Basil* can calm the mind and greatly reduce anxiety, building resilience in emotional support. This can be particularly beneficial in the workforce, where emotional control is essential in a high-stress environment [6, 7].

**In Case of Anxiety:** The use of *Ashwagandha* has been researched to effectively decrease cortisol levels and enhance GABA activity in the brain, thereby acting as a potent management tool for anxiety [ 2,6] .

**For Depression – Antidepressant Effects:** *Rhodiola* has antidepressant-like effects and contributes to mood stabilization and less fatigue [3, 4].

**Integration of Adaptogens with the Application of Therapy:** Many mental health professionals are now interested in using adaptogens alongside psychotherapy and medication to treat chronic stress, anxiety, and depression in patients [8].

**Personalized Wellness Plans:** Mental health professionals can establish personalized wellness plans including adaptogens to target specific symptoms such as insomnia, anxiety, or low energy [8].

**Constant Monitoring:** Regular monitoring of the side effects of adaptogens on sleep, mood, etc., helps in tweaking the remedy [8].

**Adaptogens for Overall Lifestyle Support:** Apart from work-related pressure, stressors at the personal level—such as relationships, finances, and lifestyle demands—tend to overwhelm individuals. Adaptogens ease the effects of these personal stressors for an overall improved quality of life [8].

**Assisting Sleep:** Adaptogens like *Ashwagandha* and *Holy Basil* can benefit sleep through cortisol level regulation and relaxation [6,7].

**Enhancing Physical Health:** Adaptogens support the immune system, reduce inflammation, and energize the body [9].

**Support for Mental Resilience:** Adaptogens help individuals build resilience needed to bounce back from life's inevitable challenges [8].

**Adaptogens for Students and Academic Performance:** Students, especially those under heavy academic pressure or preparing for exams, can benefit greatly from adaptogens to enhance focus, memory, and cognitive resilience [6,7].

**Enhancing Memory and Learning Capacity:** *Bacopamonnieri* and *Ginkgo biloba* have been studied for their cognitive-enhancing effects, improving memory and learning ability [6,7].

**Managing Exam Stress and Anxiety:** Pressure in academics often leads to stress, causing cognitive impairment and poor performance. *Ashwagandha* and *Rhodiola* are effective in reducing exam anxiety while enhancing concentration and clarity [2,3].

**Increasing Focus and Attention for High-Pressure Tasks:** Adaptogens like *Panax ginseng* improve focus, attention, and mental clarity, making them ideal for individuals working under tight deadlines or high cognitive demand [3,4].

**Cognitive Decline in the Corporate Arena:** Infusing adaptogens into daily activities reduces burnout and its cognitive impacts. Corporate wellness programs now incorporate adaptogens to boost productivity, reduce absenteeism, and enhance job satisfaction [8].

## VI. CONCLUSION

Adaptogenic herbs are becoming increasingly well-known as an innocuous and effective herbal stress management therapy in the modern era of life. Plants that originate from traditional medical systems, such as Ayurveda and Traditional Chinese Medicine, have shown potential in developing resistance to emotional, mental, and physical stressors. Scientific evidence supports ever more applications and complex modes of action due to which, in adaptations of HPA axis and with stress chemicals including cortisol, changes in response is one among several kinds offered by



adaptogens. For example, it was demonstrated that there is special efficiency through restoration in cortisol level in the ashwagandha or more widely known as *Withaniasomnifera* with *Rhodiarosea* while improving the aspects of cognition functions and inhibiting fatigue

They continue to perform their function, including the reduction of anxiety, depression, and burnout, by altering the system of neurotransmitters serotonin, dopamine, and GABA [4]. They also possess anti-inflammatory and antioxidant properties that simply prevent the body from experiencing the adverse effects of chronic stress: both systemic inflammation and oxidative stress

Adaptogens are not only used as a means of stress relief but have diversified applications from physical rehabilitation to mental health treatments, workplace wellbeing, and even some aspects of cognitive improvement. *Eleutherococcus senticosus* helps build endurance and athletics, whereas *Rhodiarosea* improves focus and productivity. Adaptogens have been used as a means of recovery against long term stress-related diseases like metabolic disorders, immunological problems, and heart disease

For holistic health, there is great potential in using them as adjunctive therapies along with traditional drugs.

Overall, adaptogens are safe and are well-tolerated by the majority. Most studies had minimal adverse effects, but their effects can be diverse in various people. The administration of certain adaptogens, like pregnant or nursing women, should be managed cautiously, or they may cause complications with other drugs. Since the focus has mainly been on short-term outcomes, long-term safety and efficacy have not been studied much. Right selection of adaptogen and the right dose is necessary. It also requires professional intervention because herbal products are generally heterogeneous in quality and standardization.

Though great potential is posed by these medicines, challenges persist. Among these are the issues of lack of standardization of adaptogen formulation, variation of active substances, and incomplete understanding of their actual molecular mechanism. Study gaps also speak to the urgent need for good and reliable research, particularly with regard to long-term effects and potential for extended usage. It can only then take care of all these issues in order to render the medicine safe and successful for use in the context of routine clinical practice.

Adaptogens hold a great deal of promise to increase the possibilities of stress management treatment in the coming future. By potentially expanding fields of application, future research can continue to discover novel, potent adaptogenic chemicals and elucidate mechanisms. The use of adaptogens and their significance in helping mankind become more resilient in this world that is progressively getting stressed would increase with knowledge of holistic health.

In Conclusion, one of the natural scientifically-supported promising strategies for handling stress reduction is the use of adaptogens. Adaptogens can be described as a whole approach to healthy living, resilience, and quality life because they provide a bridge between knowledge from traditional resources and contemporary science.

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