American Journal of Biomedical Science & Research

www.biomedgrid.com

ISSN: 2642-1747

Review Article

Therapeutic Potential of Medicinal Plants in Hypothyroidism and Hyperthyroidism: A Comprehensive Review

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***To Cite This Article:** Abhilash Choudhary, Gayatri Rai, Shashank Shakyawal and Payal Mahobiya*. Therapeutic Potential of Medicinal Plants in Hypothyroidism and Hyperthyroidism: A Comprehensive Review. Am J Biomed Sci & Res. 2025 27(6) AJBSR.MS.ID.003624,* **DOI:** 10.34297/AJBSR.2025.27.003624

Received: June 23, 2025; **Published:** July 29, 2025

Abstract

Thyroid disorders, which mostly relate to hypothyroidism and hyperthyroidism, are common endocrine illnesses that significantly impact the world's population. Numerous factors, like immunological dysfunction, environmental exposures, dietary habits, and nutrient imbalances, might contribute to illnesses. The usual course of treatment consists of suppression therapy or synthetic hormone replacement. Research into the potential of natural and plant-based medicines to modify thyroid function through anti-inflammatory, antioxidant, and hormone-regulating mechanisms has increased due to growing interest in these treatments. This review provides a comprehensive overview of the pathophysiology of thyroid disorders, considering the effects of dietary factors and environmental exposures on thyroid health. A comprehensive review of the medicinal plants used to treat thyroid disorders is provided, explaining how they modify the level of thyroid hormones, decrease thyroperoxidase activity, and regulate oxidative stress. Herbal remedies such as *Withania somnifera, Nigella sativa, Moringa oleifera*, and others are showing encouraging results in treating both hypothyroid and hyperthyroid diseases. According to the study, more clinical research is required to demonstrate effectiveness and provide a standardised dose that is safer to use for extended periods. A more thorough and customised approach to the treatment of thyroid disorders may result from combining these natural medicines with conventional therapies.

Keywords: Hypothyroidism, Hyperthyroidism, Thyroperoxidase, Antioxidant, Medicinal Plants

Introduction

Thyroid dysfunction can be directly associated with the elevated (hyperthyroidism) or decreased production of hormones by the thyroid gland. Thyroid disorders are common and tend to be more frequent with aging. Clinical thyroid illness affects 0.8% to 7.5% of the population, while subclinical thyroid disease impacts 5% to 9% of the population. Thyroid hormones, which serve two vital purposes, are the only known iodinated molecule with biological activity that contains iodine. They are one of the trigger factors that facilitate normal growth in humans and animals, especially in the CNS (Central Nervous System) [24,17]. The thyroid gland regulates the development, metabolism, homeostasis, and activities of the cell by releasing Thyroid Hormones (THs), mostly in the form of Thyroxine (T4) and the more active Triiodothyronine (T3). Mostly, T3 is formed through the deiodination of T4. THs exert their actions through binding to their respective receptors known as TRα and TRβ, which govern gene expression. The hypothalamus and pituitary glands are involved in the feedback loop that maintains the T3 and T4 levels. Both subclinical (abnormal TSH with normal T3/T4) and clinical (low TSH, T3, and T4) thyroid disorders are common and increase with age [11]. In contrast to clinical situations, subclinical illnesses frequently do not need therapy. Given the elevated risk of consequences, especially in older persons, early identification is essential [27].

Hypothyroidism

Hypothyroidism is the clinically most common thyroidal ailment, with an approximate 2% prevalence in adult females and 0.2% in adult males, with the elderly population being more affected [34,61]. Primary gland dysfunction is the hypothyroidism's main cause, while pituitary and hypothalamic abnormalities are considered secondary. With sufficient iodine, Hashimoto's thyroiditis is the primary causative factor; whereas iodine deficiency is the predominant culprit on a global scale [48]. Characteristic autoimmune features include lymphocyte tissue invasion and immune response mediating the destruction of active hormones. Many countries have effective policies to screen every newborn for Congenital Hypothyroidism (CH), a condition regarded as a major preventable cause of intellectual disability. In subclinical forms of the condition, FT4 is normal, but TSH is elevated [38]. Symptoms in older women, particularly those who have recently given birth, are vague and nonspecific. The most prevalent ones include menstruation irregularities, skin problems, sadness, exhaustion, and easy weight gain. Diagnosis is based on measuring antibodies and hormone levels. The treatment of choice is levothyroxine, while the most sensitive population is extrapolated by risk factors and age. Thyroid function tests done six weeks after initiating therapy evaluate TSH-dependent feedback [55].

Hyperthyroidism

Hyperthyroidism is the excessive concentration of the hormones released by the thyroid gland. It is essentially the increased function of the gland referring to an excess metabolic state due to the increased synthesis or secretion of hormones from the gland [6]. The prevalence of hyperthyroidism is 0.2%-0.5% in women, which is nearly 10 times higher in men. Grave's disease, which causes antibodies to build against TSH receptors that activate the thyroid gland and enhance thyroid hormone synthesis, is the main cause of hyperthyroidism in iodine-rich areas [40]. One of the main causes of hyperthyroidism in regions with a high prevalence of iodine deficiency is the overproduction of thyroid hormone brought on by toxic adenoma and toxic goiter [44]. A mild form of hyperthyroidism is called subclinical hyperthyroidism. When the concentration of FT4 is within the reference range, it is linked to low TSH levels (below the reference range). TSH levels in the serum are used to diagnose hyperthyroidism [49]. The concurrent testing of T4 improves the accuracy of the diagnosis. To confirm a suspected diagnosis of T3 toxicity, free T3 levels can be useful. When antibodies against the TR are present, Graves' disease might be diagnosed [25].

Natural Product

According to the World Health Organization (WHO), many in the population depend upon natural products, including natural medicines. [16] Natural materials, such as plants, marine life, animals, and fermentation products from microorganisms, have been utilized in traditional remedies for all recorded history. The extraction of active chemical components from ethnopharmacological plants has been made possible by the historical usage of natural products as therapeutic agents. This helps with the continuous process of developing new drugs [60,70]. Around the world, people frequently employ plants to manage and cure a variety of medical conditions. People use a variety of plant elements, including the leaves, bark, flowers, fruits, and stems [16]. On the other hand, venoms and biological oils are also utilized to treat a variety of illnesses. Among the medications derived from animal sources are insulin, heparin, adrenaline, thyroxin, musk, beeswax, enzymes, and antitoxins. An essential traditional technique for enhancing the effectiveness or minimizing side effects of herbal medications is fermentation. It has been demonstrated that the fermentation process enhances the biological characteristics of herbs, vegetables, and plants. More precisely, fermentation breaks down and bio-transforms complicated substrates into suitable parts, which modifies the quantity of some bioactive chemicals or the qualities of the final product [31].

Plants and Thyroid Disorder

The biological system is impacted by a variety of secondary metabolites found in plants, including phenols, phenolic acids, flavonoids, alkaloids, tannins, quinones, coumarins, saponins, terpenoids, triterpenoids, glycosides, and organic acids. The data from many experiments have shown that many flavonoids could inhibit thyroperoxidase activity, lowering the level of thyroid hormone, thus increasing TSH levels, causing goiter. Additionally, flavonoids impact the availability to necessary target tissues by blocking deiodinase activity, which interferes with numerous aspects of thyroid hormone production and availability [73] (Tables 1-3).

Table 1: Environmental Factors Affecting Thyroid Function and Autoimmune Thyroiditis.

Factor	Source/Examples	Mechanism of Action	Supporting Studies/Notes
Organochlorine Compounds	Pesticides	Induce hepatic enzymes, decrease serum T4 half-life	*Sirikul & Sapbamrer, et al.,* (2023) [65]
Isoflavones	Found in various plant-based foods	Inhibit Thyroperoxidase (TPO) activity	*Nakamura, et al.,* (2017) [51]
Industrial Chemicals	Polychlorinated Biphenyls (PCBs), Polybrominated Diphenyl Ethers (PBDEs), Bisphenol-A, Triclosan	Direct action on thyroid hormone receptors	*Guo, et al.,* (2019) [28]
Perchlorates, Thiocyanates, Nitrates	Rocket fuel, water contaminants, and certain foods	Interfere with iodine uptake; linked to lower T4 and higher TSH in pregnant women.	*Steinmaus, et al.,* (2016) [67]
Cosmetics (UV Filters)	Benzophenone-2, Octyl-Methoxycinnamate (OMC)	Decrease T4 and/or T3, increase TSH, alter TPO activity	*Krause, et al.,* (2018) [43]
Heavy Metals	Cadmium, lead (industrial pollution)	Alter T3/T4 levels; may stimulate thyroid autoimmunity	*Sun, et al.,* (2019) [68]
Bromine & Bacterial LPS	Environmental exposure, microbial components	Trigger autoimmune thyroiditis in genetically predisposed mice	*Feiteiro, et al.,* (2021) [23]
Smoking	Tobacco smoke	Inversely related to thyroid auto-antibodies and TSH levels (protective effect noted)	*Zhang, et al.,* (2019) [78]
Age (Menopause-related Changes)	Perimenopausal and menopausal women	Hormonal imbalance (estrogen/progesterone); mixed evidence with goitrogen (genistein) use	*Frank-Raue & Raue, et al.,* (2023) [26]

Table 2: Various dietary components and environmental exposures that influence thyroid function through mechanisms such as hormone synthesis inhibition, immune modulation, and enzyme interference, particularly in genetically susceptible individuals.

Factor	Source/Examples	Mechanism of Action	Supporting Studies/Notes
Excess Dietary Iodine	Kelp seaweed, iodinated salt, iodine in bread/flour, amiodarone, Lugol's iodine, contrast dyes, vitamins	Triggers thyroiditis in genetically susceptible individuals; highly iodinated thyroglobulin is more immunogenic; promotes oxidative stress and immune stimulation	*Karbownik-Lewińska, et al.,* (2022) [36]
Goitrogens	Cabbage, cauliflower, broccoli, turnip, cassava, legumes, amiodarone, and lithium	Inhibit iodine uptake and thyroid hormone synthesis; interfere with thyroid function.	*Bouga, et al.,* (2015) [16]
Soy & Soy Products	Soy milk, tofu, soy flour	Decreases T4 absorption, interferes with thyroid hormone action; goitrogenic in infants; increases medication dose requirement in hypothyroid patients	*Caprio, et al.,* (2022) [17]
Dietary Fat Composition	Saturated, Monounsaturated (MUFA), and Polyunsaturated Fats (PUFA: n-3, n-6)	Alters TSH secretion, TPO activity, deiodinase function; affects thyroid hormone levels and receptor binding	*Zhao, et al.,* (2024) [79]
Green Tea	Green tea extract, catechins	Decreases T3, T4; increases TSH; inhibits TPO and 5'-deiodinase activity	*Chandra & De, et al.,* (2013) [19]
Millet	Millet bran (rich in C-glycosylflavones)	Inhibits TPO activity; increases thyroid weight; mimics methimazole-like effect	*Anitha, et al.,* (2024) [8]
Micronutrient Deficiencies	Selenium, Vitamin B12	Contribute to autoimmune thyroiditis; essential for thyroid function and immune regulation.	*Shulhai, et al.,* (2024) [62]

Table 3: Mechanistic Insight into the Use of Natural Compounds for Treating Hypothyroidism and Hyperthyroidism.

Natural Compound	Effect	Mechanism	References
Nigella sativa (Black seed)	Hypo-/Hyperthyroidism	Increases TT3 in hypothyroidism; decreases TT3 in hyperthyroidism; antioxidant; reduces oxidative stress; stimulates thyroid regeneration	*Avci, et al.,* (2022); *Tajmiri, et al.,* (2016); *Tekieh, et al.,* (2019); *Wani, et al.,* (2022) [12,69,71,77]
Withania somnifera (Ashwagandha)	Hypothyroidism	Enhances T3, T4; decreases TSH; antioxidant; regulates thyroid profile; modulates inflammation	*Namdev; et al.,* (2023); *Sharma, et al.,* (2018) [52,59]
Zingiber officinale (Ginger)	Hypothyroidism	Antioxidant; reduces oxidative stress; anti-inflammatory	*Al-Amoudi, et al.,* (2018); *Ashraf H, Zarshenas MM et al.,* (2022) [5,9]
Moringa oleifera	Hypo-/Hyperthyroidism	Antioxidant modulates oxidative stress and thyroid hormones	*Alam et al.,* (2021); *Kou, et al.,* (2018) [3,42]
Aegle marmalos	Hyperthyroidism	Reduces T3, T4 in hyperthyroid models	*Chavan, et al.,* (2024) [20]
Allium sativum (Garlic)	Hyperthyroidism	Lowers T3, T4, raises TSH	*Halbuda, et al.,* (2021) [29]
Aloe barbadensis (Aloe vera)	Hyperthyroidism	Suppresses T3, T4; anti-inflammatory; safe for liver	*Panda, et al.,* (2020); *Smita Naram, et al.,* (2024) [54,66]
Althaea officinalis	Hyperthyroidism	Antioxidant; reduces T3/T4 and blood glucose	*Alam, et al.,* (2023); *Shah et al.,* (2011) [4,58]
Carica papaya	Hyperthyroidism	Affects pituitary-thyroid hormone regulation	*Jabeen, et al.,* (2021) [33]
Emblica officinalis (Amla)	Hyperthyroidism	Reduces lipid peroxidation; regulates T3/T4	*Jabeen, et al.,* (2021) [33]
Trigonella foenum-graecum	Hyperthyroidism	Reduces T3/T4; raises TSH	*Aleebrahim-Dehkordy, et al.,* (2018) [6]
Bacopa monnieri	Hypothyroidism	Increases T3/T4; stimulates T4 production	*Shokri, et al.,* (2018); *Vishwakarma, et al.,* (2016) [61,75]
Citrullus vulgaris	Hypothyroidism	Improves thyroid hormone levels and oxidative status	*Kaur, et al.,* (2016) [38]
Cucumis melo	Hypothyroidism	Improves thyroid and metabolic parameters	*Kaur, et al.,* (2016) [38]
Curcuma longa (Curcumin)	Hypothyroidism	Anti-inflammatory, antioxidant; restores TSH, T3, T4	*Abd, et al.,* (2016); *A. Kumar, et al.,* (2017) [1,45]
Fucus vesiculosus	Hypothyroidism	Iodine-rich; supports thyroid function	*Bhagawati & Dutta, et al.,* (2024); *Hatem & Almayali, et al.,* (2018) [15,30]
Mangifera indica	Hypothyroidism	Improves thyroid function, antiperoxidase activity	*Castellote-Caballero, et al.,* (2025); *Kaur, et al.,* (2016) [18,38]
Mellissa officinalis (Lemon balm)	Hyperthyroidism	Inhibits TSH binding, an antioxidant	*Kawara, et al.,* (2024) [40]
Costus pictus	Hypothyroidism	Restores thyroid hormones; anti-inflammatory; enhances antioxidant activity via nanoform	*Ashwini, et al.,* (2017); *Selvakumarasamy, et al.,* (2021) [10,57]
Citrus paradisi / C. sinensis	Hypothyroidism	Naringenin increases TSH and maintains T4	*Kumar & Abraham, et al.,* (2016); *Miler, et al.,* (2017) [46,50]
Scutellaria baicalensis	Hyperthyroidism	↓ T3, T4; ↑ TSH; daidzein & baicalein active; anti-Graves' activity	*Kim & Lee,* (2019) [41]
Atractylodes macrocephala	Hypothyroidism	↑ T3, T4; affects glycolysis, TCA cycle, and TH receptors	*Chen, et al.,* (2021) [21]

Lycopus europaeus / virginicus	Hyperthyroidism	↓T3, T4, TSH; inhibits T4→T3 conversion; blocks adenylate cyclase	*Al-Snai*, (2019); *Kaplan & Dosiou*, (2021); *Raut & Khamkar*, (2025) [7,35,56]
Annona squamosa	Hyperthyroidism	↓T3, T4, 5'-deiodinase, lipid peroxidation; ↑antioxidant enzymes	*Al Zarzour, et al.*, (2022) [2]
Salvia rosmarinus (Rosemary)	Hyperthyroidism	↓T3, T4; antioxidant; blocks TSH receptor effects	*Kasim et al.*, (2020) [37]
Glycine max (Soy)	Hypothyroidism	Inhibits TPO; increases TSH; autoimmune potential	*Doerge & Sheehan*, (2002) [22]
Pennisetum glaucum (Pearl millet)	Hypothyroidism	Contains goitrogens; disrupts iodine metabolism	*Doerge & Sheehan*, (2002) [22]
Digitaria exilis (Fonio millet)	Hypothyroidism	Goitrogenic; thiocyanate-rich	*Oko, et al.*, (2019) [53]
Brassica spp.	Hypothyroidism	Thiocyanates inhibit iodine uptake and TPO activity	*Trumbo & Ellwood*, (2021) [74]
Manihot esculenta (Cassava)	Hypothyroidism	Cyanogenic glycosides convert to thiocyanate	*Maliki, et al.*, (2021) [47]
Allium cepa (Onion)	Hypothyroidism	Inhibits thyroid activity via disulfide and alcohol compounds	*Wani, et al.*, (2018) [76]
Commiphora mukul (Guggul)	Hypothyroidism	Enhances T3 production; increases iodide uptake and TPO activity	*Iqbal et al.*, (2023); *Singha et al.*, (2019) [32,64]
Coleus forskohlii	Hypothyroidism	Forskolin stimulates T4 via adenylate cyclase	*Singh, et al.*, (2020) [63]
Linum usitatissimum (Flaxseed)	Hypothyroidism	Promotes TH production; rich in fatty acids	*Kauser, et al.*, (2024) [39]
Leonurus cardiaca (Motherwort)	Hyperthyroidism	Inhibits 5-deiodinase; modulates autoimmune response	*Fierascu, et al.*, (2019) [24]
Prunella vulgaris (Self-heal)	Both	Inhibits goiter; modulates immune activity	*Chen, et al.*, (2021) [21]
Lithospermum officinale	Hyperthyroidism	Inhibits peripheral T4 deiodination; blocks TSH receptor	*Barkizatova, et al.*, (2024) [14]
Convolvulus pluricaulis	Both	Regulates liver enzymes; useful in both hypo- and hyperthyroid conditions	*Balkrishna, et al.*, (2020) [13]
Rauvolfia serpentina	Hyperthyroidism	Reduces T3/T4 in experimental hyperthyroidism	*Tewari, et al.*, (2023) [72]

Conclusion

Health can be adversely affected by several common thyroid conditions, such as hypothyroidism and hyperthyroidism. The causes of these complex disorders include genetic, environmental, dietary, and autoimmune factors. Even while synthetic hormones still account for most of the treatments today, interest in natural alternatives is rising. According to preliminary research, several minerals and plants may enhance thyroid function by lowering inflammation, protecting against oxidative stress, and controlling hormones. This review highlights several potential medicinal plants that may help regulate thyroid hormones and alleviate symptoms, including *Nigella sativa* (black seed), *Withania somnifera* (ashwagandha), and *Moringa oleifera*. Although encouraging, further clinical studies using standardized formulations are required before we can make firm recommendations. One day, a more individualized, all-encompassing approach to thyroid health management might be possible with a mix of conventional and natural medicine.

Acknowledgements

This research was financially supported by the UGC Non-NET Fellowship. The authors express their sincere gratitude to the Endocrinology Laboratory, Department of Zoology, School of Biological Sciences, Dr. Harisingh Gour Vishwavidyalaya, Sagar (M.P.), India, for providing the necessary infrastructure and research facilities.

Conflict of Interest

None.

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