International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 13; Issue: 4; April 2026
Website: www.ijrrjournal.com
Review Paper
E-ISSN: 2349-9788; P-ISSN: 2454-2237

The Role of *Rhodiola rosea* in Immunity through a Functional Nutrition Lens

Snigdha Ranjan[1], Anupriya Borah[2], Saloni Kulkarni[3], Mugdha Pradhan[4]

[1,2]M.Sc., Researcher, Thrive Tribe Wellness Solutions Private Limited
[3]M.Sc., Functional Nutritionist, Thrive Tribe Wellness Solutions Private Limited, Pune, India
[4]M.Sc., Expert Functional Nutritionist, Thrive Tribe Wellness Solutions Private Limited, Pune, India

Corresponding Author: Anupriya Borah

DOI: https://doi.org/10.52403/ijrr.20260407

ABSTRACT

Background: *Rhodiola rosea* is an adaptogenic plant that helps maintain bodily functions while handling stress. It contains numerous phytochemicals that deliver health benefits through its anti-inflammatory properties, antioxidant effects, and ability to regulate immune functions. *R. rosea* has emerged to be of importance due to its immune-modulating functional properties.
Objectives: This review examines how *R. rosea* affects the immune system through a functional nutrition lens. The research focuses on stress response modulation, inflammatory signaling, oxidative stress, and immune-related regulatory pathways.
Methods: The narrative review focused on human clinical data, and also used preclinical data to support the findings. The review covered evidence about stress modulation and immune-related signaling together with adaptogenic effects through a functional nutrition framework that specifically studied hypothalamic-pituitary-adrenal (HPA) axis regulation and stress-immune interactions.
Results: Clinical studies demonstrate that R. rosea reduces stress, fatigue, and burnout, indicating that the herb affects the immune system through HPA axis regulation. The preclinical results demonstrate *R. rosea*'s ability to provide anti-inflammatory effects, antioxidant benefits, and support mitochondrial function. The possibility exists that the indirect effects of the herb may have an effect on gut health through immune system function, but scientific human studies remain scarce.
Conclusion: R. rosea provides immune system support through its ability to regulate stress and inflammation according to functional nutrition principles. The existing clinical research about direct immune effects shows that more studies must investigate immunological biomarkers through clinical trials.

Keywords: *Rhodiola rosea*, functional nutrition, adaptogen, stress resilience, immune modulation

1. INTRODUCTION

Chronic inflammation represents an ongoing abnormal immune response that results in tissue damage and contributes to multiple chronic health conditions (1). The body uses acute inflammation to defend itself against injuries and infections, but chronic inflammation leads to autoimmune diseases, infectious diseases, and degenerative diseases. Age-related low-grade inflammation ("inflammaging") increases susceptibility to disease and mortality, and dysregulated innate immunity, including excessive cytokine production, is implicated in conditions such as systemic lupus erythematosus and rheumatoid arthritis (2,3). Physiological stress activates the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system, which results in changes to immune cell distribution and increased production of pro-inflammatory cytokines (IL-6, TNF-α, IL-1β) that sustain immune system imbalance (4).

Metabolic regulation establishes a direct connection with immune function, as human pathways, including glycolysis, oxidative phosphorylation, and fatty acid metabolism, determine how immune cells develop and respond to their environment during both healthy and diseased states (5). Changes in nutrient availability and intracellular energy levels lead to a shift in how immune cells operate, which affects inflammatory outcomes. Dietary nutrients and bioactive food components can modulate these processes by interacting with immune signaling networks to achieve this effect (6). Together, these findings suggest that metabolic pathways, nutrient pathways, and inflammatory pathways work together to establish immune competence according to a systems-based perspective.

Functional foods and plant-derived bioactives are studied not only for their dietary benefits but also for their potential to help people cope with stress through systemic regulation that helps defend against stressful situations (7). Research describes adaptogenic botanicals as plant-based substances that help organisms develop better defenses against stress while supporting their ability to maintain internal body balance during times of medical stress (8). Reviews of adaptogenic herbs show that these plants can affect multiple biological processes because they initiate a stress response while also influencing bodily inflammation, thus making them valuable subjects for study in functional nutrition and systemic balance research (9). The research into *R. rosea* has provided extensive information about its effects on stress and its medicinal properties, yet researchers have not sufficiently investigated its potential to control immune functions in humans. Given the central roles of stress physiology, redox balance, and immunometabolism in immune function, *Rhodiola* may affect these vital processes by modulating upstream systems. This review critically examines current human and translational evidence on *Rhodiola rosea* within a functional nutrition framework and identifies key areas for future investigation.

2. FUNCTIONAL NUTRITION FRAMEWORK FOR IMMUNE REGULATION

This review examines immune function through a functional nutrition perspective, viewing it as an outcome of interconnected bodily systems rather than an isolated process. Physiological stress activates the HPA axis, leading to the secretion of corticotropin-releasing hormone (CRH), adrenocorticotropic hormone (ACTH), and cortisol, which work together to manage stress and impact immune function (10). Acute stress may enhance the body's immunity temporarily, but chronic stress results in decreased T-cell activity and increased production of pro-inflammatory cytokines, which include IL-6, TNF-α, and IL-1β (4,11). Sustained HPA axis activation, therefore, leads to increased production of pro-inflammatory cytokines and decreased capacity of the body to develop adaptive immune responses (10).

The neuroendocrine system uses its stress signaling system to control oxidative stress processes, which create a connection between immune system regulation and redox balance. Reactive oxygen species (ROS) act as immune activation signaling molecules while excessive ROS levels lead to NF-κB activation and other transcription factor activations, which cause chronic inflammation and tissue destruction (4,12). Maintaining antioxidant defenses is therefore vital for resolving inflammation and supporting immune system balance.

Immune responses require high energy, and metabolic regulation forms another key component that helps the body to achieve its immune functions. Immune cell activation, differentiation, and effector responses depend on immunometabolism, which involves altering glycolysis, oxidative phosphorylation, and fatty acid oxidation pathways (4,13). Mitochondria provide ATP and biosynthetic intermediates required for immune cell proliferation and function; dysfunction in these systems can impair immune performance and exacerbate systemic imbalance (13).

Stress pathways, redox pathways, and metabolic pathways work together to show how *R. rosea* may influence immune regulation in humans. *R. rosea* bioactive compounds affect immune outcomes through their role in physiological stress management, redox balance maintenance, and mitochondrial function protection, which demonstrates the importance of a functional nutrition-based systems approach.

3. HUMAN CLINICAL AND TRANSLATIONAL EVIDENCE RELEVANT TO IMMUNE REGULATION

3.1. Stress Reduction and Immune-Relevant Outcomes

Human clinical evidence shows that *R. rosea* supplementation helps people with stress-related problems by reducing their stress symptoms, fatigue, and ability to cope with stress. The results from randomized controlled studies show that *Rhodiola* administration leads to significant decreases in self-reported stress and fatigue when compared to placebo treatment (14). Although these trials focus on measuring psychological outcomes and fatigue outcomes rather than immune markers, chronic stress acts as a well-established driver of immune system disorders, which makes improvements in stress physiology through *Rhodiola* treatment essential for maintaining immune system balance (14).

3.2 Fatigue, Burnout, and Post-Stress States

In clinical studies, *Rhodiola rosea* has shown positive results for treating chronic fatigue and burnout symptoms, improving fatigue scores, cognitive focus, and functional capacity in affected individuals (14). A systematic review noted that *Rhodiola* showed positive effects on physical and mental fatigue according to some human studies, but no definite conclusions were made due to methodological limitations (15). These effects are in accordance with the concept of *Rhodiola* supporting an individual physiologically in regaining resilience in order to cope with stress burden, as opposed to directly stimulating immunity, positioning it as a modulator of stress-related dysregulation, thus having an indirect influence on immune status.

3.3 Infection-Related or Immune-Stress Contexts

One human study investigated the effects of *R. rosea* supplementation on the antiviral immune response of marathon runners who experienced extreme physical stress, which leads to short-term immune system deficiencies. The randomized trial showed that runners who took 600 mg of *Rhodiola* daily for 30 days experienced a slower increase in virus replication after their marathon run, when compared to participants who received a placebo during the *in vitro* testing, which used their serum samples to assess antiviral activity under stress conditions (16). While this finding does not establish direct immune system improvement through biological testing, which protects against infectious diseases, it does suggest that *Rhodiola's* active components can change how humans with acute stress conditions respond to viral replication.

3.4 Limitations of Current Clinical Evidence

Although randomized and controlled trials suggest benefits of *R. rosea* for stress and fatigue, systematic reviews emphasize that many studies have small sample sizes, short durations, and apply different research methods, which restrict their ability to make broad conclusions about general research findings. (14,15). measure primarily through subjective methods, which include stress scales and fatigue questionnaires, while using only a few validated immune biomarkers and inflammatory cytokines as assessment tools. Even in exercise-related models, immune findings rely on indirect or ex vivo assessments rather than clinical infection outcomes (16). Reviews also highlight significant variations in extract composition, including differences in rosavin and salidroside content, as well as inconsistencies in dosing and duration, complicating cross-study comparison and dose-response interpretation (14). Furthermore, risk of bias, incomplete phytochemical data, and limited testing of multiple independent cohorts hinder understanding of the mechanistic processes. The evidence confirms stress-modulating effects, yet there exists insufficient clinical evidence that specifically demonstrates immune responses.

4. PRECLINICAL MECHANISMS OF IMMUNOMODULATION BY *R. rosea*

4.1 Stress Response and HPA Axis Modulation

The extracts of *R. rosea* have been studied to affect central stress response pathways that interact with the HPA axis, which is a critical link between stress response mechanisms and immune system control. The administration of *R. rosea* in rodent models that experienced repeated stress demonstrated a decrease in stress-related increases of both CRH expression and peripheral corticosterone levels, which indicated a reduction of HPA axis activation (17). Reviews of pharmacological data signify that the plant exhibits adaptogenic effects through its ability to change the levels of monoamine neurotransmitters and endogenous opioid peptides, including β-endorphins, which, together with HPA axis regulation, create stress perception effects and neuroendocrine signaling (14). Collectively, these findings suggest that *R. rosea* may influence immune function indirectly through its ability to control body stress responses, which lead to the development of stress-related immune system disorders.

4.2 Inflammatory Signaling and Cytokine Regulation

R. rosea and its bioactive constituents, according to preclinical studies, can help in managing the immune system through their ability to modulate inflammatory signaling pathways. The *R. rosea* extract blocked NF-κB nuclear translocation in a cellular model that studied stress-induced inflammatory response, which depended on NF-κB as a critical transcription factor for pro-inflammatory gene expression (18). Salidroside and other constituents demonstrate the capacity to decrease pro-inflammatory cytokine production, including TNF-α, IL-1β, and IL-6, in both lipopolysaccharide-stimulated microglial cells and in mouse tissues following inflammatory challenge (19,20). Together, these findings provide mechanistic support from *in vitro* and animal models that *R. rosea* may influence pathways central to inflammatory responses, although there remains a need to establish its clinical immune effects on human patients.

4.3 Redox and Immunometabolic Modulation

Salidroside, a principal bioactive constituent of *R. rosea*, has been shown through preclinical studies that it can decrease the generation of reactive oxygen species (ROS) while restoring the mitochondrial membrane potential during metabolic stress conditions, which indicates its ability to protect cells from oxidative damage while supporting mitochondrial functions (21). Excessive ROS can activate transcription factors such as NF-κB, p53, and ATM/ATR, causing activation of pro-inflammatory pathways, mitochondrial dysfunction, and persistent immune dysregulation (12,13). Besides salidroside, *R. rosea* contains flavonoids such as kaempferol and quercetin, which work together to eliminate ROS and control redox-sensitive intracellular systems that help maintain immune balance, but their influence on human immune system functions needs further research to establish (22).

The process of immune cell function depends on cellular metabolism because immune cells use glycolysis and the tricarboxylic acid (TCA) cycle, fatty acid oxidation, and oxidative phosphorylation to activate, differentiate, and execute their functions (23). Mitochondria control energy production and redox homeostasis, influencing immune cell signaling and function (5). Preclinical evidence suggests that *R. rosea* constituents help maintain mitochondrial function while enabling metabolic changes during high-stress situations, which supports its use as a treatment for controlling immune system functions throughout the body. The investigation of redox and immunometabolic processes makes it possible to study how *Rhodiola* affects human biological functions.

4.4 Potential Interaction with the Gut-Immune Axis

Redox and immunometabolic modulation represent only part of the systemic network through which *Rhodiola rosea* may influence immunity. The gut microbiota functions as an essential interface that determines both the strength of inflammatory responses and the health of epithelial tissues and the progress of immune system maturation. The connection between the two variables is backed by preclinical research, which shows that *Rhodiola* changed *Drosophila* gut microbial composition without direct antimicrobial effects (24), while in juvenile *Lateolabrax maculatus,* supplementation resulted in better intestinal barrier function, lower inflammatory response, and partial restoration of gut microbiome balance (25). Phytochemical analyses further indicate that microbial transformation results in the development of antioxidant metabolites (26,27). However, controlled human microbiome data remain absent.

Thus, the key phytochemicals of *R. rosea*, such as salidroside, rosavins, and flavonoids, deserve special attention because they support the plant's antioxidant, immunometabolic, and stress-modulating effects as seen in preclinical and clinical models.

5. KEY PHYTOCHEMICALS OF *Rhodiola rosea*

The biological activity of *R. rosea* results from multiple phytochemicals that exist in its roots and rhizomes instead of depending on a single active compound. Among these, *R. rosea* L. plant contains three specific phenylpropanoid glycosides known as rosavins (rosavin, rosin, and rosarin), which serve as botanical markers for standardizing extracts. Scientists study these compounds to understand how they affect cellular stress-response pathways and redox pathways in experimental models (14).

In addition, the phenolic compound salidroside and its aglycone tyrosol together serve as its primary active ingredients and bring significant bioactive value to the plant's total phenolic content (28). Preclinical studies demonstrate that salidroside impacts oxidative stress responses while it changes inflammatory signaling pathways, including its effects on cytokine expression and immune cell defense functions (22).

Beyond these well-characterized constituents, *R. rosea* contains additional polyphenolic compounds, which include the flavonoids kaempferol and quercetin, along with their glycosides. These compounds show antioxidant and anti-inflammatory effects in experimental models. They also interact with redox-sensitive signaling pathways (22,29).

The combination of these phytochemical properties in *R. rosea* creates a biochemical base that demonstrates its adaptogenic effects and shows its capacity to impact interconnected stress pathways, redox processes, and immunometabolic pathways, which control immune functions.

6. SAFETY AND FUNCTIONAL CONSIDERATIONS

6.1 Tolerability and Contraindications

Human studies on *R. rosea* demonstrate that this herb has high tolerance, according to clinical evidence, which shows that adverse effects occur in rare cases and appear as mild symptoms (30). A systematic review investigated 446 study participants and found only minor adverse events, which included incidents that happened in the placebo groups, and the study showed no reliable instances of severe toxic reactions (15). However, a review emphasizes that there is a need for more controlled studies to have adequate evidence about the long-term safety and effects of the herb on pregnant and lactating women (30).

6.2 Dose Timing and Adaptogenic Use Principles

Clinical trials summarized in pharmacological reviews have shown how *R. rosea* extract doses influence stress, fatigue, and cognitive performance, but they did not establish standard therapeutic dosing guidelines based on the research results (30). A short-term supplementation study with physically active adults used a specific extract protocol but focused on exercise performance outcomes rather than timing-related physiological effects (31). Reviews on plant compounds that impact the HPA axis explain how neuroendocrine stress responds to *R. rosea*, but they lack details about specific administration timing strategies for *R. rosea* in humans (32).

6.3 Quality and Standardization Considerations

Comprehensive reviews about phytochemical analyses show that rosavins and salidroside exist as main components of *R. rosea,* while their concentrations show significant variations based on different species, plant sources, and extraction methods. The same review notes that differences in extract composition complicate the comparison of findings across clinical studies. The study further emphasizes that botanical authentication, together with phytochemical characterization, serves as an essential element that enhances consistency and interpretability for research and clinical applications (30).

7. RESEARCH GAPS AND FUTURE DIRECTIONS

Clinical studies suggest *R. rosea* may enhance stress relief and fatigue reduction and help people build resilience, but research studies rarely include immune-specific measures, thereby showing limited direct effects on immune functions (30). Reviews of human research note that endpoints mainly focus on achieving psychological or performance outcomes instead of measuring inflammatory cytokines and immune cell markers (14). This existing gap between stress research and immune system studies highlights the need for future research to assess both immune parameters and stress-related outcomes.

A second limitation is the gap between mechanistic findings and clinical trial design. Experimental studies describe antioxidant, mitochondrial, and anti-inflammatory actions of *R. rosea* constituents, yet these pathways are rarely examined in human trials (19). The research findings on immunometabolism demonstrate that immune responses depend on the control of cellular energy and redox balance, which establishes the need to include metabolic and immune biomarkers in future human research studies (5).

Finally, variability in extract composition and reporting standards complicates comparison across studies. The research shows that different extraction techniques lead to different amounts of rosavin and salidroside, which results in difficulties reproducing research studies and interpreting medical results (30). Similar concerns are noted in broader reviews of *Rhodiola* preparations used in research (14). Improved Standardization and proper reporting of phytochemical content will be essential for advancing evidence-based functional nutrition applications.

CONCLUSION

Current human evidence supports that *R. rosea* functions as a stress regulator, which also impacts fatigue levels while affecting the body's immune system response. Preclinical studies show that these compounds have anti-inflammatory properties, redox modulation capabilities, and the ability to support mitochondrial function, but there is a lack of clinical studies that test their effects on the immune system. Importantly, existing research shows that *R. rosea* does not function as an immune stimulant but as a modulator, as it affects the primary pathways that control both stress and inflammation to create an indirect impact on immune system activities. Within a functional nutrition framework, *R. rosea* is therefore best understood as an upstream regulator of physiological resilience rather than a direct immune-targeted intervention.

Declaration by Authors

Ethical Approval: Not Applicable
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Yacine A, Ali MZ, Alharbi AB, Alanaz HQ, Alrahili AS, Alkhdairi AA. Chronic Inflammation: A Multidisciplinary Analysis of Shared Pathways in Autoimmune, Infectious, and Degenerative Diseases. Cureus. 2025 Apr 19;17(4).
2. Shive C, Pandiyan P. Inflammation, immune senescence, and dysregulated immune regulation in the elderly. Frontiers in aging. 2022 Apr 27; 3:840827.
3. Akbarzadeh R, Humrich JY, Németh T, Amber KT. Innate immune dysregulation: a driving force of autoimmunity and chronic inflammation. Frontiers in Immunology. 2025 Jun 9; 16:1632416.
4. Alotiby A. Immunology of stress: A review article. Journal of clinical medicine. 2024 Oct 25;13(21):6394.
5. Hu T, Liu CH, Lei M, Zeng Q, Li L, Tang H, Zhang N. Metabolic regulation of the immune system in health and diseases: mechanisms and interventions. Signal Transduction and Targeted Therapy. 2024 Oct 9;9(1):268.
6. Méndez López LF, González Llerena JL, Vázquez Rodríguez JA, Medellín Guerrero AB, González Martínez BE, Solís Pérez E, López-Cabanillas Lomelí M. Dietary Modulation of the Immune System. Nutrients. 2024 Dec 18;16(24):4363.
7. Jahan FM, Razavi SH, Nouri M, Shafiepour M, Afraei M. Unlocking Nature's Potential: The Power of Adaptogens in Enhancing Modern Health and Wellness. Journal of Agriculture and Food Research. 2025 Nov 1:102501.
8. Sharma R, Sharma P, Bhardwaj R. Adaptogens: new age healing gems for physical wellbeing. Am J Multidiscip Res Dev (AJMRD). 2021 Oct;3(10):26-35.
9. Tóth-Mészáros A, Garmaa G, Hegyi P, Bánvölgyi A, Fenyves B, Fehérvári P, Harnos A, Gergő D, Do To UN, Csupor D. The effect of adaptogenic plants on stress: A systematic review and meta-analysis. Journal of Functional Foods. 2023 Sep 1; 108:105695.
10. Nunez SG, Rabelo SP, Subotic N, Caruso JW, Knezevic NN. Chronic stress and autoimmunity: the role of HPA axis and cortisol dysregulation. International journal of molecular sciences. 2025 Oct 14;26(20):9994.
11. Balakin E, Yurku K, Ivanov M, Izotov A, Nakhod V, Pustovoyt V. Regulation of Stress-Induced Immunosuppression in the Context of Neuroendocrine, Cytokine, and Cellular Processes. Biology. 2025 Jan 15;14(1):76.
12. Bellanti F, Coda AR, Trecca MI, Lo Buglio A, Serviddio G, Vendemiale G. Redox imbalance in inflammation: the interplay of oxidative and reductive stress. Antioxidants. 2025 May 29;14(6):656.
13. Zhou NJ, Bao WQ, Zhang CF, Jiang ML, Liang TL, Ma GY, Liu L, Pan HD, Li RZ. Immunometabolism and oxidative stress:

roles and therapeutic strategies in cancer and aging. npj Aging. 2025 Jul 1;11(1):59.
14. Ivanova Stojcheva E, Quintela JC. The effectiveness of rhodiola rosea L. Preparations in alleviating various aspects of life-stress symptoms and stress-induced conditions-encouraging clinical evidence. Molecules. 2022 Jan;27(12):3902.
15. Ishaque S, Shamseer L, Bukutu C, Vohra S. Rhodiola rosea for physical and mental fatigue: a systematic review. BMC complementary and alternative medicine. 2012 May 29;12(1):70.
16. Ahmed M, Henson DA, Sanderson MC, Nieman DC, Zubeldia JM, Shanely RA. Rhodiola rosea exerts antiviral activity in athletes following a competitive marathon race. Frontiers in nutrition. 2015 Jul 31; 2:24.
17. Xia N, Li J, Wang H, Wang J, Wang Y. Schisandra chinensis and Rhodiola rosea exert an anti-stress effect on the HPA axis and reduce hypothalamic c-Fos expression in rats subjected to repeated stress. Experimental and therapeutic medicine. 2016 Jan 1;11(1):353-9.
18. Borgonetti V, Governa P, Biagi M, Dalia P, Corsi L. Rhodiola rosea L. modulates inflammatory processes in a CRH-activated BV2 cell model. Phytomedicine. 2020 Mar 1; 68:153143.
19. Li Y, Pham V, Bui M, Song L, Wu C, Walia A, Uchio E, Smith-Liu F, Zi X. Rhodiola rosea L.: an herb with anti-stress, anti-aging, and immunostimulating properties for cancer chemoprevention. Current pharmacology reports. 2017 Dec;3(6):384-95.
20. Lee Y, Jung JC, Jang S, Kim J, Ali Z, Khan IA, Oh S. Anti-inflammatory and neuroprotective effects of constituents isolated from Rhodiola rosea. Evidence-Based Complementary and Alternative Medicine. 2013;2013(1):514049.
21. Ju L, Wen X, Wang C, Wei Y, Peng Y, Ding Y, Feng L, Shu L. Salidroside, a natural antioxidant, improves β-cell survival and function via activating AMPK pathway. Frontiers in Pharmacology. 2017 Oct 18; 8:749.
22. Bernatoniene J, Jakstas V, Kopustinskiene DM. Phenolic compounds of Rhodiola rosea L. as the potential alternative therapy in the treatment of chronic diseases. International journal of molecular sciences. 2023 Jul 31;24(15):12293.
23. O'Neill LA, Kishton RJ, Rathmell J. A guide to immunometabolism for immunologists. Nature reviews immunology. 2016 Sep;16(9):553-65.
24. Labachyan KE, Kiani D, Sevrioukov EA, Schriner SE, Jafari M. The impact of Rhodiola rosea on the gut microbial community of Drosophila melanogaster. Gut pathogens. 2018 Mar 20;10(1):12.
25. Jafari M, Juanson Arabit JG, Courville R, Kiani D, Chaston JM, Nguyen CD, Jena N, Liu ZY, Tata P, Van Etten RA. The impact of Rhodiola rosea on biomarkers of diabetes, inflammation, and microbiota in a leptin receptor-knockout mouse model. Scientific Reports. 2022 Jun 22;12(1):10581.
26. Olennikov DN, Chirikova NK, Vasilieva AG, Fedorov IA. LC-MS profile, gastrointestinal and gut microbiota stability and antioxidant activity of Rhodiola rosea herb metabolites: A comparative study with subterranean organs. Antioxidants. 2020 Jun 16;9(6):526.
27. Klančnik A, Kunčič A, Smole Možina S, Bucar F. The antibacterial potential and effects of Rhodiola sp. on gut microbiota. Phytochemistry Reviews. 2025 Jun;24(3):2309-28.
28. Kim KJ, Jung YS, You DM, Lee SH, Lee G, Kwon KB, Kim DO. Neuroprotective effects of ethanolic extract from dry Rhodiola rosea L. rhizomes. Food Science and Biotechnology. 2021 Feb 5;30(2):287.
29. Masi F, Chianese G, Hofstetter RK, Cavallaro AL, Riva A, Werz O, Taglialatela-Scafati O. Phytochemical profile and anti-inflammatory activity of a commercially available Rhodiola rosea root extract. Fitoterapia. 2023 Apr 1; 166:105439.
30. Tao H, Wu X, Cao J, Peng Y, Wang A, Pei J, Xiao J, Wang S, Wang Y. Rhodiola species: A comprehensive review of traditional use, phytochemistry, pharmacology, toxicity, and clinical study. Medicinal research reviews. 2019 Sep;39(5):1779-850.
31. Ballmann CG, Maze SB, Wells AC, Marshall MR, Rogers RR. Effects of short-term Rhodiola Rosea (Golden Root Extract) supplementation on anaerobic exercise

performance. Journal of sports sciences. 2019 May 3;37(9):998-1003.

32. Lopresti AL, Smith SJ, Drummond PD. Modulation of the hypothalamic–pituitary–adrenal (HPA) axis by plants and phytonutrients: a systematic review of human trials. Nutritional neuroscience. 2022 Aug 3;25(8):1704-30.

How to cite this article: Snigdha Ranjan, Anupriya Borah, Saloni Kulkarni, Mugdha Pradhan. The role of *Rhodiola rosea* in immunity through a functional nutrition lens. *International Journal of Research and Review*. 2026; 13(4): 74-82. DOI: *https://doi.org/10.52403/ijrr.20260407*

******