



CASE REPORT

EXPLORING THE WONDERS OF NATURE: AN IN-DEPTH ANALYSIS OF NATURAL PRODUCTS AND THEIR SIGNIFICANCE IN AUTISM SPECTRUM DISORDER

*Sakshi Soni, Kalyani Dhatadak, Aman Upaganlawar and Chandrashekhar Upasani

Department of Pharmacology, SNJBs Shriman Sureshdada Jain College of Pharmacy, Chandwad, Nashik

ARTICLE INFO

Article History:

Received 20th July, 2025

Received in revised form

24th August, 2025

Accepted 29th September, 2025

Published online 29th October, 2025

Keywords:

Autism Spectrum Disorder (ASD),
Natural Products, Herbal Medicine,
Cannabidiol (CBD), Dietary
Interventions.

*Corresponding author: Sakshi Soni

ABSTRACT

The complicated neurodevelopmental disorder known as autism spectrum disorder (ASD) is typified by deficits in speech, social interaction, and repetitive behaviours. While behavioural therapy is the main emphasis of traditional therapies and pharmacological interventions, emerging research suggests that natural products offer promising complementary therapeutic benefits. This review explores the role of polyphenols, probiotics, herbal extracts, cannabidiol (CBD), and dietary interventions in ASD management. Antioxidant and anti-inflammatory polyphenols, including resveratrol and curcumin, lower oxidative stress and neuroinflammation, two important aspects of the pathogenesis of ASD. Sulforaphane, derived from cruciferous vegetables, has been shown to improve behavioral symptoms through Nrf2 pathway activation. Probiotic supplementation influences the gut-brain axis, restoring gut microbiota balance and improving ASD-related gastrointestinal and behavioral symptoms. Medicinal herbs like Ginkgo biloba and Centella asiatica modulate neurotransmitter function, enhancing cognitive performance and neural plasticity. Cannabidiol (CBD) demonstrates anxiolytic and neuroprotective effects, reducing aggression and social impairments in ASD individuals. Nutritional strategies, including omega-3 supplements and the gluten-free and casein-free (GFCF) diet, have been explored for their role in alleviating inflammation and behavioral symptoms. Despite these promising findings, challenges such as dosage standardization, bioavailability, and long-term safety remain. To provide individualized, multimodal therapeutic options for the management of ASD, future research should focus on conducting extensive clinical trials that combine natural treatments with traditional therapies.

Copyright©2025, Sakshi Soni et al. 2025. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Sakshi Soni, Kalyani Dhatadak, Aman Upaganlawar and Chandrashekhar Upasani. 2025. "Exploring the Wonders of Nature: An In-Depth Analysis of Natural Products and Their Significance in Autism Spectrum Disorder". *International Journal of Current Research*, 17, (10), 34859-34863.

INTRODUCTION

About 1 in 100 children worldwide suffer from autism spectrum disorder (ASD), a neurodevelopmental disorder marked by limited interests, repetitive activities, and poor social communication. The multifactorial etiology of ASD involves genetic, environmental, and immunological factors, making its diagnosis and treatment highly complex¹. Conventional pharmacological treatments such as antipsychotics and stimulants provide symptomatic relief but often lead to adverse side effects, necessitating the search for safer and more effective therapies². Natural products' neuroprotective, anti-inflammatory, and antioxidant qualities have drawn more attention in recent years, which can address underlying pathophysiological mechanisms of ASD. Polyphenols, including curcumin and theaflavin, have been shown to alleviate oxidative stress and cognitive impairments in ASD models². Probiotic supplementation enhances gut microbiota balance, improving gastrointestinal symptoms and social behavior, underscoring the importance of the gut-brain axis in ASD management³. Cannabinoids, particularly

cannabidiol (CBD), interact with the endocannabinoid system, offering anxiolytic and anti-inflammatory effects that improve behavioral outcomes⁴. Additionally, sulforaphane, a bioactive compound derived from cruciferous vegetables, has demonstrated promising results in clinical trials by modulating antioxidant defenses and reducing neuroinflammation⁵. Traditional medicine practices have also explored herbal formulations like Hiwa syrup, which has shown beneficial effects in improving social interaction and Children with ASD and their communicative abilities⁶. Despite the promising therapeutic potential of natural products, challenges such as bioavailability, dosage standardization, and long-term safety remain unresolved. Large-scale randomized controlled trials should be the main focus of future research to confirm the safety and effectiveness of natural products in the treatment of ASD. In order to shed light on the biochemical processes, clinical results, and potential avenues for future study, this review attempts to present a thorough examination of the available data pertaining to the use of natural products in ASD as mentioned in Figure 1.

Autism Spectrum Disorder (ASD)



Figure 1. Autism Spectrum Disorder (ASD)

Herbal and Traditional Medicines in ASD: The complex neurodevelopmental disorder known as autism spectrum disorder (ASD) is typified by repetitive behaviours, sensory sensitivity, and difficulties with social communication. While conventional treatments focus on behavioral therapy and pharmacological interventions, natural products and dietary supplements are gaining attention for their potential neuroprotective and therapeutic effects. This review explores various natural compounds and their implications for ASD management, drawing insights from recent research. Herbal remedies have been traditionally used to manage neurodevelopmental disorders, including ASD. According to Orouji et al. (2025)⁷ medicinal herbs, such as Ginkgo biloba, Centella asiatica, is vinifera, exhibit beneficial effects on cognitive and behavioral aspects of ASD. These herbs potentially modulate neurotransmitter activity, reduce oxidative stress, and improve neural plasticity. However, to prove their safety and effectiveness, thorough clinical trials are required.

Cannabidiol and ASD Symptom Management: A non-psychoactive substance obtained from the Cannabis sativa plant, cannabidiol (CBD), has gained attention as a possible treatment for autism spectrum disorder (ASD) symptoms. Research suggests that CBD exerts its effects by modulating the endocannabinoid system, reducing neuroinflammation, and influencing neurotransmitter balance, which can lead to improvements in social interaction, anxiety, and behavioural challenges in ASD individuals⁸.

Mechanisms of Action of CBD in ASD

Modulation of the Endocannabinoid System: The endocannabinoid system plays a critical role in neurodevelopment, mood regulation, and cognitive role. ASD individuals often exhibit alterations in this system, including dysregulated cannabinoid receptor signaling. CBD has been found to enhance anandamide levels, a key endocannabinoid, which can improve behavioral symptoms and emotional regulation⁹.

Reduction of Neuroinflammation: Chronic neuroinflammation is a hallmark of ASD, contributing to neuronal dysfunction and behavioral abnormalities. Research has demonstrated that CBD has strong anti-inflammatory effects by blocking pro-inflammatory cytokines such TNF- α , IL-6, and IL-1 β . In people with ASD, this decrease in neuroinflammation has been connected to improvements in social behaviour and a decrease in anxiety¹⁰.

Neurotransmitter Regulation: CBD interacts with a variety of neurotransmitter systems, such as glutamate pathways,

gamma-aminobutyric acid (GABA), and serotonin (5-HT). These exchanges can lessen tension, aggression, and hyperactivity in ASD individuals, leading to better emotional regulation and cognitive function¹¹.

Potential for Seizure Control: Many ASD individuals also suffer from epilepsy and seizure disorders, as shown in Figure 2. Clinical studies have shown that CBD-based medications, such as Epidiex, effectively reduce seizure frequency in children with ASD-related epilepsy, further supporting its therapeutic role¹².

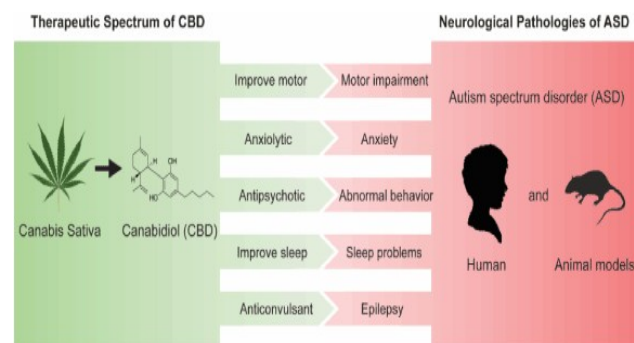


Figure 2. Potential for Seizure Control

Anti-Inflammatory Natural Interventions: Neuroinflammation is a key pathological feature of Autism Spectrum Disorder (ASD), contributing to cognitive impairments, behavioral abnormalities, and sensory dysfunctions. Natural anti-inflammatory substances obtained from food and plants have demonstrated promise in reducing ASD symptoms associated with inflammation. These bioactive compounds regulate immune responses, modulate inflammatory cytokines, and support neuroprotection, making them promising therapeutic alternatives¹³.

Mechanisms of Natural Anti-Inflammatory Interventions in ASD

Modulation of Inflammatory Pathways: Numerous natural substances target pro-inflammatory pathways, including cyclooxygenase (COX-2) and nuclear factor-kappa B (NF- κ B), reducing excessive cytokine production. For example, resveratrol, a polyphenol found in grapes, inhibits NF- κ B signaling, decreasing neuroinflammation in ASD models¹⁴.

Antioxidant and Free Radical Scavenging Effects: Oxidative stress is linked to inflammation in ASD. Sulforaphane, a bioactive compound in broccoli, activates Nrf2, a transcription factor that regulates antioxidant defense mechanisms, thereby lowering inflammation and oxidative stress in the brain¹⁵.

Gut Microbiota and Immune Regulation: Systemic inflammation can be brought on by gut dysbiosis in ASD. Natural prebiotics and probiotics, such Bifidobacterium breve and Lactobacillus rhamnosus, aid in reestablishing microbial equilibrium, which lowers inflammation and enhances social behaviours¹⁶ mentioned in Figure 3.

Dietary Interventions and Nutritional Supplements: Nutritional interventions play a crucial role in managing Autism Spectrum Disorder (ASD) by addressing gut microbiota imbalances, oxidative stress, and neuroinflammation. Emerging evidence suggests that dietary

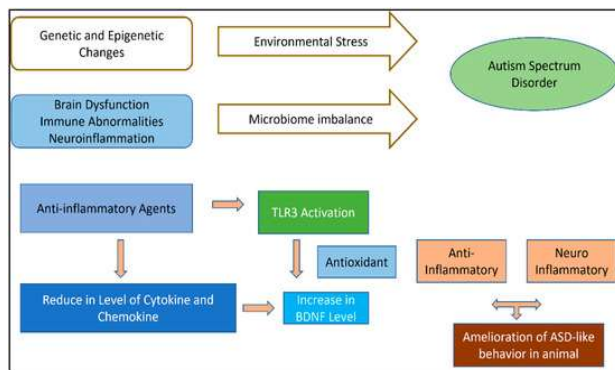


Figure 3. Gut Microbiota and Immune Regulation

modifications and targeted supplementation may enhance behaviour, cognitive function, and general health outcomes in people with ASD¹⁷.

Omega-3 Fatty Acids for Brain Development:

Neurodevelopment and cognitive function depend on omega-3 polyunsaturated fatty acids (PUFAs), such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). According to studies, giving children with ASD omega-3 supplements may help them communicate better, be less hyperactive, and have their immune systems adjusted¹⁸.

Gluten-Free and Casein-Free (GFCF) Diet: The GFCF diet excludes casein, which is present in dairy products, and gluten, which is present in wheat to reduce gut inflammation and improve behavior. Research has shown that this diet may help alleviate ASD symptoms in children with gut permeability issues, also known as leaky gut syndrome¹⁹.

Sulforaphane-Rich Foods (Broccoli Extracts):

Sulforaphane, a compound derived from cruciferous vegetables like broccoli, activates Nrf2 signaling, which reduces oxidative stress and inflammation. Clinical trials have demonstrated improvements in ASD-related behaviors such as social responsiveness and verbal communication following sulforaphane supplementation²⁰ as shown in Figure 4.

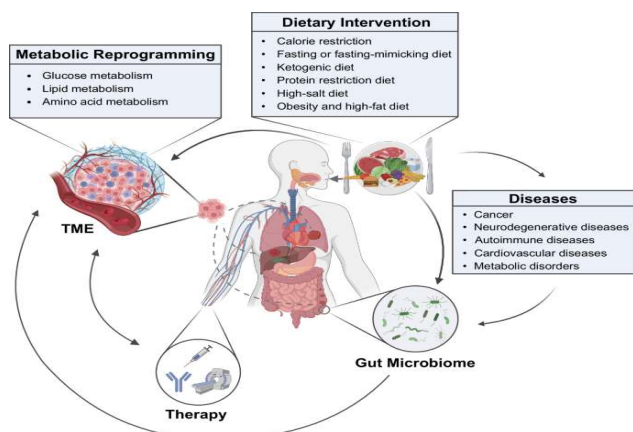


Figure 4. Sulforaphane-Rich Foods (Broccoli Extracts)

Licorice Extract and Neurobiochemical Insights: The popular medical plant licorice (*Glycyrrhiza glabra*) is well-known for its antioxidant, anti-inflammatory, and neuroprotective qualities. According to recent research, licorice extract may be very helpful in reducing the neurobiochemical abnormalities linked to autism spectrum disorder (ASD) particularly in regulating neurotransmitters,

reducing oxidative stress, and modulating neuroinflammation²¹.

Neuroprotective Mechanisms of Licorice Extract in ASD

Regulation of Neurotransmitters: People with ASD frequently have neurotransmitter abnormalities, especially those affecting dopamine (DA), serotonin (5-HT), and gamma-aminobutyric acid (GABA). Glycyrrhizin and liquiritigenin, two active substances found in licorice, alter the action of these neurotransmitters, improving mood management, anxiety, and cognitive performance²².

Reduction of Oxidative Stress: In ASD, oxidative stress plays a role in brain damage. Licorice extract lowers reactive oxygen species (ROS) and stops lipid peroxidation in brain tissues by increasing the activity of antioxidant enzymes such as glutathione peroxidase (GPx), catalase (CAT), and superoxide dismutase (SOD)²³.

Modulation of Neuroinflammatory Pathways: One of the main causes of ASD symptoms is neuroinflammation. According to research, licorice extract lowers pro-inflammatory cytokines such as TNF- α , IL-6, and IL-1 β by blocking the nuclear factor-kappa B (NF- κ B) pathway. In models of ASD, this modulation improves neurodevelopmental outcomes²³ as shown in Figure 5.

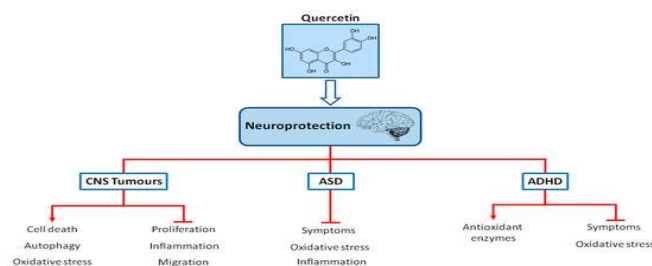


Figure 5. Modulation of Neuroinflammatory Pathways

Future Directions and Challenges in Autism Spectrum Disorder (ASD) Treatment:

Despite significant progress in understanding autism spectrum disorder (ASD), challenges remain in diagnosis, treatment, and therapeutic interventions. Current treatment approaches, including behavioral therapy, pharmacological interventions, and complementary medicine, require further optimization to enhance efficacy and accessibility. Future research must address these gaps while incorporating technological advancements, precision medicine, and integrative approaches to improve ASD management²⁴.

Challenges in ASD Treatment

Limited Personalized Treatment Approaches: ASD presents with a wide spectrum of symptoms, making it difficult to develop standardized treatment protocols. The heterogeneity in genetic, environmental, and neurobiological factors complicates treatment responses, necessitating a shift toward personalized medicine²⁵.

Gaps in Early Diagnosis and Intervention: Early intervention has been linked to better developmental outcomes in ASD individuals. However, delays in diagnosis due to limited screening tools, lack of awareness, and disparities in healthcare access remain significant barriers²⁶.

Table 1. Future Research Directions in Autism Spectrum Disorder (ASD) Treatment

Research Focus	Key Areas of Development
Precision Medicine	Genetic and biomarker-based individualized treatments for ASD.
AI & Machine Learning	AI-driven diagnostic tools for early ASD detection and personalized therapy.
Natural & Herbal Therapies	Investigating efficacy, bioavailability, and safety of plant-based interventions.
Gut-Brain Axis Research	Exploring gut microbiota role in ASD and potential probiotic/prebiotic treatments.
Neuroimaging Techniques	Advancing functional MRI and brain connectivity studies for improved diagnostics.
Gene Therapy & Epigenetics	Exploring CRISPR and gene-editing technologies for ASD-related mutations.
Neuroinflammation & Immune Modulation	Developing anti-inflammatory therapies targeting neuroimmune dysregulation.
Behavioral & Sensory Interventions	Enhancing sensory integration, music therapy, and behavioral interventions.
Policy & Inclusivity	Improving healthcare access, insurance coverage, and societal inclusion.
Multimodal Therapy Approaches	Combining pharmacological, behavioral, and technological interventions.

Safety and Efficacy of Alternative Therapies: Natural and herbal interventions, including polyphenols, cannabinoids, and probiotics, show promise in managing ASD symptoms. However, issues related to bioavailability, dosage standardization, and long-term safety require further investigation before these therapies can be widely adopted²⁷.

Ethical and Social Challenges: ASD research must address ethical concerns related to experimental treatments, particularly in pediatric populations. Social challenges, including stigma and accessibility of care, also require policy-level changes to improve inclusivity and support for ASD individuals and their families²⁸.

Future Research Directions in Autism Spectrum Disorder (ASD) Treatment as shown inTable 1.: Advancements in genomics, neuroimaging, and AI-driven diagnostics hold promise in revolutionizing ASD management. Future clinical trials should focus on evaluating combination therapies that integrate pharmacological, behavioral, and nutritional interventions for comprehensive ASD care. There is currently no cure for autism spectrum disorder (ASD), which is a complicated neurological disorder.As research advances, several key areas are being explored to enhance diagnosis, management, and therapy. Precision medicine aims to develop individualized treatments based on genetic and biomarker profiles, improving therapeutic outcomes. Similarly, AI and machine learning are being integrated into ASD research to enhance early detection and create personalized intervention strategies. The gut-brain axis has gained attention as gut microbiota imbalances are linked to ASD symptoms. To find out how probiotics and prebiotics affect behaviour and cognitive function, research is being done.Additionally, natural and herbal therapies are being investigated for their potential to modulate neuroinflammation and oxidative stress. In parallel, neuroimaging techniques, such as functional MRI, are helping researchers understand brain connectivity issues in ASD, leading to better diagnostic and therapeutic approaches.

Recent advancements in gene therapy and epigenetics, including CRISPR technology, hold promise for addressing genetic mutations associated with ASD. Moreover, neuroinflammation and immune modulation are being targeted to develop anti-inflammatory treatments, as chronic neuroinflammation is a major contributor to ASD symptoms. Behavioral and sensory interventions, such as music therapy and sensory integration, are also being refined to improve communication and adaptive skills. To ensure inclusivity, policy and healthcare accessibility improvements are being explored to provide better resources for ASD individuals. Ultimately, a multimodal therapy approach that combines pharmacological, behavioral, and technological interventions is expected to revolutionize ASD treatment in the future.

These research directions highlight the shift toward personalized, integrative, and evidence-based treatment strategies for ASD.

CONCLUSION

Natural products hold significant potential in ASD management by targeting neuroinflammation, oxidative stress, and neurotransmitter modulation. While herbal medicines, CBD, dietary interventions, and specific plant-based compounds show promising results, To confirm their effectiveness and provide uniform treatment methods, more clinical studies are required. A multifaceted method that incorporates both conventional and natural therapy may provide a more thorough approach to enhancing the quality of life for people with ASD.

Summary

A complicated neurodevelopmental disorder, autism spectrum disorder (ASD) is typified by behavioural, cognitive, and social deficits. While conventional pharmacological and behavioral interventions remain the primary treatment modalities, increasing research highlights the therapeutic potential of natural products in ASD management. This review explores various natural compounds, including polyphenols, probiotics, herbal extracts, and dietary interventions, that have shown promise in mitigating ASD symptoms through their neuroprotective, anti-inflammatory, and gut-modulating properties.

ACKNOWLEDGEMENTS

The authors are grateful to SNJBs College of Pharmacy for support.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

Cruz Puerto M, Sandín Vázquez M. Understanding heterogeneity within autism spectrum disorder: a scoping review. *Advances in Autism*. 2024 Nov 20;10(4):314-22.

Akpovwre CO, Eduviere AT, Isibor H, Edje KE, Ewhre LO, Akinsola AO, Idada JE, Avwotuhwaye FE. Theaflavin

- Alleviates Memory Deficit and Anxiety-Like Phenotypes in Valproic Acid Murine Model of Autism: Impact on Cholinergic and Oxido-Nitric Stress Mechanisms. *Tropical Journal of Natural Product Research*. 2024 Dec 1;8(12).
- Sneha G, Krishnamoorthy NK, Hediya TA, Kendaganna PH, Chidambaram SB. Role of Diet in Improving Gut Microbiota in Autism. In *Handbook of Neurodegenerative Disorders* 2024 Oct 24 (pp. 997-1012). Singapore: Springer Nature Singapore.
- Sampaio L, Campos RM, Karhson D, Iannotti FA. Insights on cannabinoid translational science and medicine: the endocannabinoidome as a target for clinical practice. *Frontiers in Neuroscience*. 2024 Jun 3;18:1432892.
- Fahey JW, Moreno DA, Licciardi P, Grassi F, Karagiannis TC, Mazarakis N. Sulforaphane and isothiocyanates in health. *Frontiers in Nutrition*. 2025 Feb 11;12:1558025.
- Karimi M, Latifi SA, Zafarghandi MB, Salehi M. Effect of Hiwa syrup, a Persian Medicine Product, on Autism Symptoms and in Children with Autism Spectrum Disorders: A Randomized Double-Blinded Clinical Trial. *Galen Medical Journal*. 2024 Oct 9;13:e3553.
- Orouji N, Karimi M, Sadat-Shirazi MS, Zargar A. A Narrative Review of Effective Herbal and Traditional Medicines on Management of Autism. *Traditional and Integrative Medicine*. 2024 Dec 28;478-87.
- Raza MH, Bhutta ME, Siddique MH. Shifting focus: the need for early intervention and safer alternatives in autism spectrum disorder treatment. *Trends in Psychiatry and Psychotherapy*. 2024;46:e20240953.
- Thapliyal A, Suri K, Chauhan R, Murugan NA, Maurya SK. Unveiling the role of phytochemicals in autism spectrum disorder by employing network pharmacology and molecular dynamics simulation. *Metabolic Brain Disease*. 2024 Nov 21;40(1):34.
- Specchio N, Di Micco V, Aronica E, Auvin S, Balestrini S, Brunklaus A, Gardella E, Scheper M, Taglialatela M, Trivisano M, Curatolo P. The epilepsy–autism phenotype associated with developmental and epileptic encephalopathies: New mechanism-based therapeutic options. *Epilepsia*. 2025 Apr;66(4):970-87.
- Pedrazzi JF, Sales AJ, Ponciano RS, Ferreira LG, Ferreira FR, Campos AC, Hallak JE, Zuadi AW, Del Bel EA, Guimarães FS, Crippa JA. Acute cannabidiol treatment reverses behavioral impairments induced by embryonic valproic acid exposure in male mice. *Pharmacology Biochemistry and Behavior*. 2025 Feb 1;247:173919.
- Ashwlayan VD, Ratnesh RK, Sharma D, Sharma A, Sangal A, Saifi A, Singh J. A comprehensive review on plant-based medications and chemical approaches for autism spectrum disorders (ASDs) psychopharmacotherapy. *Indian Journal of Microbiology*. 2025 Mar;65(1):15-31.
- Feng S, Gong Y, Xia L, Lang Y, Shen Y, Li H, Feng W, Chen F, Chen Y. Calcium hexacyanoferrate (III) nanocatalyst enables redox homeostasis for autism spectrum disorder treatment. *Advanced Materials*. 2024 Sep;36(39):2405655.
- Chattopadhyay S, Malayil L. Reviews in microbiome in health & disease. *Frontiers in Cellular and Infection Microbiology*. 2024 May 27;14:1423386.
- Holston H, Karvat A, Lallian S, Wu P. Anti-Inflammatory Interventions for Autism Spectrum Disorder. *Berkeley Pharma Tech Journal of Medicine*. 2024 Jun 28;4(1):59-82.
- Wankhede N, Kale M, Shukla M, Nathiya D, Kaur P, Goyanka B, Rahangdale S, Taksande B, Upaganlawar A, Khalid M, Chigurupati S. Leveraging AI for the diagnosis and treatment of autism spectrum disorder: Current trends and future prospects. *Asian Journal of Psychiatry*. 2024 Nov 1;101:104241.
- Hoxha M, Abbasciano M, Avantiaggiato G, Zappacosta B, Tricarico D. Mycotoxins and neuropsychiatric symptoms: possible role in special refugee populations. *Frontiers in Pharmacology*. 2025 Mar 19;16:1524152.
- Arif MI, Ru L, Maimaiti R. Effect of different nutritional interventions in children with autism spectrum disorder: A systematic review. *Research in Autism*. 2025 Feb 1;120:202535.
- Fahey JW, Moreno DA, Licciardi P, Grassi F, Karagiannis TC, Mazarakis N. Sulforaphane and isothiocyanates in health. *Frontiers in Nutrition*. 2025 Feb 11;12:1558025.
- Mazlan FM, Bakar RS. Unmasking hidden deficiencies: determinants of micronutrient shortages in children with autism.
- Rode MR, Kolhe SU, Patil CN. Therapeutic potential of licorice extract in a prenatal valproic acid model of autism spectrum disorder in Wistar rats: Neurobehavioral and neurobiochemical insights. *Brain Disorders*. 2024 Jun 1;14:100128.
- Zitter A, Fernandes S, Vivanti G. The Early Start Denver Model. In *Handbook of Evidence-Based Practices in Autism Spectrum Disorder* 2025 Feb 18 (pp. 85-98). Cham: Springer Nature Switzerland.
- Zhao L, Wang Y, Zhang Z. Music in intervention for children with autism: a review of the literature and discussion of implications. *Current Psychology*. 2025 Mar;44(6):4411-21.
- Chan HW, Hsu LS, Shum KK. Exploring the Human–Animal Interaction (HAI) for Children with ASD Across Countries: A Systematic Review. *Journal of Autism and Developmental Disorders*. 2025 Mar 3:1-40.
- Al Noman A, Flora SA, Tonni SD, Barua C, Nath AK, Bristy KF, Ahmad I, Pathak R, Sharma H. Plants as Medicine for Autism: Reviewing the Evidence for Phytopharmaceuticals for ASD. *Current Bioactive Compounds*. 2025 Feb 11.
- Steinbrenner JR, Odom SL. Identifying Evidence-Based Practices for Autistic Individuals: Issues and Trends. In *Handbook of Evidence-Based Practices in Autism Spectrum Disorder* 2025 (pp. 489-503). Springer, Cham.
