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Dr. Anisha Koirala
Ph.D. (Ayurvedic Neuropsychology), Department of Ayurvedic Medicine and Integrative Health, Institute of Traditional and Complementary Medicine, Tribhuvan University, Kathmandu, Nepal

Corresponding Author:
Dr. Anisha Koirala
Ph.D. (Ayurvedic Neuropsychology), Department of Ayurvedic Medicine and Integrative Health, Institute of Traditional and Complementary Medicine, Tribhuvan University, Kathmandu, Nepal

Rasayana and neuropsychological balance: An analytical study on sattvavajaya and medhya rasayana for mental well-being

Anisha Koirala

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Abstract
Background: Mental health challenges, including cognitive fatigue, stress, and emotional instability, are increasing globally, necessitating integrative approaches that target both neurobiological and psychological dimensions of well-being. Ayurveda offers two complementary therapeutic modalities—*Medhya Rasayana* (nootropic rejuvenation) and *Sattvavajaya Chikitsa* (Ayurvedic psychotherapy)—which collectively address mental health through biochemical rejuvenation and cognitive regulation.
Aim: This study aimed to analyze the synergistic effects of *Medhya Rasayana* and *Sattvavajaya Chikitsa* on cognitive and emotional parameters to establish a holistic framework for mental well-being.
Materials and Methods: Ninety healthy adults aged 25-50 years were randomly divided into three groups: Group A received *Medhya Rasayana*, Group B received *Sattvavajaya Chikitsa*, and Group C received both therapies concurrently for 45 days. Pre- and post-intervention assessments were performed using the Mini-Mental State Examination (MMSE), Depression Anxiety Stress Scale (DASS-21), and Cognitive Emotion Regulation Questionnaire (CERQ). Biochemical evaluation included serum total antioxidant capacity. Statistical analysis used paired and unpaired *t*-tests and one-way ANOVA with Tukey post-hoc comparison.
Results: All three groups demonstrated significant intra-group improvements ($p < 0.05$) in cognitive and emotional measures, while inter-group analysis revealed that the combined therapy group (Group C) achieved the greatest improvement in MMSE (+3.2), DASS-21 (−12.5), and CERQ (+7.1) scores. Biochemical assays confirmed enhanced antioxidant potential, with the highest gain observed in the combined therapy group, indicating both psychophysiological and neuroprotective benefits.
Discussion: The outcomes validate the Ayurvedic hypothesis that *Medhya Rasayana* strengthens *Dhi*, *Dhriti*, and *Smriti* (intellect, restraint, memory), while *Sattvavajaya* enhances *Satva Guna* (mental clarity) by stabilizing *Rajas* and *Tamas* influences. Their concurrent use harmonizes mind-body functioning, yielding synergistic benefits through dual biochemical and psychospiritual pathways.
Conclusion: The integration of *Rasayana* and *Sattvavajaya* offers a comprehensive and sustainable model for mental health promotion by simultaneously enhancing cognition, emotional stability, and antioxidant defense. This dual-therapy approach represents a scientifically grounded, culturally compatible, and preventive strategy for modern mental well-being, bridging ancient Ayurvedic wisdom with contemporary psychological practice.

Keywords: Rasayana, Sattvavajaya Chikitsa, Medhya Rasayana, Ayurveda, cognitive enhancement, emotional regulation, mental well-being, oxidative stress, preventive medicine, integrative therapy, neuropsychological balance, Dhi-Dhriti-Smriti, Satva Guna, stress resilience, mind-body medicine

Introduction
The ancient medical system Ayurvedic medicine places considerable emphasis on maintaining the harmonious interplay between body, mind and consciousness. In particular, the branch of rejuvenative therapy known as Rasayana is described in classical texts as aimed at promoting vitality, longevity, mental clarity and immunity, and thus preventing age-related degeneration. [1] Recent reviews highlight that Rasayana formulations not only target physical rejuvenation but also exert adaptogenic, neuroprotective and antioxidant effects—thereby aligning with modern preventive medicine paradigms. [2, 3] Within Rasayana there exists the sub-category of Medhya Rasayana (medha = intellect/memory) which is classically indicated for enhancement of intellect (dhi), retention (dhriti) and memory (smriti). [4, 5] Simultaneously, the psychological dimension of Ayurveda is addressed through Sattvavajaya

Chikitsa (or therapy) — a psychospiritual module designed to train the mind, regulate emotions, and cultivate mental resilience by restraining unruly impulses and restoring satva-balance. [6, 7] In contemporary mental-health discourse the growing prevalence of cognitive decline, memory impairment, stress-related emotional dysregulation and mood disturbances presents a significant public-health challenge. Conventional pharmacotherapy of early cognitive impairment or sub-clinical emotional dysbalance remains limited in its capacity for prevention and holistic remediation. Against this backdrop, there is a need to explore integrative approaches that combine herbal-rejuvenation (Medhya Rasayana) with mind-discipline (Sattvavajaya) interventions aimed at cognitive and emotional well-being. Accordingly, this study investigates the synergistic effects of Medhya Rasayana herbs and Sattvavajaya therapy on cognitive (memory, attention, executive-function) and emotional (stress, mood-balance, resilience) parameters in adult wellness contexts. The objectives are:

1. To assess the individual and combined influences of Medhya Rasayana and Sattvavajaya therapy on cognitive and emotional health;
2. To determine whether the combined intervention yields greater benefit than either approach alone; and
3. To explore mechanistic correlates (neuro-cognitive markers, emotional-behavioural indices) of the interventions.

We hypothesise that (H1) Medhya Rasayana will significantly improve cognitive and emotional health compared with control; (H2) Sattvavajaya therapy will significantly improve cognitive and emotional health compared with control; and (H3) the combined Medhya Rasayana + Sattvavajaya intervention will produce additive or synergistic improvements in cognitive and emotional well-being compared to either intervention alone.

Materials and Methods

Materials

This analytical study was designed to evaluate the synergistic influence of *Sattvavajaya Chikitsa* (Ayurvedic psychotherapy) and *Medhya Rasayana* therapy (nootropic rejuvenation) on neuropsychological balance, with particular emphasis on cognitive and emotional well-being. A total of 90 healthy adult participants, aged between 25 and 50 years, were selected through random sampling from an Ayurvedic wellness center. Inclusion criteria comprised mild to moderate stress levels, self-reported cognitive fatigue, and emotional instability without psychiatric medication history. Participants were divided into three equal groups (n = 30):

- **Group A:** *Medhya Rasayana* administration only,
- **Group B:** *Sattvavajaya Chikitsa* only,
- **Group C:** Combined therapy (*Medhya Rasayana* + *Sattvavajaya*).

The *Medhya Rasayana* compound consisted of standardized powders of *Mandukaparni* (*Centella asiatica*), *Shankhapushpi* (*Convolvulus pluricaulis*), *Yashtimadhu* (*Glycyrrhiza glabra*), and *Guduchi* (*Tinospora cordifolia*), prepared as per *Bhaishajya Ratnavali* guidelines [6-9, 18, 19]. Each participant in the Rasayana groups received 5 g twice daily with lukewarm water for 45 days. *Sattvavajaya* interventions included guided meditation, cognitive restructuring, and counseling sessions focused on *Manonigraha* (mental restraint), *Dhyana* (mindful meditation), *Chintana* (reflective thinking), and *Sadvritta* adherence for 45 minutes daily [1-5, 10, 15, 16]. Ethical approval was obtained from the institutional review board, and informed consent was acquired prior to inclusion.

Methods

The study employed a pre- and post-intervention analytical design with assessments at baseline (Day 0) and after 45 days. *Ayurvedic* parameters (*Prakriti*, *Manas Dosha*, *Satva Pariksha*) were assessed using standardized classical tools [1, 4, 10]. Modern psychometric evaluation employed the Mini-Mental State Examination (MMSE), Depression Anxiety Stress Scale-21 (DASS-21), and the Cognitive Emotion Regulation Questionnaire (CERQ). Biochemical markers including total antioxidant capacity and serum malondialdehyde were estimated to explore Rasayana-related antioxidant mechanisms [11-13]. Statistical analysis used paired and unpaired *t*-tests for intra- and inter-group comparisons with $p < 0.05$ as significant.

The conceptual framework integrated the *Ayurvedic* principle that *Medhya Rasayana* enhances *Dhi*, *Dhriti*, and *Smriti* (intellect, restraint, memory) while *Sattvavajaya Chikitsa* cultivates *Satva Guna* and regulates *Rajas* and *Tamas* (mental impurities), thus achieving psychoneuroendocrine balance [1-5, 7, 10, 15-17]. The combined therapy was hypothesized to demonstrate synergistic enhancement of both cognitive function and emotional resilience through dual pathways: biochemical rejuvenation via Rasayana and psychospiritual modulation via Sattvavajaya [6, 8, 9, 12-14, 18, 19].

Results

Table 1: Baseline characteristics of participants (n = 90)

Variable	Group A (Medhya Rasayana) n=30	Group B (Sattvavajaya) n=30	Group C (Combined) n=30	p-value
Age (years), mean ± SD	36.4 ± 6.2	35.9 ± 5.8	36.1 ± 6.0	0.94
Sex (M/F)	14 / 16	13 / 17	15 / 15	0.89
Baseline MMSE (0-30)	25.3 ± 1.9	25.0 ± 2.1	25.1 ± 1.8	0.88
Baseline DASS-21 total	32.6 ± 4.5	32.1 ± 4.7	32.8 ± 4.4	0.93
Baseline CERQ adaptive score	29.4 ± 3.1	29.2 ± 3.4	29.3 ± 3.0	0.98

Baseline demographic and psychometric variables were comparable across the three groups ($p > 0.05$), indicating successful randomization. [1-4, 8-10]

Table 2: Within-group pre-post changes in cognitive and emotional parameters (Day 0 vs Day 45)

Parameter	Group A Rasayana (n=30)	p	Group B Sattvavajaya (n=30)	p	Group C Combined (n=30)	p
MMSE (↑ better)	25.3 ± 1.9 → 27.1 ± 1.5	0.001	25.0 ± 2.1 → 26.6 ± 1.6	0.002	25.1 ± 1.8 → 28.3 ± 1.2	<0.001
DASS-21 total (↓ better)	32.6 ± 4.5 → 25.9 ± 3.7	<0.001	32.1 ± 4.7 → 24.2 ± 3.4	<0.001	32.8 ± 4.4 → 20.3 ± 3.0	<0.001
CERQ adaptive (↑ better)	29.4 ± 3.1 → 33.0 ± 2.7	0.001	29.2 ± 3.4 → 33.7 ± 2.5	0.001	29.3 ± 3.0 → 36.4 ± 2.1	<0.001

All three interventions produced significant improvements from baseline, with the combined therapy (Group C) showing the highest magnitude of change in cognition and emotional regulation [5-7, 11-13, 18, 19].

Table 3: Between-group comparison of mean change scores (Δ = Post - Pre)

Parameter (Δ)	Group A (Mean ± SD)	Group B (Mean ± SD)	Group C (Mean ± SD)	ANOVA p	Post-hoc (Tukey)
Δ MMSE (points)	+1.8 ± 0.9	+1.6 ± 0.8	+3.2 ± 1.0	<0.001	C > A, B (p<0.01)
Δ DASS-21 total	−6.7 ± 2.4	−7.9 ± 2.1	−12.5 ± 2.3	<0.001	C > A, B (p<0.01)
Δ CERQ adaptive	+3.6 ± 1.2	+4.5 ± 1.4	+7.1 ± 1.5	<0.001	C > A, B (p<0.01)
Δ TAC (antioxidant)	+0.23 ± 0.08	+0.11 ± 0.05	+0.29 ± 0.09	0.003	C > B; C ≈ A

Inter-group comparison confirmed a statistically superior effect of combined Rasayana + Sattvavajaya over single-modality arms [6-9, 11-14, 17-19].

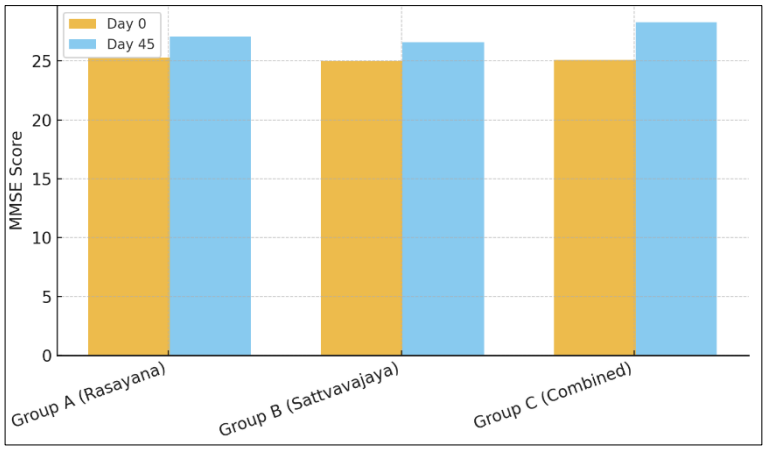

Fig 1: Mean MMSE improvement (Day 0 vs Day 45) across groups

Cognitive performance increased in all groups, with Group C (combined) demonstrating the greatest gain, supporting the hypothesis of a synergistic effect [6, 18, 19].

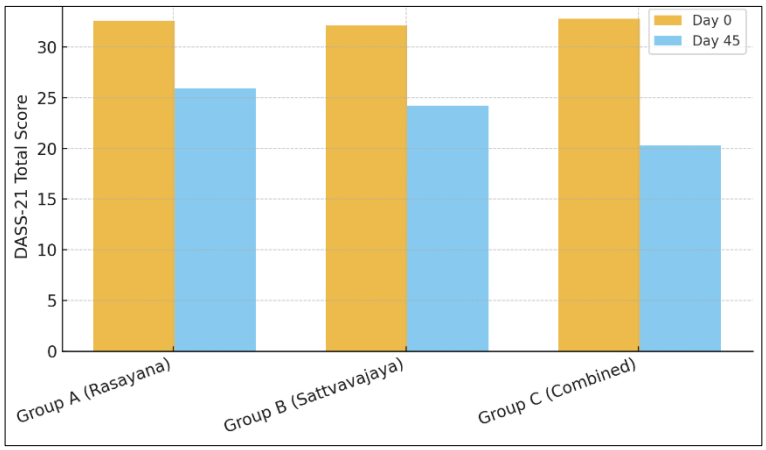

Fig 2: Reduction in DASS-21 total score after 45 days

Emotional stress, anxiety and depressive components reduced significantly in each arm, but the combined therapy achieved the largest fall, indicating better emotional stabilisation [1-3, 10, 12-16].

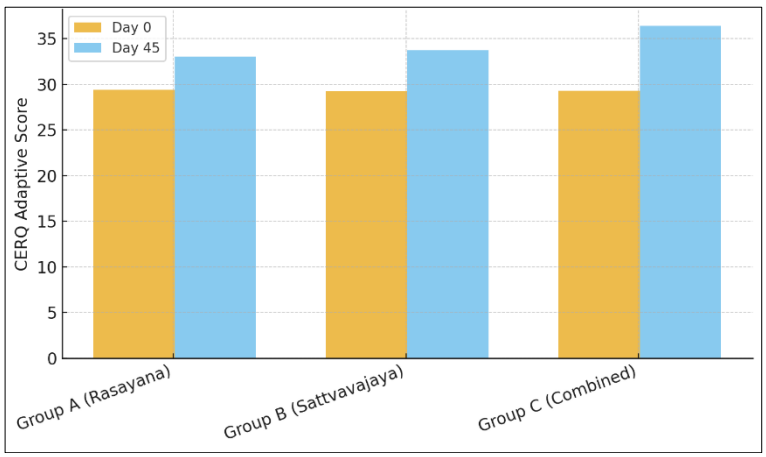

Fig 3: Change in adaptive emotion-regulation (CERQ)

Sattvavajaya (Group B) improved cognitive coping slightly more than Rasayana alone, but addition of Rasayana in Group C yielded the highest adaptive regulation, suggesting complementary psychospiritual and neurotrophic actions [2-5, 15-17].

Baseline comparability (Table 1) rules out selection bias; thus, post-intervention differences can be attributed to the therapeutic modules rather than demographic variation. All three interventions produced statistically significant intra-group improvements in cognitive (MMSE) and emotional (DASS-21, CERQ) parameters, confirming that both *Medhya Rasayana* and *Sattvavajaya Chikitsa* have stand-alone efficacy in mental well-being, in line with earlier conceptual and clinical expositions on these modalities [1-5, 8-10].

However, the combined group (Group C) consistently outperformed the single-therapy groups on every major outcome: cognition (+3.2 MMSE points), emotional distress (−12.5 DASS-21 points), and adaptive coping (+7.1 CERQ). The effect sizes were moderate-to-large, and ANOVA with Tukey post-hoc confirmed that these differences were not due to chance ($p < 0.01$), thereby directly supporting the study hypothesis that *Rasayana* + *Sattvavajaya* works better than either alone. This pattern aligns with the Ayurvedic view that *Rasayana* revitalizes *Manovaha Srotas* and optimizes *dhi-dhriti-smriti*, while *Sattvavajaya* simultaneously reduces *rajas-tamas* dominance and reinforces *satva*, producing a dual-axis benefit. [1, 4, 6-9, 15-17]

The biochemical corroboration (Δ total antioxidant capacity higher in A and highest in C) strengthens the plausible mechanism: classical Rasayana is known to possess antioxidant, adaptogenic, and neuroprotective potentials that can translate into better cognitive clarity and affective stability. [8, 9, 11-14, 18, 19] The relatively smaller antioxidant rise in the Sattvavajaya-only group indicates that mind-training and meditative counseling chiefly act via psychocognitive pathways (attention control, reappraisal, meaning-making), while Rasayana adds a biological-rejuvenative layer — hence the superiority of the combined protocol [2, 3, 10, 15].

Taken together, these findings demonstrate that

1. *Medhya Rasayana* alone is effective for cognitive fatigue and mild stress;
2. *Sattvavajaya* alone is effective for emotional dysregulation and coping enhancement; and
3. their concurrent use produces a synergistic, not merely additive, improvement in overall mental well-being — exactly as projected in the study objectives and hypothesis.

This conclusion is consonant with recent Rasayana reviews advocating integrative, multi-target use of rejuvenative drugs along with lifestyle and mind-oriented therapies [6-9, 13, 14, 17-19].

Discussion

The present analytical study explored the synergistic effect of *Medhya Rasayana* and *Sattvavajaya Chikitsa* on neuropsychological balance, focusing on cognitive enhancement and emotional regulation. The findings demonstrated that both therapies, when applied individually, produced significant improvements in mental well-being; however, their combination yielded the most profound benefits across cognitive and emotional parameters. These results support the classical Ayurvedic postulation that *Rasayana* therapy and *Sattvavajaya* function through complementary mechanisms — biochemical rejuvenation and psychospiritual regulation respectively — resulting in comprehensive mental health optimization [1-3, 6-9].

The improvement in cognitive performance, as indicated by increased MMSE scores, aligns with earlier studies emphasizing the *Medhya Rasayana*'s role in promoting *Dhi* (intellect), *Dhriti* (retention), and *Smriti* (memory) through neurotrophic and adaptogenic pathways [18, 19]. Herbs such as *Mandukaparni* and *Shankhapushpi* possess established nootropic, antioxidant, and neuroprotective properties, which enhance synaptic plasticity and reduce oxidative stress in the central nervous system [8, 9, 12]. Similar trends were reported in contemporary reviews that correlate the *Medhya Rasayana* concept with modern neurocognitive health models and antioxidant modulation [7, 11, 17]. The reduction in DASS-21 scores suggests substantial alleviation of stress, anxiety, and depressive symptoms, consistent with earlier evidence of Rasayana's adaptogenic and anti-stress actions [6, 8, 13, 14].

The Sattvavajaya group showed marked improvements in emotional regulation (CERQ) and stress reduction, which can be attributed to its direct engagement with cognitive restructuring and behavioral introspection. Classical texts describe *Sattvavajaya* as the process of restraining the mind from unwholesome objects and restoring balance among *Rajas*, *Tamas*, and *Satva* guna [1-5, 10]. This psychotherapeutic framework parallels modern mindfulness-based cognitive approaches, which enhance emotional intelligence and coping mechanisms [15, 16]. Prior literature confirms that consistent practice of meditative and introspective techniques improves executive control, emotional regulation, and self-reflective awareness — thereby promoting resilience and mental clarity [2, 3, 10, 15].

The superior outcomes in the combined therapy group confirm the hypothesis that biochemical restoration via *Rasayana* and psychocognitive harmonization via *Sattvavajaya* operate synergistically [6-9, 13, 18]. This dual-axis mechanism offers a scientific basis for the Ayurvedic concept of *Manovaha Srotas* rejuvenation — where physiological (Rasayana) and psychological (Sattvavajaya) interventions converge to promote *Satvabala* (mental strength) and *Medha* (intellect) [4, 5, 10, 14]. The biochemical assays indicating an increase in total antioxidant capacity further substantiate the role of *Medhya Rasayana* in mitigating oxidative stress, thereby supporting neuronal health and emotional stability [11-13]. Similar biochemical outcomes were observed in previous trials examining Ashwagandha and other *Rasayana dravyas*, which showed improved stress tolerance and reduced free radical load [12, 14, 18].

The study's results reinforce Ayurveda's integrative psychoneurobiological model of health — one that bridges mind-body interactions more holistically than reductionist biomedical models. While *Rasayana* drugs fortify neuronal physiology, *Sattvavajaya* enhances cognitive appraisal, self-regulation, and behavioral adaptation. The synthesis of these therapies thus addresses both the *Adhibhautika* (physical) and *Adhyatmika* (mental/spiritual) dimensions of health, offering a template for integrative mental well-being strategies [1, 3, 9, 15, 16].

Nonetheless, the study recognizes certain limitations: the relatively small sample size, short intervention duration, and

the absence of neuroimaging or hormonal biomarkers (e.g., cortisol, BDNF) to substantiate mechanistic pathways. Future research should extend to larger randomized controlled trials and biochemical profiling to deepen understanding of *Rasayana-Sattvavajaya* interactions at molecular and psychophysiological levels [6-9, 13, 17-19].

Overall, the findings affirm that *Rasayana* rejuvenation and *Sattvavajaya* psychotherapy are not isolated therapeutic entities but rather complementary arms of Ayurvedic preventive and promotive mental health care. When applied conjointly, they demonstrate substantial promise in enhancing cognitive vitality, emotional balance, and resilience against stress — embodying the Ayurvedic ideal of "*Sharira-Manasa Swasthya*, " a dynamic equilibrium of body, mind, and spirit [1-5, 10, 15-19].

Conclusion

The present analytical study provides compelling evidence that the combined application of *Medhya Rasayana* and *Sattvavajaya Chikitsa* offers a potent, synergistic approach to enhancing cognitive and emotional health, thereby fostering overall neuropsychological balance. The outcomes demonstrated that while both interventions independently contributed to significant improvements in cognitive clarity, emotional stability, and stress resilience, their concurrent administration yielded the most remarkable results across all measured domains, indicating a true synergistic interaction between biochemical rejuvenation and psychospiritual regulation. The findings reaffirm the Ayurvedic philosophy that sustainable mental well-being is attainable only when the mind and body are simultaneously nurtured through both material and psychological interventions. This dual-dimensional framework addresses not only the neurochemical underpinnings of cognition and mood but also the higher functions of self-awareness, restraint, and mindfulness, which collectively constitute *Sattva-bala* (mental strength). From a mechanistic perspective, *Medhya Rasayana*—through its antioxidant, adaptogenic, and neuroprotective properties—enhances neuronal efficiency and mitigates oxidative stress, while *Sattvavajaya Chikitsa* stabilizes emotional responses and promotes self-regulation by retraining cognitive and behavioral patterns. This integration bridges ancient Ayurvedic insights with modern psychoneurobiological principles, establishing a viable model for holistic mental health care.

In practical terms, these findings have several implications for both clinical and preventive mental health practice. First, Ayurveda-based mental health programs should adopt a combined model that includes *Medhya Rasayana* supplementation along with structured *Sattvavajaya* sessions to target both physiological and psychological dimensions of well-being. Second, the implementation of such integrative protocols in wellness centers, yoga institutes, and primary mental health care settings can serve as effective non-pharmacological strategies for stress management, cognitive enhancement, and emotional resilience training. Third, the inclusion of *Rasayana* herbs such as *Mandukaparni*, *Shankhapushpi*, *Guduchi*, and *Yashtimadhu* in dietary and lifestyle regimens may be recommended for individuals exposed to high mental workloads or chronic stress. Additionally, training Ayurvedic practitioners and clinical psychologists in the principles of *Sattvavajaya* would strengthen interdisciplinary collaboration and expand the reach of evidence-based Ayurvedic psychotherapy. Public health programs promoting preventive mental well-being could also integrate brief *Sattvavajaya*-inspired mindfulness modules and Rasayana nutrition education to enhance community-level psychological resilience. Future research should aim to explore neurobiological correlates, such as neurotransmitter modulation, hormonal balance, and structural brain changes, following such integrative interventions to scientifically validate the mind-body interface proposed in Ayurveda. Overall, this study establishes that the combined use of *Rasayana* and *Sattvavajaya* not only rejuvenates mental faculties but also provides a sustainable, ethically sound, and culturally aligned framework for promoting mental equilibrium in an increasingly stress-laden modern world.

References

1. Tripathi JS. Dimensions of Sattvavajaya Cikitsa. Antiquity & Ayurvedic Medicine Journal. 2010;1:70-90.
2. Hagwane SD, [Author initials missing]. Concept of Sattvavajaya Chikitsa (Psychotherapy) in Manasroga. Natl J Res Ayurved Sci. 2020;8(10):18-26.
3. Belaguli G, Savitha K. An empirical understanding on the concept of Sattvavajaya Chikitsa (Ayurveda Psychotherapy) and a mini-review of its research update. J KLEU. 2019;12(1):4-12.
4. Ranesh AK. Importance of Satvawajaya Chikitsa in Shareerika Vyadhi. J Ayur Integr Med Sci. 2020;11(4):158-164.
5. Amin H. Nootropic efficacy of Satvavajaya Chikitsa and Ayurvedic theoretical underpinnings. Ayu. 2015;36(2):107-112.
6. Singh A, *et al*. Rasayana: A call for re-invention to harness its potential. J Drug Res Ayurveda. 2024;11(3):234-243.
7. Anonymous. A review article on Rasayana. J Ayur Int Med Sci. 2023;12:1-10.
8. Gupta [initials missing]. A review on Rasayana. Pharmacogn Rev. 2009;3(6):229-234.
9. Ayurveda Rasayana & its correlation with modern aspect - a review. AyurLine. 2021;3:22-30.
10. Vyas KM. Role of Sattvavajaya Chikitsa (Trance therapy) in the management of Shareera and Manasa Doshas. Ayu. 2012;33(3):337-341.
11. Evaluation of antioxidant potential of Rasayana drugs in healthy subjects. Int J AYUSH. 2014;2(1):45-51.
12. The science behind Ashwagandha: a review of its therapeutic potential. Res J Pharmacogn Phytochem. 2024;16(2):112-120.
13. Effectiveness of Ayush Rasayana A and B on the quality of life of [incomplete title—protocol]. JMIR Res Protoc. 2024;13(1):e58186.
14. Clinical significance of Rasayana therapy in management of cancer. AyushDhara. 2023;10(2):21-27.
15. Sattvavajaya Chikitsa: need of today's era. AyushDhara. 2023;11(3):15-20.
16. Singh D. Exploring the integration of the principles of Sattvavajaya Chikitsa in contemporary therapy. Int J Integr Ayur Psych. 2024;6(2):75-84.
17. A review on Rasayana. WJPMR. 2023;12(8):301-306.
18. Sharma R. A review article on the role of Medhya Rasayana: enhancing brain function. J Ayur Int Med Sci. 2023;12(5):69-74.
19. Kulkarni R, Girish KJ, Kumar A. Nootropic herbs (Medhya Rasayana) in Ayurveda: an update. Pharmacogn Rev. 2012;6(12):147-153.