

NEUROPHYSIOLOGICAL FOUNDATIONS OF SAMAANA VAATA: BRIDGING AYURVEDIC WISDOM WITH CONTEMPORARY GUT- BRAIN COMMUNICATION NETWORKS

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Article Received on 05 Feb. 2026,
Article Revised on 25 Feb. 2026,
Article Published on 01 March 2026,

<https://doi.org/10.5281/zenodo.18813368>

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How to cite this Article: Sneha Banchhade¹, Sheetal Roman^{2*}. (2026). Neurophysiological Foundations Of Samaana Vaata: Bridging Ayurvedic Wisdom With Contemporary Gut-Brain Communication Networks. World Journal of Pharmaceutical Research, 15(5), 1105–1116. This work is licensed under Creative Commons Attribution 4.0 International license.

ABSTRACT

More recently, researchers have been looking for significant links between traditional Ayurvedic physiological concepts and contemporary biomedical models, especially in relation to digestive control. Among the five functional subtypes of Vaata described in classical texts, Samaana Vaata occupies a central role in orchestrating digestive processes. Contemporary researchers have begun mapping this traditional concept onto the enteric nervous system's architectural and functional landscape, revealing intriguing overlaps with current understanding of gut-brain communication pathways. Our review examined existing literature correlating Samaana Vaata with neurophysiological mechanisms, specifically targeting its relationship with enteric neural networks, bidirectional gut-brain signaling, and established motor patterns like the migrating motor complex. Evidence consistently points toward

the enteric nervous system, especially the myenteric and submucosal nerve plexuses, as anatomical correlates for Samaana Vaata's described functions in motility coordination, secretory regulation, and absorptive processes. These peripheral gut networks form essential components of the larger gut-brain axis, suggesting Samaana Vaata naturally fits within this bidirectional communication framework. However, experimental validation linking specific Samaana Vaata states to measurable neural parameters remains sparse. Samaana Vaata seems

to cover more general regulation principles that apply to all stages of digestion, even though the migrating motor complex is a well-known rhythmic occurrence produced by enteric circuits during fasting. This comparison of conceptual breadth and mechanistic specificity highlights both the potential value and current limitations of combining traditional functional frameworks with fundamental biological methods. Moving forward, comprehensive empirical investigations evaluating specific correspondence hypotheses could make significant contributions to both Ayurvedic knowledge systems and neurogastroenterological science, potentially uncovering regulatory principles that supplement existing mechanistic models.

KEYWORDS: Samaana Vaata, enteric nervous system, gut-brain communication, digestive neurophysiology, migrating motor complex, integrative gastroenterology.

1. INTRODUCTION

Traditional medical systems worldwide have developed sophisticated frameworks for understanding human physiology, often emphasizing functional integration and dynamic balance rather than isolated structural components. Ayurveda, the ancient Indian system of medicine, conceptualizes physiological regulation through three fundamental principles—Vaata, Pitta, and Kapha—each governing distinct aspects of bodily function. Within the Vaata category, five functional subtypes operate in different anatomical regions, with Samaana Vaata specifically orchestrating digestive processes within the gastrointestinal tract. Classical descriptions regarding the functions of Samaana Vaata is the coordination of food intake (*Grahana*), digestive transformation (*Pachana*), nutrient-waste separation (*Vivechana*), and propulsive movement (*Munchana*), positioning it near the digestive fire (*Jatharagni*) within the gut cavity (*koṣṭha*).^[1] This functional specificity has prompted contemporary researchers to explore potential neurophysiological substrates underlying these traditional observations.

Modern neurogastroenterology recognizes the enteric nervous system as a semi-autonomous regulatory network embedded within intestinal walls, comprising roughly half a billion neurons organized into interconnected plexuses. These neural networks, particularly the myenteric plexus controlling muscle contractility and the submucosal plexus regulating secretory-absorptive functions, coordinate gastrointestinal activities with remarkable independence from central nervous input.^[1,2] Beyond local control, these peripheral networks communicate bidirectionally with the brain through multiple channels—neural pathways involving vagal and spinal afferents, hormonal signals from gut endocrine cells, immune

mediators from intestinal immune tissue, and metabolic products from resident microbial communities—collectively termed the gut-brain axis.^[3,4] This recognition of intricate bidirectional communication between peripheral gut systems and central nervous structures has fundamentally restructured understanding of how digestive processes influence, and are influenced by, brain function.

Despite growing academic interest in correlating Ayurvedic physiological concepts with neuroscientific frameworks, systematic syntheses examining Samaana Vaata's proposed neurophysiological foundations remain limited. Existing correlative work suggests meaningful overlaps between traditional functional descriptions and modern anatomical-physiological constructs, yet the nature, extent, and empirical validity of these correspondences require careful evaluation. This review therefore pursues four specific objectives: first, to map proposed neurophysiological mechanisms corresponding to Samaana Vaata functions as described in contemporary literature; second, to evaluate how this traditional concept integrates with current gut-brain axis frameworks; third, to assess available evidence regarding central nervous system influences on Samaana Vaata-related functions; and fourth, to compare Samaana Vaata's conceptual scope with well-defined phenomena like the migrating motor complex, thereby illuminating both convergences and divergences between traditional functional principles and modern mechanistic models.

2. METHODS

2.1 Literature Identification Strategy

Our methodological approach followed established guidelines for scoping review conduct, emphasizing comprehensive coverage of diverse literature sources.^[5] We systematically searched multiple electronic databases spanning both conventional biomedical literature (PubMed/MEDLINE, Scopus, Web of Science) and specialized repositories covering complementary medicine research. Search strategies combined controlled vocabulary terms and free-text keywords addressing Ayurvedic concepts (Samaana Vaata, Samana Vata, digestive Vaata), neurophysiological constructs (migrating motor complex, enteric nervous system, myenteric plexus, submucosal plexus, gastrointestinal motility), and integrative frameworks (gut-brain axis, gut-brain communication, neurogastroenterology). No temporal restrictions were imposed to capture the full evolution of this emerging research area. Reference lists of identified articles underwent manual screening to locate additional relevant sources not captured through database searches.

2.2 Selection Criteria

Articles qualified for inclusion if they addressed Samaana Vaata in relation to contemporary physiological or neurophysiological mechanisms, explored correlations between Ayurvedic digestive concepts and modern biomedical constructs, examined gut-brain communication pathways relevant to digestive regulation, or investigated neural control mechanisms governing gastrointestinal functions. We deliberately maintained broad inclusion criteria to capture the full conceptual landscape. Exclusion criteria removed purely clinical case reports lacking mechanistic discussion, traditional Ayurvedic texts without attempted modern correlations, non-English publications where translation was unavailable, and commentaries or editorials without substantive analysis. Both empirical studies and theoretical/review articles received consideration given the exploratory nature of this research area.

2.3 Data Analysis and Synthesis

Given the heterogeneous nature of included literature—spanning conceptual mappings, anatomical correlations, and mechanistic proposals—we employed narrative synthesis rather than quantitative meta-analysis. Data extraction focused on proposed anatomical substrates, specific neurophysiological mechanisms, neurotransmitter and neuromodulator involvement, hormonal influences, evidence for central nervous connectivity, and methodological quality indicators. We organized findings thematically around our four research objectives, identifying convergent themes and noting gaps or contradictions in the existing literature. This approach enabled comprehensive characterization of current knowledge while highlighting areas requiring further investigation.

3. RESULTS

3.1 Anatomical and Physiological Correlates of Samaana Vaata

Contemporary interpretations consistently map Samaana Vaata to specific components of the ENS explicitly state that 'neurotransmitter activity in the gastrointestinal tract can be considered as the functions of Samaana Vaata,' correlating this Ayurvedic construct with the myenteric plexus for motility control (governing Grahana and Munchana functions) and the submucosal plexus for secretion and absorption (governing Pachana and Vivechana functions). This anatomical mapping extends beyond the ENS to include sympathetic and parasympathetic autonomic supply, emphasizing Samaana Vaata's role in maintaining enteric homeostasis and gut barrier function.^[1]

The functional scope of Samaana Vaata encompasses all phases of digestion, from ingestion through nutrient separation and waste propulsion. This comprehensive regulatory principle situates it near Jatharagni (the 'digestive fire') within the koṣṭha (gastrointestinal tract), positioning it as a local gut wall phenomenon rather than extending to brainstem or higher CNS structures.^[1] This localization distinguishes Samaana Vaata from systemic Vaata functions and aligns it specifically with peripheral gut neural control mechanisms.

3.2 Integration with Gut-Brain Axis Frameworks

The modern gut-brain axis represents a bidirectional communication network involving multiple pathways: neural connections through the ENS, vagus nerve, and autonomic nerves; endocrine signaling via gut hormones and the hypothalamic-pituitary-adrenal (HPA) axis; immune pathways mediated by cytokines; and microbiota-derived metabolites.^[5,6,8] As a crucial peripheral link in this network, the ENS can operate independently while still being modulated centrally.^[9]

Samaana Vaata's correlation with ENS components positions it naturally within the gut-brain axis framework at the peripheral gut/ENS side.^[2] Any changes in 'Samaana Vaata-like' ENS activity would theoretically influence: (1) vagal and spinal afferents projecting to brainstem nuclei including the nucleus tractus solitarius (NTS) and dorsal motor nucleus of the vagus (DMV), subsequently affecting higher centers; and (2) microbiota-immune-neuroendocrine feedback loops, since ENS and gut barrier function shape microbiota composition and immune tone.^[2,10,11]

However, a critical limitation emerges in the current literature: no studies have traced a complete, explicit chain from specific 'Samaana Vaata states' to measurable CNS or behavioral outcomes. The integration remains conceptual and correlative rather than experimentally demonstrated.^[1,2] This represents a significant gap between traditional functional descriptions and modern empirical validation.

3.3 Evidence for Central Nervous System Modulation

Modern neurogastroenterology has identified detailed central circuits controlling gastrointestinal motility. The dorsal vagal complex (DVC)—comprising the NTS, DMV, and area postrema—serves as the primary brainstem hub for central control of gastric motility.^[12,13,14] Vagal afferents convey gut sensory signals to the NTS, where integration

with inputs from higher centers modulates DMV neurons that regulate gastric and intestinal motility via vagal efferents.

Crucially, available literature on Samaana Vaata does not describe any influence on CNS nuclei (NTS, DMV, hypothalamus, cortex) or on vagal/sympathetic preganglionic neurons. The Samaana Vaata framework remains confined to intrinsic enteric control of motility and secretion, without extending to central (brainstem or supratentorial) motility circuits. Contemporary reviews of central motility control detail how the CNS modulates the ENS but do not reference Samaana Vaata as a conceptual or experimental variable.^[12,13,14]

This creates an interesting parallel: while the ENS can function autonomously and generate complex motor patterns independent of CNS input, the traditional Samaana Vaata concept similarly emphasizes local gut regulation. However, modern physiology recognizes significant central modulation of ENS function—a dimension not yet empirically mapped onto the Samaana Vaata framework. Any claims that Samaana Vaata directly modulates central neurocircuits remain speculative and lack experimental support.

3.4 Comparative Analysis: Samaana Vaata and the Migrating Motor Complex

The migrating motor complex (MMC) provides an instructive comparison for understanding Samaana Vaata's scope and specificity. The MMC represents a well-defined, cyclic interdigestive motor pattern characterized by four phases, with phase III featuring strong propagating contractions that sweep undigested material through the intestines.^[1] This 'housekeeping' function occurs during fasting states and depends on intrinsic ENS circuits acting as central pattern generators (CPGs), with modulation from hormones (particularly motilin and ghrelin), neurotransmitters (acetylcholine, nitric oxide, serotonin, ATP, VIP), and vagal input.^[17,18]

Recent research has revealed that enteric glia, particularly through S100B protein signaling, play crucial roles in regulating excitability and rhythmicity within motor neurocircuits.^[19] The ENS can autonomously generate MMCs in isolated intestinal segments, demonstrating that central input modulates but is not essential for small bowel motor patterns, though gastric MMCs show greater vagal dependence.^[20]

The key distinction between MMC and Samaana Vaata lies in scope and specificity. The MMC is a discrete, experimentally measurable physiological phenomenon with defined phases, specific molecular mechanisms, and temporal characteristics confined to

interdigestive periods. In contrast, Samaana Vaata represents a broader regulatory principle encompassing all digestive phases—both fasting and feeding—and integrating motility with nutrient-waste separation (*Vivechana*), and propulsive movement (*Munchana*). While both concepts center on ENS networks as primary controllers, Samaana Vaata operates at a higher level of functional organization, potentially incorporating the MMC as one specific manifestation of its broader regulatory scope.

This comparison highlights a fundamental difference in conceptual frameworks: modern physiology dissects digestive regulation into discrete, measurable components (MMC, fed-state motility patterns, secretory responses), each with defined molecular mechanisms. Ayurvedic physiology, conversely, describes integrated functional principles (like Samaana Vaata) that encompass multiple modern physiological phenomena. Neither approach is inherently superior; rather, they represent complementary levels of analysis—molecular/mechanistic versus integrated/functional.

3.5 Neurotransmitter and Molecular Mechanisms

Both Samaana Vaata correlates and the MMC involve overlapping neurotransmitter systems. Key excitatory mechanisms include acetylcholine (ACh) acting through muscarinic receptors, while inhibitory mechanisms involve nitric oxide (NO), vasoactive intestinal peptide (VIP), and ATP.^[16,22] Serotonin (5-HT) serves multiple roles as both a neurotransmitter and paracrine signaling molecule, modulating motility, secretion, and sensory functions.^[22]

Hormonal modulation adds another layer of complexity. Motilin and ghrelin can trigger phase III MMC activity, particularly in the stomach and proximal small intestine.^[17,18] The identification of enteric glial modulation through S100B protein represents a recent advance, demonstrating that non-neuronal cells within the ENS actively regulate motor neurocircuit excitability and contribute to rhythmic motor patterns.^[19]

While these molecular mechanisms are well-characterized for specific motor patterns like the MMC, their relationship to the broader Samaana Vaata construct remains inferential. The statement that 'neurotransmitter activity in the GIT can be considered as the functions of Samaana Vaata'^[1] suggests a comprehensive correlation, but lacks the specificity needed to predict how alterations in particular neurotransmitter systems would manifest as Samaana Vaata imbalances in traditional diagnostic frameworks.

4. DISCUSSION

4.1 Synthesis of Evidence

This scoping review reveals substantial conceptual overlap between Samaana Vaata and modern neurophysiological constructs, particularly the ENS and gut-brain axis frameworks. The evidence supports interpreting Samaana Vaata as an integrative regulatory principle that encompasses what contemporary science dissects into myenteric control of motility, submucosal regulation of secretion and absorption, and their coordination to achieve effective digestion.^[1] This alignment positions Samaana Vaata naturally within the peripheral gut/ENS component of the gut-brain axis, with theoretical connections to central, immune, endocrine, and microbial pathways through established gut-brain communication routes.^[2]

However, critical gaps limit the current integration. Most significantly, no studies have empirically demonstrated how specific 'states' of Samaana Vaata (whether balanced or imbalanced) correspond to measurable alterations in ENS firing patterns, neurotransmitter profiles, or downstream CNS effects. The correlation remains conceptual—mapping traditional functional descriptions onto modern anatomical structures without experimental validation of the correspondence. This contrasts sharply with constructs like the MMC, where decades of research have established clear relationships between molecular mechanisms (motilin signaling, ICC pacemaker activity, myenteric neuron excitability) and observable physiological outcomes (phase III contractions, interdigestive cleansing).^[16,17]

4.2 Implications for Integrative Research

The integration of traditional medical frameworks with contemporary neuroscience faces both opportunities and challenges. On one hand, Ayurvedic concepts like Samaana Vaata may offer holistic perspectives that capture integrated function in ways that reductionist molecular approaches sometimes miss. Traditional systems emphasize functional balance and dynamic regulation, potentially complementing modern mechanistic understanding. On the other hand, rigorous integration requires empirical validation: which specific ENS parameters correspond to Samaana Vaata balance? How would Samaana Vaata imbalance manifest in measurable neurophysiological terms? What interventions that traditionally 'balance Samaana Vaata' actually alter ENS function, and through what mechanisms?

Several research directions emerge from this analysis. First, experimental studies could assess whether Ayurvedic diagnostic indicators of Samaana Vaata status correlate with measurable ENS parameters (motility patterns, neurotransmitter levels, electrophysiological recordings).

Second, interventional studies could evaluate whether treatments aimed at balancing Samaana Vaata (specific herbs, dietary modifications, practices) alter ENS function in predicted ways. Third, comparative physiology studies could examine whether the regulatory principles embodied in Samaana Vaata have analogues in other traditional medical systems, potentially revealing universal aspects of digestive regulation.

4.3 Limitations and Considerations

Several limitations affect this synthesis. The literature correlating Samaana Vaata with modern physiology remains relatively sparse, with most detailed analyses emerging only recently.^[1,2] Translation challenges exist when mapping concepts developed in classical Sanskrit texts onto categories established by Western biomedical science—the two frameworks may not align perfectly, and forcing correspondence could distort either or both perspectives.

Additionally, traditional Ayurvedic understanding emphasizes individual constitution (Prakriti), dynamic balance, and context-dependent manifestations—aspects that may not readily translate to universal neurophysiological mechanisms. What manifests as Samaana Vaata imbalance might involve different ENS parameters in different individuals, times, or contexts. This personalized, dynamic aspect represents both a potential strength (capturing individual variation) and a challenge (complicating standardized measurement and validation).

4.4 Future Directions

Future research should prioritize: (1) developing operational definitions linking Samaana Vaata concepts to measurable ENS parameters; (2) conducting prospective studies correlating traditional assessments with modern neurophysiological measures; (3) investigating whether enteric glial functions, recently recognized as critical for motor pattern generation,^[19] correspond to regulatory principles implicit in Samaana Vaata; (4) examining potential connections between Samaana Vaata states and central nervous system functions through gut-brain axis pathways; and (5) exploring whether computational models of ENS function can capture the regulatory dynamics described by Samaana Vaata principles.

Methodologically, successful integration will require interdisciplinary collaboration between Ayurvedic scholars, neurogastroenterologists, systems biologists, and clinicians. Research designs must respect the integrity of both frameworks while rigorously testing

correspondence hypotheses. Mixed-methods approaches combining traditional assessment techniques with modern experimental methods may prove particularly valuable.

5. CONCLUSIONS

This scoping review demonstrates that Samaana Vaata, as currently interpreted in contemporary literature, aligns conceptually with the enteric nervous system and its integrated control of digestive functions. Strong parallels exist at the level of anatomical structures (myenteric and submucosal plexuses) and functional roles (motility, secretion, absorption). The construct fits naturally within modern gut-brain axis frameworks as a peripheral regulatory principle, with theoretical connections to central, immune, endocrine, and microbial pathways.

However, empirical validation of these correlations remains limited. Direct evidence linking specific Samaana Vaata states to measurable ENS parameters, neurotransmitter profiles, or CNS effects is lacking. The comparison with well-defined constructs like the MMC highlights this gap: while the MMC represents a discrete, mechanistically understood phenomenon, Samaana Vaata encompasses broader regulatory principles that have not yet been decomposed into testable neurophysiological hypotheses.

The integration of traditional Ayurvedic concepts with contemporary neurogastroenterology offers promising opportunities for advancing both fields. Traditional perspectives may capture aspects of integrated function and dynamic regulation that complement molecular mechanistic approaches. However, realizing this potential requires rigorous empirical research that tests specific correspondence hypotheses while respecting the integrity of both conceptual frameworks. Future investigations should prioritize developing operational definitions, conducting prospective correlational studies, and exploring mechanistic links through the gut-brain axis.

As the field of neurogastroenterology continues evolving—with recent insights into enteric glial functions, gut microbiota influences, and bidirectional gut-brain communication—opportunities for meaningful integration with traditional medical frameworks will likely expand. The Samaana Vaata concept may ultimately prove valuable not only as a historical curiosity but as a functional framework that captures regulatory principles still being discovered by modern science.

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