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AYURVEDA MEETS THE GUT MICROBIOME: INTEGRATING ANCIENT KNOWLEDGE WITH CONTEMPORARY MICROBIOME RESEARCH

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ABSTRACT:
The human gut microbiome plays a central role in digestion, metabolism, immune regulation, intestinal integrity, and communication along the gut–brain axis. Growing interest in traditional medical systems has created new opportunities to examine Ayurvedic principles through the lens of contemporary microbiome science. This review explores the possible connections between key Ayurvedic concepts, including Agni, Ama, Ojas, Prakriti, and Dosha balance, and modern understandings of microbial homeostasis, dysbiosis, host metabolism, and disease susceptibility. It further evaluates how Ayurvedic dietary practices, seasonal and daily routines, meal timing, fasting, yoga, stress regulation, medicinal herbs, polyherbal formulations, Rasayana therapies, and Panchakarma may influence gut microbial diversity and function. Particular attention is given to commonly used interventions such as Triphala, curcumin, ginger, and ashwagandha, along with the role of microbial biotransformation in modifying the bioavailability and activity of phytochemicals. The review also discusses emerging evidence linking Ayurvedic interventions with gastrointestinal, metabolic, inflammatory, immune, and neuropsychological conditions. However, major limitations remain, including small sample sizes, methodological heterogeneity, insufficient standardization of formulations, and limited longitudinal and randomized clinical evidence. Future research should integrate metagenomics, metabolomics, and other multi-omics approaches with carefully designed clinical trials to establish mechanistic validity and therapeutic relevance. Such integration may support the development of personalized, preventive, and microbiome-informed healthcare rooted in both traditional knowledge and modern biomedical science.

KEYWORDS: Ayurveda; gut microbiome; Agni; Prakriti; dysbiosis; herbal medicine.

INTRODUCTION

The gut microbiome of humans is emerging as a dynamic biological ecosystem that plays a key role in human health and disease. The gastrointestinal microbiota is composed of trillions of microorganisms which are involved in digestion, use of nutrients, energy metabolism, immune regulation, and maintenance of intestinal barrier. The development of new sequencing and computational technologies has changed how the microbiome is understood from a set of commensal organisms to a metabolically active system that interacts with host physiology. Changes in the composition of microbes and their functions have been linked to obesity, type 2 diabetes, cardiovascular disease, inflammatory bowel disease, and other metabolic and inflammatory diseases (Fan & Pedersen, 2021).

The study of microbiological interactions, ecological relationships and metabolic outputs are increasingly highlighted, as well as interactions with the intestinal environment. This has led to microbiome studies being broadened into various fields of gastroenterology, immunology, nutrition, endocrinology, neuroscience and personalized medicine, and its use in understanding disease mechanisms and developing treatments (Huang et al., 2022). The gastrointestinal tract has a non-uniform distribution of microbial communities. The intestinal environment of the host is a heterogeneous habitat, where microbial biogeography and functional specialization occur along spatial niches, oxygen gradients, nutrient availability, pH, host secretions and other local conditions (McCallum & Tropini, 2024). The complexity underscores the importance of considering the gut microbiome in the context of diet, metabolism, lifestyle, host individuality and environmental exposures.

As microbiomes gain scientific importance, Ayurveda is also experiencing a resurgence in scientific interest as a traditional personalized and preventative healthcare system. In Ayurveda, individual diet, digestive function, medicinal plants and physiological balance are stressed. Instead of just intervening in diseases, Ayurvedic medicine takes care of health by considering the interactions that take place between food, digestion, constitution, lifestyle and environment.

The principles are applicable to integrative healthcare as many of the factors highlighted in Ayurveda are known to influence gut microbial composition and function.
The feasibility of modifying intestinal microbiota by dietary and lifestyle modifications as per Ayurveda is a subject of emerging literature. Dietary composition, dietary patterns, plant foods, spices, physical activity and behavioral patterns offer plausible pathways by which Ayurvedic interventions might impact microbial ecology and host metabolism. Chauhan et al., (2023) emphasized the hypothesis of the importance of Ayurvedic diet and lifestyle in gut microbiota modulation in metabolic disturbances like type 2 diabetes. The gut microbiota has been discussed as a potential link in which Ayurvedic concepts and therapies could have an impact on metabolic health and the management of metabolic disease by Jangra et al. (2025). But there are not enough mechanistic and clinical data, and one must be careful about the equivalences between the traditional notions and biomedical mechanisms.
The relevance of the integration of Ayurveda with microbiome research is due to its emphasis on variation in the biological mechanism. Prakriti is the ayurvedic term for an individual's constitutional phenotype (phenotype), and is traditionally used to inform dietary, lifestyle and therapeutic recommendations. Personalized ayurvedic approaches to disease management also converge with microbiome-based approaches to stratification as microbiome science also reveals significant inter-individual variation in gut microbial communities. Jnana et al. (2020) suggested that Prakriti phenotypes may provide a useful means to stratify the microbiome traits and as such offer an emerging “biological” approach to individual Ayurvedic classification.
Empirically, it has been found that there are microbial signatures that are unique to Ayurvedic Prakriti. The authors of Shalini et al. (2021) observed distinct gut and oral microbiome signatures of various Prakritis, warranting the exploration of the relationship between the constitutional types and gut and oral microbiome. These results are preliminary and do not indicate that the Ayurvedic constructs are related to specific microbial configurations. Instead, they are a testable framework to consider if traditional classification models reflect aspects of host biology in relation to microbial composition and function.
This review is a critical appraisal of convergence between Ayurvedic knowledge and contemporary gut microbiome science. It addresses concepts from Ayurveda that pertain to digestion and health such as Agni, Ama, Ojas, Prakriti and Dosha imbalances, and considers potential relationships with microbial homeostasis, dysbiosis, metabolism and host susceptibility. It also discusses the evidence on Ayurvedic diet, life style, fasting, circadian rhythm, yoga, medicinal plants, polyherbal formulations, Rasayana therapy, panchakarma, and microbial biotransformation of phytochemicals. Distinction makes a big difference between conceptual parallels and experimentally demonstrated mechanisms with a particular emphasis.

2. The Human Gut Microbiome: Composition and Biological Functions

2.1 Composition and Development of the Gut Microbiota

Human gut microbiota is a complex ecosystem with bacteria as the dominant component, but also includes archaea, fungi, viruses, and other microorganisms. It is formed in early life and affected by diet, age, genetic factors, medications, lifestyle and environmental factors. The different parts of the gastrointestinal tract have different pH, oxygen levels, nutrients, mucus levels, and intestinal transit times, leading to the existence of distinct ecological niches, with functions of microbial communities (McCallum & Tropini, 2024). Although there is significant interindividual differences, there is a strong association between microbial composition and functional activity with metabolic and physiological health (Fan & Pedersen, 2021).

2.2 Role in Digestion, Metabolism, Immunity, and Intestinal Homeostasis

In addition to the digestive function of food digestion, gut microorganisms perform additional functions such as fermentation of indigestible dietary substrates to produce metabolites that regulate energy balance, glucose homeostasis, and host metabolism. These dietary changes can therefore impact on the composition of microbes and metabolic health (Howard et al., 2022). In addition, the microbiota also plays a role in innate and adaptive immunity, and metabolites of the microbiota regulate inflammatory pathways and immune tolerance (Yang & Cong, 2021). A healthy microbial ecosystem helps maintain integrity of the epithelial barrier and intestinal homeostasis, while the disruption of host–microbial interactions are strongly linked with chronic intestinal inflammation and inflammatory bowel disease (IBD) (Shan et al., 2022). Meta-omics research further supports close links among diet, gut microbial function, and cardiometabolic health (Valles-Colomer et al., 2023).

2.3 Microbial Metabolites and Host–Microbiome Communication

Microbial metabolites are key signals in communication between the gut microbiota and host. Microbiota metabolites, such as short-chain fatty acids, bile acid derivatives, indoles, and others, regulate metabolic, epithelial, endocrine, and inflammatory processes. The disruption of the production of these compounds is associated with metabolic disorders (Agus et al., 2021). Other compounds, such as short-chain fatty acids, secondary bile acids, and indoles, influence enteroendocrine signalling, appetite, and glucose regulation (Masse & Lu, 2023). Further, the communication between the microbiota and the central nervous system occurs via neural, endocrine, immune, and metabolic pathways, all of which make up the microbiota–gut–brain axis (Morais et al., 2021).

2.4 Gut Dysbiosis and Its Association with Human Diseases

Dysbiosis of the gut are the disturbance in the composition, diversity, function and/or ecological stability of the microbial community that results in a loss of homeostasis of the host. The imbalance of metabolism of microbes and host–microbial interactions both cause intestinal inflammation and progression of inflammatory bowel diseases (Adolph et al., 2022). Specific microbiome profiles have also been examined for their link as biomarkers of the risk of inflammatory and metabolic diseases (Metwaly et al., 2022). An alteration in the diversity and activity of microbial communities has been linked specifically to the intestinal homeostasis disruption in inflammatory bowel disease, though there is not yet a clear causal connection (Shan et al., 2022). The gut microbiome is a significant biological interface between diet, metabolism, immunity, gut integrity and susceptibility to disease.

3. Ayurvedic Understanding of Digestion and Gut Health

3.1 Fundamental Principles of Ayurveda

In Ayurveda, health is seen as a dynamic balance between physiological functions, diet, lifestyle, environment, and individual physiology. It emphasizes on prevention, personalized care, digestive efficiency and internal balance. Agni, Ama, Ojas, Prakriti and the three doshas Vata, Pitta and Kapha are the core concepts. Emerging studies have started to explore if dietary and lifestyle guidance from Ayurveda can affect gut microbiome structure and function (Chauhan et al., 2023). It has also been suggested that the gut microbiota could serve as a potential biological pathway by which certain Ayurvedic techniques can modulate metabolism and susceptibility to disease (Jangra et al., 2025).

3.2 Role of Agni in Digestion and Metabolism

According to Ayurveda, Agni is the functional ability of digestion, transformation, assimilation and metabolism. Efficient digestion and physiological stability are correlated to Balanced Agni and digestive and systemic disturbances to impaired Agni. In modern times, this concept can be loosely analogized to nutrient processing, metabolic regulation and host–microbial interactions. The potential of diet and lifestyle measures in Ayurveda for gut microbiota modulation and metabolic health have been discussed (Chauhan et al., 2023). Similarly, the emerging literature correlate's digestive function, microbial activity, and metabolic disease from an Ayurvedic perspective (Jangra et al., 2025). Agni should not be viewed as a gut microbiome per se.

3.3 Concepts of Ama, Ojas, and Gastrointestinal Imbalance

Ama is associated with partial digestion, impaired digestion and metabolism, while Ojas is associated with vitality, resilience and physiological stability. The following concepts could be used as a traditional approach to talking about digestive and metabolic imbalance. The dietary and lifestyle interventions used in Ayurveda to achieve digestive balance are believed to be potential modulators of gut microbial and metabolic health (Chauhan et al., 2023). Similarly, the changed microbial profile can provide a modern-day biological backdrop to explore the classical notions of gastrointestinal imbalance (Jangra et al., 2025). These relationships are still of a conceptual nature, and must be validated mechanically.

3.4 Influence of Prakriti and the Three Doshas on Digestive Health

Prakriti is the individual's constitutional phenotype, which represents the relative predominance of the Vata, Pitta, and Kapha and traditionally leads to personalized dietary, lifestyle, and therapeutic recommendations. In recent works, efforts have been directed towards studying if there exists a measurable difference between the microbes of the different Prakriti phenotypes. Prakriti was proposed as a possible stratifier of the gut microbiome and its relevance to biological individuality and personalized health by Jnana et al. (2020). Shalini et al. (2021) also found orally specific gut and oral microbial signatures for each of the Ayurvedic Prakriti groups. While these results suggest a link between the microbial ecology and the constitutional phenotypes, more and standardized research is required to validate this link.

4. Integrating Ayurvedic Concepts with Contemporary Microbiome Science

4.1 Agni as a Traditional Framework for Metabolic and Microbial Activity

Ayurvedically, Agni is the capacity of digestion and metabolism, including transformation, assimilation and maintenance of metabolic balance. The gut microbiota is also a dynamic participant in nutrient utilization, energy metabolism and metabolite synthesis as revealed by modern microbiome science. For this reason, Ayurvedic diet and lifestyle measures for the support of Agni have been mentioned in relation to microbial and metabolic health (Chauhan et al., 2023). The interaction of diet and microbiota also affects glucose homeostasis and host metabolism (Howard et al., 2022), and the metabolites produced by the microbiota can regulate metabolic responses and produce dysfunction when the balance of the microbiota is disrupted (Agus et al., 2021). But Agni is not a "straight" biological parallel of the process of microbial metabolism, it is a traditional conceptual framework.

4.2 Ama and Its Possible Relationship with Dysbiosis and Metabolic Endotoxemia

Ama is believed to be the result of incomplete digestion or metabolic processing. Conceptual parallels can be made with dysbiosis, changes in microbial metabolites, leakage of the intestinal barrier and systemic inflammation. When microbial homeostasis is disturbed, gut metabolites can contribute to the metabolic disturbance (Agus et al., 2021). Inflammatory and metabolic disease risk has also been linked to alterations in the microbiome (Metwaly et al., 2022) and inflammatory bowel disease shows complex interactions between microbial metabolism, barrier dysfunction, and immune responses (Adolph et al., 2022). However, there is a difference between Ama and metabolic endotoxemia and they are not the same.

4.3 Prakriti-Based Differences in Gut Microbial Composition

Prakriti is an Ayurvedic model that explains variation among people in terms of constitution. The gut microbiome differences among Prakriti phenotypes were also proposed by Jnana et al. (2020) and could be pertinent to personalized microbiome research. Some unique mouth and gut microbial signature among specific Prakriti groups have also been identified by Shalini et al. (2021). These results suggest that there may be a significant association between constitutional phenotypes and the microbial ecology; however, further studies with more subjects and larger sample size are needed to confirm the association. Specific differences in the abundance of gut microbes among Vata, Pitta, and Kapha types are further observed in the differences in the load of individual bacterial taxa, as shown in Figure 1.

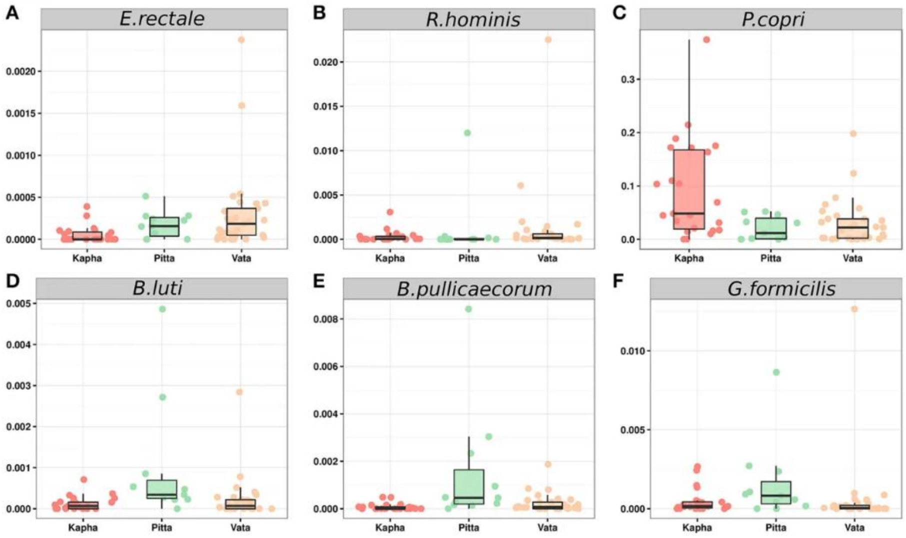

Figure 1. Relative abundance of Prakriti-specific signature gut bacterial taxa among Vata, Pitta, and Kapha female subjects (Chauhan et al., 2018)

4.4 Dosha Imbalance, Intestinal Homeostasis, and Host Susceptibility

The understanding of health in Ayurveda is in part represented by the balance of Vata, Pitta, and Kapha, while microbiome science focuses on ecological stability and the relationship between microbes and the host. The Ayurvedic view posits that disruptions in digestive and metabolic equilibrium can also coexist with changes in microbes in metabolic diseases (Jangra et al., 2025). Recent research also links alterations in the composition and activity of gut flora to obesity, diabetes and other diseases (Fan & Pedersen, 2021). The risk profile of the microbiome can also affect the susceptibility of each person to inflammatory and metabolic diseases (Metwaly et al., 2022). Therefore, one can make conceptual comparisons between Dosha imbalance and dysbiosis but cannot directly equate the two.

4.5 Areas of Convergence and Conceptual Limitations

The most apparent commonalities between Ayurveda and microbiome science are the focus on biological individuality, diet, digestion, and environmental factors that impact health. Based on the concept of Prakriti, microbiome studies have proposed that using conventional constitution may provide valuable hypotheses for inter-individual variation in the microbiome (Jnana et al., 2020). Variations between the Prakriti groups corroborate further study, but cannot be attributed to causality (Shalini et al., 2021). Likewise, an effective personalized microbiome-based intervention should consider variation in microbial diversity, nutrition, metabolism and drug response (Schupack et al., 2022). Thus, Ayurveda–microbiome integration is not evidence of any biomedical equivalence, but should be approached as a cross-disciplinary, hypothesis generating approach. The following sections review the conceptual overlaps and their drawbacks and summarize these in Table 1. Figure 2 shows the proposed relationship between the ayurvedic concepts and practices, the composition and function of the gut microbiome and how they are expected to affect digestive, metabolic, immune, neurological, cardiovascular and endocrine health.

Table 1. Conceptual Relationships Between Ayurvedic Principles and Contemporary Gut Microbiome Science

Ayurvedic concept	Traditional interpretation	Potential contemporary microbiome relevance	Important limitation	References
Agni	Capacity for digestion, transformation, assimilation, and metabolism	Nutrient processing, microbial metabolism, metabolite production, and host metabolic regulation	Agni is not biologically equivalent to microbial metabolism	Chauhan et al. (2023); Howard et al. (2022); Agus et al. (2021)
Ama	Incompletely processed material associated with impaired digestion/metabolism	Possible conceptual correspondence with dysbiosis, altered microbial metabolites, barrier dysfunction, and metabolic inflammation	Ama should not be equated directly with endotoxemia or dysbiosis	Agus et al. (2021); Metwaly et al. (2022); Adolph et al. (2022)
Ojas	Vitality, resilience, and physiological stability	May be conceptually considered alongside immune homeostasis and host resilience	No validated microbiome biomarker represents Ojas	Chauhan et al. (2023); Jangra et al. (2025)
Prakriti	Individual constitutional phenotype	Potential stratification according to interindividual microbial differences	Evidence is preliminary and population dependent	Jnana et al. (2020); Shalini et al. (2021)
Dosha	Functional equilibrium	Conceptual comparison with	Doshas are not	Jangra et al.

balance	among Vata, Pitta, and Kapha	ecological stability and host–microbiome homeostasis	microbial community types	(2025); Fan and Pedersen (2021)

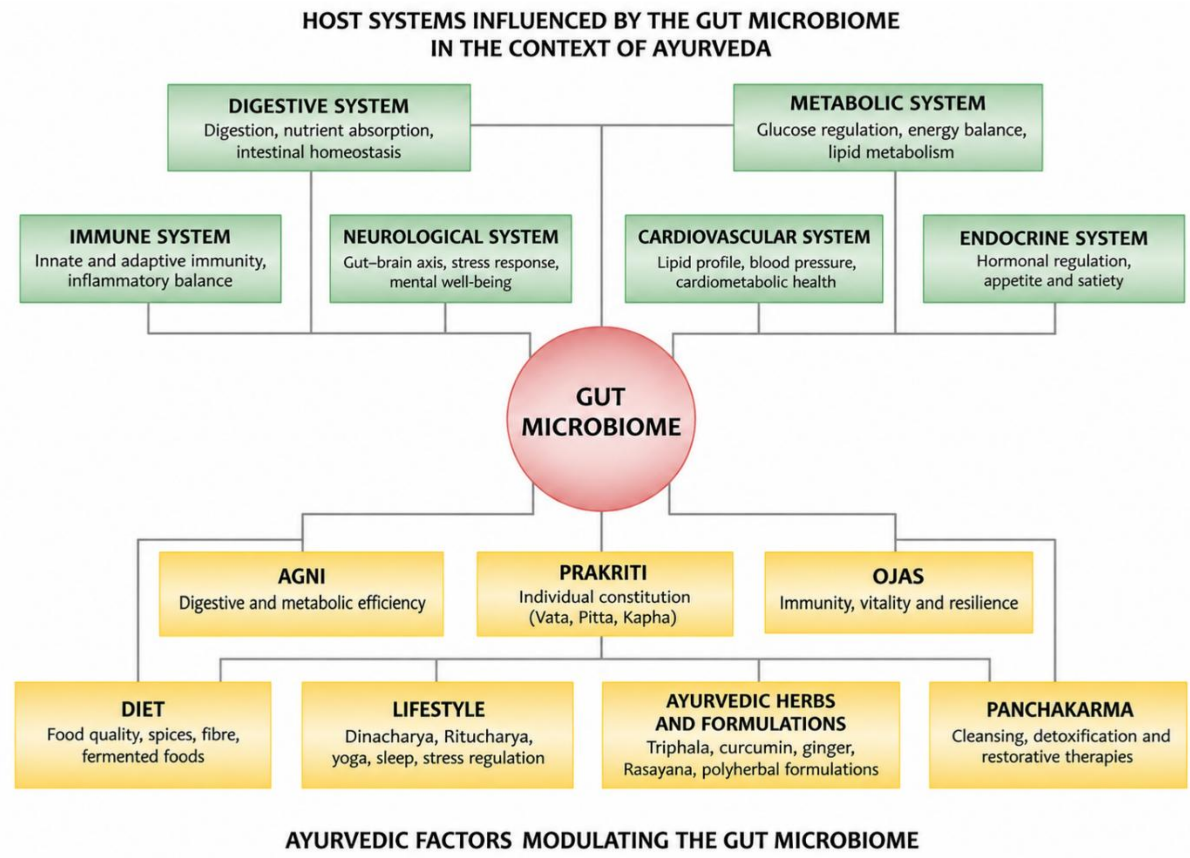

Figure 2. Integrative framework showing the relationship between Ayurvedic factors, gut microbiome modulation, and host physiological systems

5. Ayurvedic Diet and Lifestyle as Modulators of the Gut Microbiome

5.1 Individualized Dietary Recommendations Based on Prakriti and Agni

In Ayurveda, diet is personalized since Prakriti, Agni, season, lifestyle and health status. This is like precision nutrition, which acknowledges substantial interindividual differences in metabolic and microbial responses to food. The composition of the gut microbiota could possibly be used to predict the response to dietary and weight management interventions (Hernández-Calderón et al., 2022). The personalized nutrition based on the microbiome is thus under investigation for personalized dietary recommendations based on the individual's biological characteristics (Simon et al., 2023). The concept of personalized diet based on microbial profile is similar in some respects to the concept of individualized nutrition (Ayurveda) (Song & Shin, 2022). Also, dietary and lifestyle recommendations of Ayurveda have been suggested to modulate microbial composition and metabolic health (Chauhan et al., 2023).

5.2 Effects of Dietary Diversity, Spices, Fibre, and Fermented Foods

Gut microbial composition and function are influenced by diet. A person's gut microbiome and metabolism are also linked to their eating habits (Asnicar et al., 2021). Dietary fibre can serve as fermentable substrates for the microorganisms in the intestine, and fermented foods can provide microorganisms and bioactive compounds that can affect the gut ecosystem (Leeuwendaal et al., 2022). Herbs and spices are common ingredients in Ayurvedic diets which can have a regulatory effect on the microorganisms and host metabolism (Sudheer et al., 2022). Plant-based eating patterns also could support beneficial shifts in the microbiome and health (Cassidy, 2020). Moreover, polyphenols from the diet can be further metabolized by gut microorganisms into bioactive metabolites, altering their bioavailability and physiological activity (Alqudah & Claesen, 2024).

5.3 Meal Timing, Fasting, and Circadian Regulation of the Microbiome

In Ayurveda, time of meals is important and periods of rest for the digestive system are encouraged. The current evidence indicated that the gut microbial communities have circadian oscillations, which are associated with the feeding pattern, metabolism, and sleep–wake cycle (Bishehsari et al., 2020). Dietary signals can also be mediated by gut microbes and affect the circadian metabolism of the host (Choi et al., 2021). The results regarding the effects on microbial diversity, metabolite production and metabolism regulation are inconclusive, and intermittent fasting might have the ability to shift them all (Paukkonen et al., 2024). There is also systematic evidence of the effect of the day's feeding window changes on the composition and function of the microbiome (Pérez-Gerdel et al., 2023). Studies on the microbiome during Ramadan also show that the changes in the microbiome are influenced by fasting and its corresponding dietary and lifestyle habits (Saglam et al., 2023). A scoping review further suggests that intermittent fasting may influence gut microbial composition and function, although current human evidence remains heterogeneous (Popa et al., 2023).

5.4 Dinacharya and Ritucharya in Maintaining Microbial Balance

Dinacharya and Ritucharya help bring into harmony the activities of day and season and our bodies' physiology. While there is currently limited direct evidence from the microbiome, there is a biological framework in circadian research. The composition and function of microbiota undergo daily oscillations related to feeding schedules and host metabolism (Bishehsari et al., 2020). Changes in the timing of the meal may affect microbial communication and metabolic balance (Choi et al., 2021). Hence, the Ayurvedic suggestions for regular food intake, sleep, activity, and seasonal variation could potentially help maintain the microbial and metabolic balance (Chauhan et al., 2023).

5.5 Yoga, Sleep, Stress Regulation, and the Gut–Brain Axis

Physical activity, mental balance, proper sleep and stress management are also important aspects of Ayurvedic lifestyle practices. Some studies have explored the potential impact of yoga and meditation on gut microbiota, but the findings are still preliminary (Math et al., 2025). These practices can impact the microbiota–gut–brain axis, a complex network of neural, endocrine, immune, and metabolic communication (Morais et al., 2021). This communication and its systemic impact on the central nervous system and gastrointestinal system is further controlled by gastrointestinal and brain barriers (Aburto & Cryan, 2024). All in all, an Ayurvedic lifestyle approach can impact on gut health in a coordinated fashion on diet, circadian control, stress physiology and host–microbiome interactions. The main dietary and lifestyle factors and their possible association with gut microbial composition and function are summarized in Table 2.

Table 2. Ayurvedic Diet and Lifestyle Factors Potentially Modulating the Gut Microbiome

Diet/lifestyle factor	**Ayurvedic context**	**Potential microbiome-related effect**	**Current interpretation**	**References**
Individualized diet	Diet according to Prakriti and Agni	Individual-specific microbial and metabolic responses to food	Potential link with personalized nutrition	Hernández-Calderón et al. (2022); Simon et al. (2023)
Plant-rich dietary diversity	Diverse foods adapted to individual digestive capacity	Increased substrate diversity for microbial metabolism	Dietary patterns strongly influence microbiome structure	Asnicar et al. (2021)
Spices and phytochemicals	Routine use of herbs and spices	Microbial modulation and generation of bioactive metabolites	Bidirectional phytochemical–microbiome interactions	Sudheer et al. (2022); Alqudah and Claesen (2024)
Fermented foods	Traditionally consumed dietary preparations	May introduce microorganisms and microbial metabolites	Effects depend on food type and microbial composition	Leeuwendaal et al. (2022)
Fasting	Periodic digestive rest	Possible alterations in microbial diversity and metabolic function	Human evidence remains heterogeneous	Paukkonen et al. (2024); Pérez-Gerdel et al. (2023)
Meal timing	Regularity of food intake	Synchronization of microbial and host circadian rhythms	Feeding time is an important circadian cue	Choi et al. (2021)
Dinacharya/Ritucharya	Daily and seasonal routines	Possible alignment of lifestyle with host–microbial rhythms	Direct evidence for these Ayurvedic practices is limited	Bishehsari et al. (2020); Chauhan et al. (2023)
Yoga and meditation	Mind–body regulation	Potential modulation through stress and gut–brain pathways	Emerging evidence; further controlled studies required	Math et al. (2025); Morais et al. (2021)

6. Ayurvedic Herbs and Formulations in Microbiome Modulation

6.1 Triphala and Gastrointestinal Microbial Homeostasis

Triphala is a classical Ayurvedic formulation, which is composed of the three plants Terminalia chebula, Terminalia bellirica and Phyllanthus emblica and it has been reported that it could affect the gut microbial ecology. Human evidence indicates that Triphala supplementation could alter gut microbiota composition, but this effect needs to be validated clinically (Peterson et al., 2020). The latest studies also emphasize the association between Triphala phytochemicals interacting with the metabolism of microorganisms and metabolic health (Gurjar et al., 2025). Triphala polyphenols can also undergo additional metabolic transformations by gut microbes leading to the production of bioactive metabolites like urolithins, which have antioxidant and anti-inflammatory properties (Jangra et al., 2026). The results suggest that there is a potential role of the microbiome in the gastrointestinal health effects of Triphala.

6.2 Curcumin, Ginger, Ashwagandha, and Other Medicinal Plants

The anti-inflammatory and metabolic effects of turmeric could be mediated partly by its principal bioactive component, curcumin, which is known to modulate the gut microbiota (Balaji et al., 2025). Clinical studies have also explored the changes in microbial community associated with curcumin in individuals with inflammatory bowel disease and healthy subjects; however, results are context-dependent (Kroon et al., 2026). Turmeric-based interventions have also exhibited several benefits in IBS, although clinical outcomes are varied (Jafarzadeh et al., 2022). Bioactive substances in ginger (Zingiber officinale) can affect the intestinal flora, inflammation, digestive function and microbial metabolism (Lai et al., 2022). In general, phytochemicals from plants can also influence the makeup of microbes and produce metabolites with different biological activities (Sudheer et al., 2022). Ashwagandha is a popular herbal supplement in Ayurvedic medicine, but there is still not as much evidence regarding its effects on the microbiome as there is for Triphala, curcumin, and ginger.

6.3 Rasayana Therapies and Their Possible Prebiotic Effects

Rasayana treatments are a system of ancient medicine that focuses on enhancing the body's vitality, resilience and physiological balance. A variety of intestinal microorganisms can interact with many preparations, which contain polyphenols and other plant constituents. According to the Rasayana tradition, Triphala can affect microorganisms and metabolism (Gurjar et al., 2025). Additionally, preliminary evidence indicates that human supplementation studies can demonstrate effects on gut microbiota composition (Peterson et al., 2020), with Ayurvedic botanical formulations. Products rich in phytochemicals may thus have potential prebiotic properties that involve modulation of microbial ecology and production of metabolites but may not have been classified as prebiotics in the near future.

6.4 Polyherbal Formulations and Herb–Microbiome Interactions

The Ayurvedic polyherbal formulations can have multiple interactions between the plants, the flora of the gut and the metabolism of the body. The interest in microbiome mediated mechanisms of Ayurvedic formulations has been growing and a recent randomized controlled trial protocol includes gut microbiota as an outcome (Khanduri et al., 2026). Herbal compounds may also be enzymatically transformed and produce metabolites by gut bacteria, which can alter their activity (Chen et al., 2025). Further, human evidence supports changes in the microbial ecosystem with combined botanical interventions (Peterson et al., 2020). With the growing acceptance of the gut microbiota in Ayurvedic research, the role of the microbiota in herbal and lifestyle medicine for metabolic diseases is gaining more attention (Jangra et al., 2025).

6.5 Microbial Biotransformation and Bioavailability of Ayurvedic Phytochemicals

The microbial biotransformation is a crucial point of linkage between the ayurvedic phytochemicals and host physiology. Unabsorbed polyphenols are metabolized by gut bacteria to produce smaller, more absorbable metabolites that have different biological activity (Alqudah & Claesen, 2024). Many medicinal natural products also undergo similar processes, thus affecting their pharmacokinetics, efficacy, and metabolic fate (Ansari et al., 2023). In Triphala, polyphenols are chemically altered by microorganisms into compounds known as urolithins that offer antioxidant and anti-inflammatory benefits (Jangra et al., 2026). There can be a bidirectional interaction between the microbiome and the phytochemicals, as microbiota can also affect the effect of herbs, and herbs may alter the structure and function of the microbiota (Chen et al., 2025). This bi-directional communication between plant and microbes offers a possible link between Ayurvedic pharmacology and modern microbiome research. Representative ayurvedic herbs/fomulations and their suggested microbiome related mechanisms are summarized in Table 3, along with some of the evidence which exists at present. Figure 3 shows the intestinal absorption, gut microbial biotransformation and systemic distribution of metabolites derived from phytochemicals.

Table 3. Ayurvedic Herbs and Formulations with Potential Gut Microbiome-Modulating Effect

Herb/formulation	Major constituents/features	Proposed microbiome-related action	Reported relevance	References
Triphala	Polyphenol-rich combination of three medicinal fruits	Modulation of microbial composition and microbial transformation of polyphenols	Gastrointestinal and metabolic homeostasis; generation of urolithins	Peterson et al. (2020); Gurjar et al. (2025); Jangra et al. (2026)
Turmeric/curcumin	Curcuminoids	Modulation of microbial communities and inflammatory pathways	Investigated in IBS and IBD-related settings	Jafarzadeh et al. (2022); Balaji et al. (2025); Kroon et al. (2026)
Ginger	Gingerols, shogaols, and related phytochemicals	Potential modulation of microbiota and microbial metabolism	Gastrointestinal and anti-inflammatory relevance	Lai et al. (2022)
Ashwagandha	Withanolides and other phytochemicals	Potential microbiome interaction remains insufficiently characterized	Evidence insufficient for strong microbiome-specific conclusions	Current reference set provides insufficient direct evidence
Trikatu	Polyherbal Ayurvedic formulation	Potential alteration of microbial composition alongside metabolic effects	Under clinical investigation in dyslipidemia	Khanduri et al. (2026)
Triphala + Manjistha	Combined botanical supplementation	Modulation of human gut microbial	Preliminary randomized pilot	Peterson et al. (2020)

		composition	evidence	
Phytochemical-rich herbal preparations	Diverse polyphenols and secondary metabolites	Reciprocal herb–microbiome interactions and biotransformation	May influence bioavailability and biological activity	Chen et al. (2025); Ansari et al. (2023)

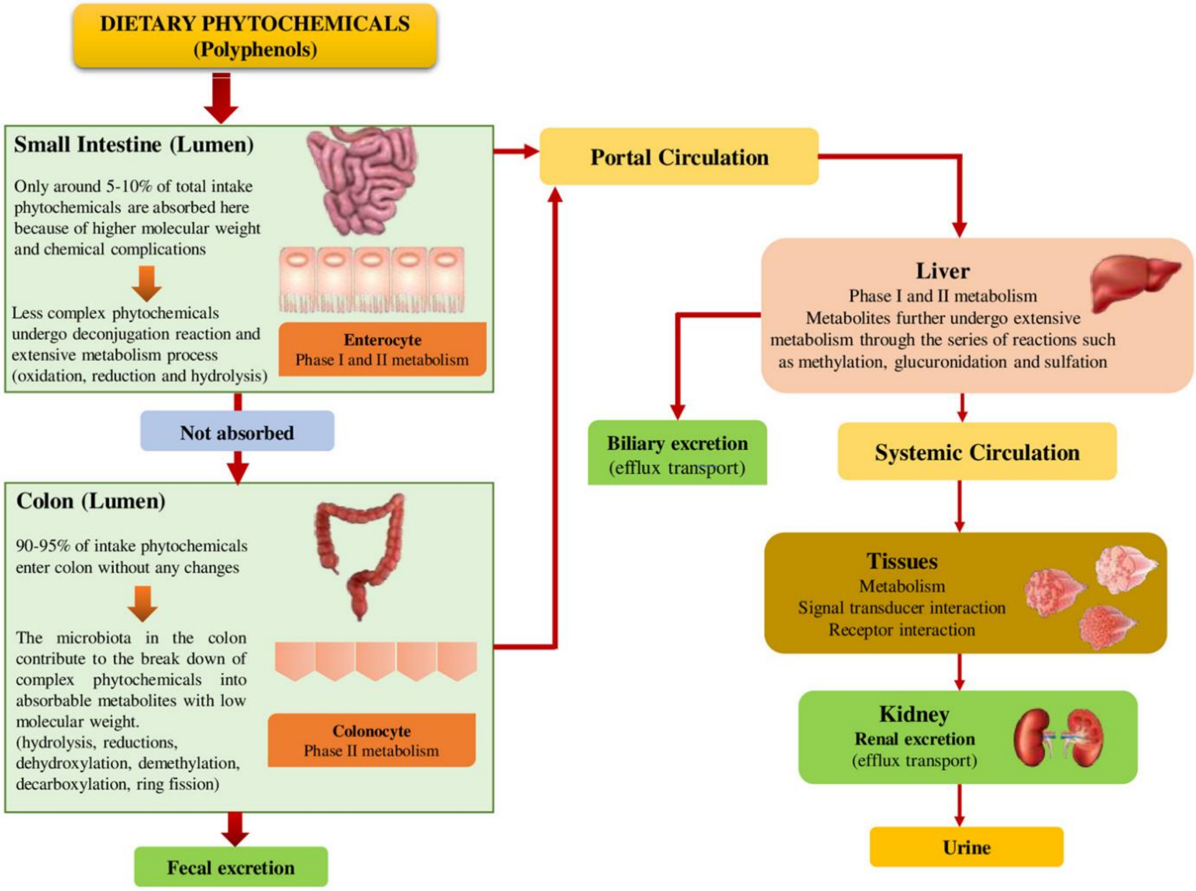

Figure 3. Metabolic fate and microbial biotransformation of dietary phytochemicals (Santhiravel et al., 2022)

7. Panchakarma and Microbiome-Targeted Therapeutic Applications

7.1 Ayurvedic Cleansing and Detoxification Principles

Panchakarma is a classical Ayurvedic treatment therapy that consists of preparatory, purification and recuperative measures that aim to restore physiological balance. It's usually associated with getting rid of metabolic waste, digestive function and general balance. Microbiological and metabolic processes could be affected due to the dietary and digestive regimen and lifestyle of ayurvedic healing (Chauhan et al., 2023). The gut microbiota has also been suggested as a possible bridge between the effects of Ayurvedic practices and metabolic health (Jangra et al., 2025). However, the traditional detoxification concepts cannot be directly correlated with the microbiome-mediated detoxification mechanism.

7.2 Potential Effects of Panchakarma on Gut Microbial Composition

The beneficial effects of Panchakarma on the gut microbes are perhaps related to alterations in diet, fasting, bowel movements, herbal exposure and the lifestyle. These factors can change the condition of the bowel and the normal flora. The literature on ayurveda emphasizes that the wide range of possibilities exists for the use of traditional methods to impact the gut microbial ecology (Jangra et al., 2025), and ayurvedic diet and lifestyle practices have been linked to microbiota modulation and metabolic regulation (Chauhan et al., 2023). However, there is scant clinical data to support the microbiome changes that occur reliably following Panchakarma.

7.3 Ayurveda-Based Interventions in Metabolic and Gastrointestinal Disorders

The use of ayurvedic interventions is gaining popularity for metabolic and gastrointestinal conditions where the gut microbiome could play a role in disease. In diseases like type 2 diabetes, dietary and lifestyle approaches have been suggested to modulate and regulate the microbiota and the metabolism (Chauhan et al., 2023). Evidence-based interactions among traditional therapeutics, microbial ecology and metabolic disease management are also indicated in the ayurvedic context (Jangra et al., 2025). Gut microbiota has been recently included as an outcome parameter in a randomized controlled trial protocol of Trikatu in dyslipidemia (Khanduri et al., 2026). Clinical studies of turmeric's efficacy in IBS have been inconsistent, but it has demonstrated some potential benefits (Jafarzadeh et al., 2022). The effect of curcumin on gut microbiota has also been assessed in patients with ulcerative colitis, Crohn's disease and healthy controls (Kroon et al., 2026).

7.4 Relevance to Inflammatory, Immune, and Neuropsychological Conditions

There may be interactions between Ayurveda and the microbiome in certain inflammatory, immune-related and neuropsychological diseases. Intestinal inflammation in inflammatory bowel disease (IBD) is associated with alterations in the metabolism of the intestinal microbiota and in host–microbial interactions (Adolph et al., 2022). Microbiota-derived metabolites can induce the regulation of immunity and inflammatory pathways (Yang & Cong, 2021), and microbiota–gut–brain signaling serves as a pathway that may allow microbial changes to impact behavior, stress responses, and neurological function (Morais et al., 2021). This bidirectional communication is also regulated by gastrointestinal and brain barriers (Aburto & Cryan, 2024). The risk markers are also linked to inflammatory and metabolic disease susceptibility that come from the microbiome (Metwaly et al., 2022). The existing clinical and experimental literature on the microbiome effect of some Ayurvedic measures is summarized in Table 4.

7.5 Current Clinical and Experimental Evidence

There is limited evidence for microbiome modulation in relation to ayurveda. In a pilot study with a random control design, human gut microbiota changes in response to Triphala and Manjistha supplementation were reported (Peterson et al., 2020). Clinically, investigation has also grown to include Trikatu, and gut microbiota is a pre-defined outcome in a randomized trial protocol for dyslipidemia (Khanduri et al., 2026). The effects of curcumin on the composition of microbes in healthy populations and in inflammatory bowel disease have been evaluated (Kroon et al., 2026). Experimental studies also indicate that gut microbes can metabolize the polyphenols of Triphala into urolithins, which possess antioxidant and anti-inflammatory properties (Jangra et al., 2026). There is systematic evidence supporting the possible gastrointestinal benefit of turmeric in IBS, with conflicting evidence relating to the formulations and outcomes (Chetty & Blekhman, 2024). In conclusion, the overall results are encouraging but not conclusive enough to prove Panchakarma or other Ayurvedic treatments as proven microbiome-targeted therapies. Advanced multi-omic integration methods may further improve mechanistic interpretation of complex host–microbiome interactions (Muller et al., 2026). Figure 4 depicts a personalised treatment pipeline, where the biological and lifestyle data are combined with the microbiome-based metabolic modelling for personalised therapeutic strategies.

Table 4. Current Clinical and Experimental Evidence for Ayurveda-Related Gut Microbiome Interventions

Intervention/exposure	Evidence type	Focus	Microbiome/clinical relevance	Major limitation	References
Triphala and Manjistha	Randomized, double-blind, placebo-controlled pilot study	Human gut microbiota	Preliminary evidence of microbiota modulation	Pilot-scale evidence	Peterson et al. (2020)
Trikatu	Randomized, double-blind, placebo-controlled trial protocol	Dyslipidemia and gut microbiota	Designed to evaluate metabolic and microbiome outcomes	Protocol does not establish efficacy	Khanduri et al. (2026)
Curcumin	Clinical microbiome investigation	Healthy participants and patients with UC/Crohn's disease	Evaluation of curcumin-associated microbial changes	Effects may vary according to disease state	Kroon et al. (2026)
Triphala polyphenols	Experimental/mechanistic study	Microbial biotransformation	Formation of urolithins associated with antioxidant and anti-inflammatory activity	Mechanistic evidence requires broader clinical validation	Jangra et al. (2026)
Turmeric	Systematic review	Irritable bowel syndrome	Potential gastrointestinal therapeutic benefit	Heterogeneity of interventions and outcomes	Jafarzadeh et al. (2022)
Panchakarma	Emerging/insufficient direct evidence	Whole-system Ayurvedic intervention	Plausible microbiome effects through diet, herbs, fasting, and bowel-related procedures	Direct controlled microbiome evidence remains insufficient	Chauhan et al. (2023); Jangra et al. (2025)

Treatment Pipeline

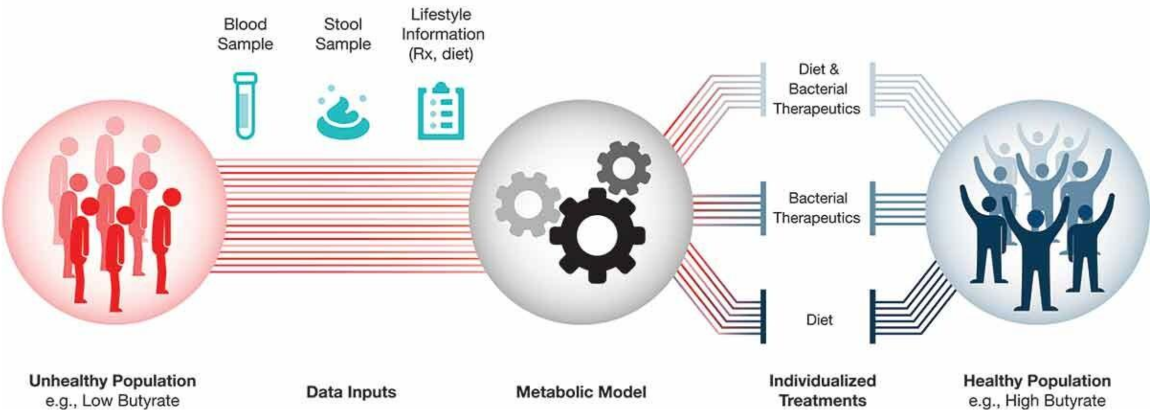

Figure 4. Personalized microbiome-guided treatment pipeline integrating patient-derived data, metabolic modeling, individualized interventions, and health outcomes (Wilmanski et al., 2021)

8. Future Perspectives and Challenges

There are several conceptual, methodological, and translational hurdles for future research on gut microbiome–Ayurveda interactions to draw meaningful clinical conclusions. These are small cohorts, varied study designs, uncontrolled diet, medication intake, geography, age and lifestyle, and inconsistent microbiome sampling, sequencing platforms and controls. The standardization of the interventions is also needed in the context of ayurveda as the identity of the herbs, the formulation used, the process of preparation, doses, duration of treatment, and quality control may vary significantly between different studies. The other challenge is to draw a direct biomedical equivalence between traditional concepts like Agni, Ama, Dosha and Prakriti with specific microbial or metabolic mechanism, which are to be scientifically tested with well formulated, measurable and testable hypothesis while maintaining the separate conceptual framework of Ayurveda. Randomized controlled trials and longitudinal studies with proper design are necessary to establish whether ayurvedic diet, herbs, Rasayana therapies, yoga, or Panchakarma results in reproducible alteration in the microbial composition, functional pathways, and clinically relevant outcomes. The combination of multi-omics (metagenomics, metatranscriptomics, metabolomics, proteomics, and host phenotyping) may help elucidate mechanisms associated with the traditional intervention and microbial metabolites, intestinal barrier function, and systemic metabolism. Herb–Drug interaction, safety, regulatory quality and interindividual variability in microbial biotransformation of phytochemicals of Ayurvedic origin should also be studied in future. Importantly, Prakriti-based stratification could provide a testable model for tailored microbiome studies that needs to be validated in more ethnically diverse and larger populations. Combination of the traditional phenotyping with standardized clinical parameters and advanced microbiomics analysis might eventually lead to the development of evidence-based, microbiome-informed, personalized and preventative Ayurvedic interventions. Worldwide, shared reporting standards, preregistered protocols, open datasets, and multicenter collaborations will be paramount to enhancing the reproducibility, transparency, comparability, and independent validation.

9. CONZCLUSION

The convergence of Ayurveda and gut microbiome science provides a promising route to understanding health — from the Ayurvedic perspective and the scientific perspective. The importance of individualized constitution, digestive capacity, diet, lifestyle, herbal medicine and individual constitution are all emphasized in Ayurveda, while today microbiome studies illustrate the role of gut microorganisms in metabolism, immunity, barrier integrity, neuroendocrine communication and susceptibility to disease. This balancing of concepts like Agni, Ama, Ojas, Prakriti and Dosha could prove to be useful conceptual frameworks for developing testable hypotheses, but should not be applied directly as biomedical equivalents of microbial balancing. Emerging evidence concerning Prakriti associated microbial variation, Ayurvedic dietary practices, Triphala, curcumin, ginger, polyherbal formulations, fasting, circadian routines, yoga and microbial biotransformation calls for additional interdisciplinary investigations. At present, however, the results of the studies are limited by small sample size, inconsistent methodologies, lack of standardisation, and lack of randomized and longitudinal studies. Rigorous clinical trial design, using standardized Ayurvedic interventions, advanced multi-omics, and meticulous control of host and environment confounders will be essential to progress in this field. Overall, the convergence of validated Ayurvedic principles and microbiome studies could pave the way for more personalized, preventative, and mechanism-driven healthcare approaches while maintaining scientific rigor and acknowledging the unique epistemological underpinnings of Ayurveda. This should be evidence-based, reproducible, clinically relevant and responsible.

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