

AYURNUTRIGENOMICS: BRIDGING TRADITIONAL AYURVEDIC WISDOM WITH
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ABSTRACT

Ayurveda emphasizes that food and medicine are interconnected concepts essential for human survival and for preventing and treating diseases. Food significantly influences the molecular mechanisms of an organism's physiology and is consumed in much larger quantities than any medication. Therefore, studying its effects and interactions with the genome is crucial for understanding diseases and their treatments. Ayurgenomics offers a personalized approach to predictive, preventive, and curative aspects of stratified medicine, focusing on individual genetic variability to assess susceptibility and establish diagnoses and prognoses based on a person's constitution or *Prakriti*. Ayurnutrigenomics is an emerging area that integrates Ayurvedic principles with systems biology, where dietary, therapeutic, and lifestyle choices are tailored to an individual's *Prakriti*. This innovative concept of personalized nutrition aims to develop functional foods and nutraceuticals suited to an individual's genetic profile, drawing on Ayurvedic wisdom. We present this new concept of Ayurnutrigenomics and its potential research areas, which may lead to advanced and safe therapeutic options in the future.

KEYWORDS: Ayurveda, nutrigenomics, individualized nutrition, nutraceuticals, ayurgenomics.

INTRODUCTION

The capacity of food components to influence the molecular mechanisms underlying an organism's "physiome" has sparked a transformative shift in how we view our diets.^[1] Pharmacogenomics and nutrigenomics—are the fields that explore how genes interact with drugs and nutrients, respectively. They are closely related. We are generally exposed to food far more frequently than to pharmaceuticals. Ayurveda, an ancient system of medicine practiced for thousands of years, is rooted in the principles of preventive and personalized healthcare. It is based on maintaining equilibrium among the three biological energies, or Tridoshas: Vata, Pitta, and Kapha.

Ayurveda adopts a holistic approach to health, integrating the mind, body, and spirit, along with other dimensions of well-being. A unique feature of this system is its integration of food (Pathya or Ahara) and medicine (Ausadha) within its therapeutic framework. This approach emphasizes the harmonization of Doshas based on an individual's unique constitution (Prakriti)

and various environmental influences. For instance, ginger (*Zingiber officinale*), commonly used as a spice or food ingredient in cooking. It relieves constipation, relieves gas and bloating, it is also prescribed for a wide range of health conditions ranging from gastrointestinal disorders to cancer.^[2] Therefore, nutrition plays an important role in Ayurvedic treatment, tailored to suit each person's individual constitution.

The personalized approach to nutrition has emerged more recently, aiming to understand individual differences in nutritional responses through the lens of nutrigenomics. Nutrition plays a vital role in both maintaining health and influencing disease, particularly in the prevention and management of complex, multifactorial chronic conditions. Nutrigenomics has become increasingly relevant in public health due to its focus on how genetic variations affect individual responses to nutrients. Its broad, genome-wide scope enables the identification of novel biological mechanisms that govern how the body responds to food. Research also suggests that genetics significantly

influence dietary habits, food preferences, and nutritional responses, though the degree of heritability varies across studies.

The concept of “Ayurnutrigenomics” emerged from the fusion of Ayurgenomics with Ayurveda’s traditional dietary principles of *Ahara* (diet) and *Pathya* (wholesome food). It represents a systematic approach to aligning nutrition with an individual's *Prakriti* (constitution), integrating insights from genomics, proteomics, and metabolomics. This integration aims to establish a scientifically robust, evidence-based framework for advancing personalized Ayurvedic nutrition.

Metabolome-standardized foods and nutraceuticals—rich in diverse biochemical compounds—hold potential as novel therapeutic agents, particularly in cases where conventional drugs are ineffective or for preventive strategies in at-risk populations. Personalized holistic dietary interventions inspired by Ayurvedic traditions may thus play a pivotal role in enhancing healthcare and advancing preventive medicine. This review highlights the core principles of Ayurveda-inspired nutrition and explores innovative nutrigenomic applications, offering a comprehensive perspective on the emerging field of Ayurnutrigenomics.

MATERIALS AND METHODS

Ayurvedic principles have been shaped through countless clinical observations over centuries, offering a time-tested foundation for its medical philosophy. The scientific credibility of these principles is not solely rooted in ancient texts, such as the *Astanga Hridaya* (AH.Ut.-40/81), but also in their consistent, demonstrable outcomes—an attribute comparable to the goals of modern translational research. This long history of empirical validation has allowed Ayurveda to evolve in a way that aligns closely with contemporary systems biology.

Understanding disease at the systems biology level—particularly at the genomic scale—provides a strategic edge in identifying therapeutic targets and addressing associated challenges in disease management.

Modern genomic tools, such as Genome-Wide Association Studies (GWAS), enable comparisons of genetic variation across populations of healthy and diseased individuals to identify genome regions associated with specific conditions. Interestingly, Ayurvedic classification of diseases and remedies is based on phenotypic groupings that align with genomic concepts such as *Prakriti*, which includes the three biological constitutions: Vata, Pitta, and Kapha.^[3]

To fully integrate Ayurvedic wisdom with modern science, disease phenotypes must be accurately classified, and research must focus on uncovering the molecular pathways or biological networks underlying

these conditions. This approach will enhance our understanding of the pharmacological actions of Ayurvedic herbs and their ability to modulate physiological systems—both mental and physical—toward healing.

Ahara: The concept and importance of Personalized Nutrition- In Ayurveda, *Ahara* (diet or food) is not a one-size-fits-all concept but is tailored according to the time of day, seasonal variations, age, and most significantly, an individual's unique constitution or *Prakriti*. This personalized approach to diet is deeply rooted in classical Ayurvedic texts.

The historical significance of diet in human life and health is also highlighted in the *Charaka Samhita*, where *Ahara* is acknowledged as a fundamental factor in the origin of life (*Purusha*) and disease.^[4] The *Susruta Samhita* provides a detailed description on dietetics, further highlighting the importance of diet in Ayurvedic philosophy.

Ahara is defined as any substance ingested through the mouth that, upon proper digestion, is converted into bodily tissues and supports vital functions such as growth, healing, and disease prevention. According to Charaka, a balanced diet promotes the harmony of *Doshas* (biological energies) and *Dhatus* (bodily tissues), contributing to overall health and disease resistance^[4] Additionally, a well-regulated diet is said to restore vitality, build strength, sustain life, and enhance longevity, joy, memory, *Ojas* (the essence of immunity), and digestive capacity.^[5]

In Ayurvedic therapeutics, the classification of food into wholesome and unwholesome categories is central to achieving health or preventing disease. In many cases, dietary regulation alone can serve as a complete form of treatment. Unlike modern nutritional science, which often focuses on nutrient content, Ayurvedic dietetics takes a more holistic view. It considers not only the nutritional value of food but also factors such as the method and timing of consumption, the nature and quality of the ingredients, the individual's digestive strength (*Agnibala*), cooking techniques, food combinations, seasonal variations, and the environmental and social context in which food is consumed.

What is Ayurgenomics- Ayurgenomics offers a personalized framework that bridges traditional Ayurvedic principles with modern molecular biology, aiming to enhance predictive, preventive, and curative strategies in stratified medicine. This approach emphasizes the interplay between mind and body while focusing on individual genetic variability to assess disease susceptibility and guide diagnosis and prognosis—primarily through the Ayurvedic concept of *Prakriti*, or constitutional type.

Prakriti is determined by the relative balance of the three

biological energies (*Tridoshas*): Vata, Pitta, and Kapha. While it is influenced by genetic factors (Shukra Shonita), it is also shaped by environmental elements (Mahabhuta Vikara), including maternal diet and lifestyle during pregnancy (Matura Ahara Vihara), the age of the parents at conception (Kala Garbhashaya), as well as broader influences such as ethnicity (Jati), familial compatibility (Satmya), and geographic origin (Desha).

Clinical evaluation of an individual's *Prakriti* guides the personalized selection of diet, therapy, and lifestyle practices. Recent studies have linked metabolic differences associated with *Prakriti* to genetic variations such as CYP2C19 polymorphisms and Human Leukocyte Antigen (HLA) gene variability, providing a scientific basis for the Ayurvedic understanding of personalized medicine and aligning it with pharmacogenomic principles.^[6]

Given the wide genetic diversity across the Indian population, Ayurgenomics holds significant potential in deciphering variability even among healthy individuals. Transcriptomic analyses of pooled RNA samples from individuals classified as Vata, Pitta, and Kapha have shown distinct differences in core biological processes. These variations correspond with known biochemical pathways and profiles, supporting the Ayurvedic assertion that constitutional types are genetically and functionally distinct.

Ayurnutrigenomics: Integration of Nutrigenomics with Ayurveda- Ayurveda places strong emphasis on *Prakriti*—an individual's unique constitutional makeup—in determining appropriate dietary choices. According to Ayurvedic theory, three primary biological forces (*Tridoshas*): Vata, Pitta, and Kapha, create seven *Prakriti* types, each exhibiting distinct phenotypic characteristics.^[7] These traditional classifications now find scientific parallels in *Ayurgenomics*, which identifies significant differences in gene expression, biochemical markers, and hematological profiles among *Prakriti* types.

Ayurveda's holistic philosophy inherently merges personalized diet and medicine based on *Prakriti*, advocating that individuals should consume foods suited to their dominant *Doshas* and adjust these according to seasonal changes. This personalized approach forms the foundation for a new research paradigm termed *Ayurnutrigenomics*—the intersection of Ayurvedic nutritional principles with modern nutrigenomics.

As we advance into the "omics" era, the ancient Ayurvedic understanding of nutrition based on biological individuality gains renewed relevance. Even in classical times, Ayurvedic scholars recognized the importance of linking diet to biological phenotypes, a concept now echoed in genome-based nutrition science. The U.S. National Institutes of Health defines genomics as the

study of all genes and their interactions with each other and the environment. Nutrigenomics builds on this by examining how nutrients affect gene expression across various biological layers—transcriptomics, proteomics, metabolomics—ultimately shaping the phenotype.

Additionally, nutrigenomics investigates how genetic differences impact nutrient metabolism and utilization—also known as pharmacokinetics and nutrikinetics—to tailor diets to individual genotypes. This aligns with Ayurveda's personalized approach to food and health. However, molecular nutrition goes even further, examining how nutrients influence overall physiological processes and health outcomes at a systems biology level. It seeks to clarify molecular mechanisms underlying health and disease, offering vast potential for disease prevention and health promotion.^[8]

One of Ayurveda's key contributions to personalized nutrition is the concept of *Satmya*—adaptability. Even if a dietary habit may not align with a person's genetic constitution, factors such as climate (*Ritu Satmya*), geography (*Desha Satmya*), disease condition (*Roga Satmya*), habitual consumption (*Oka Satmya*), and sociocultural background (*Jati Satmya*) can enable the body to adapt. This interaction between habitual diet (the *nutriome*) and one's genome or *physiome* explains cases like the prevalence of diabetes in populations consuming high-carbohydrate diets, such as rice-based diets in India.

Ayurveda offers several clinical principles for guiding preventive and personalized health strategies—*Prakriti* (constitution), *Dosha-Dushya* (pathophysiological state), and *Satmya* (habitual compatibility)—to determine suitable foods, medicines, and lifestyle practices. As such, *Ayurnutrigenomics* holds immense promise for advancing our understanding of nutrigenomics and molecular nutrition. These foundational insights can inform the development of personalized health recommendations and targeted dietary interventions.

RESULTS AND DISCUSSION

Ayurnutrigenomics represents a convergence of food and medicine, designed to function in harmony with an individual's genetic constitution (*Prakriti*) through the lens of systems biology. This emerging field leverages modern analytical techniques to propel research and innovation in personalized nutrition based on Ayurvedic principles. From nutritional epidemiology to food quality control, metabolomics is set to play a central role in establishing rigorous and inclusive methodologies for Ayurnutrigenomic investigations.

Traditionally inspired, scientifically validated approaches will guide the development of safer, more personalized dietary interventions and novel food products. These will contribute to improved health outcomes and refined dietary recommendations. Furthermore, this approach opens the door to the development of "smart" Ayurnutrigenomic-inspired foods and *Ayurceuticals*—

functional food-based therapeutic agents that support healing and disease prevention.

According to Ayurvedic theory, disease pathogenesis (*Nidana*) in polygenic, diet-related disorders arises from an interplay of genetic predisposition (*Prakriti*), environmental influences (*Mahabhuta Vikara*), dietary habits (*Ahara*), and lifestyle factors (*Dinacharya*). Specifically, overnutrition (*Satmya*) and sedentary living (*Eksthana*) are recognized contributors to disease development.^[7] Modern tools—ranging from high-throughput analyses of genes, transcripts, proteins, and metabolites to advanced imaging and bioinformatics—enable us to integrate this multifactorial information into a systems biology framework.

Although sophisticated platforms for genomics, proteomics, and metabolomics are increasingly available, their combined application in understanding how nutrition impacts metabolism remains underutilized. Yet, the integration of these technologies is vital to reveal how dietary factors influence cellular function and phenotype at the molecular level. Such insights are necessary to align Ayurvedic knowledge with current biomedical science.

Nutrigenomics investigates how dietary molecules interact with the genome, leading to phenotypic changes in metabolic processes and overall biological homeostasis. These outcomes can be modulated by genetic interactions. Traditionally, many plants used in Ayurveda serve dual roles as food and medicine, offering a rich source of bioactive compounds that hold promise for the development of personalized nutraceuticals and functional foods.

Metabolomics, a rapidly advancing discipline, plays a pivotal role in systems biology and nutrigenomics. It involves the comprehensive analysis of metabolites—either as focused subsets or broader profiles—for applications in diagnostics, toxicology, disease modeling, drug discovery, phytomedicine, and more. In the context of Ayurveda, metabolomics can be used to monitor how metabolites respond to dietary interventions or herbal treatments, reflecting the dynamic biochemical shifts within tissues or fluids in relation to health or disease states.

Various analytical techniques are used in metabolite profiling, including gas chromatography–mass spectrometry (GC–MS), liquid chromatography–mass spectrometry (LC–MS), nuclear magnetic resonance (NMR), Fourier transform infrared (FTIR) spectroscopy, and Raman spectroscopy. GC–MS, in particular, has been widely applied in analyzing human body fluids and plant extracts, offering high precision in both profiling and quality control.

CONCLUSION

In summary, Ayurnutrigenomics-inspired foods and

nutraceuticals hold transformative potential for the future of personalized health. By integrating ancient Ayurvedic wisdom with cutting-edge molecular technologies, this field promises a new generation of therapeutic foods designed to align with individual genetic profiles and biological responses.

The Ayurveda-inspired framework of personalized nutrition presents a groundbreaking direction in nutrigenomic research, aiming to develop functional foods and nutraceuticals tailored to an individual's genetic profile. This approach emphasizes the intersection of food and medicine, guided by one's inherent constitution (*Prakriti*), within the context of systems biology. The advanced analytical techniques discussed throughout this review—rooted in various “omics” disciplines such as genomics, epigenomics, transcriptomics, proteomics, and metabolomics—hold significant promise for deepening our understanding of Ayurvedic principles and their application in modern science.

This review introduces *Ayurnutrigenomics* as a pioneering and evolving field that bridges traditional Ayurvedic wisdom with contemporary molecular research. It offers exciting prospects for the development of intelligent, personalized, and safe therapeutic strategies in the future.

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