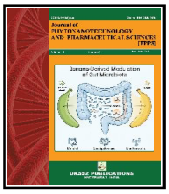
Journal of Phytonanotechnology and Pharmaceutical Sciences 6(1): 54-57, 2026

Online ISSN:2583-0376
http://jpps.ukaazpublications.com
DOI: http://dx.doi.org/10.54085/jpps.2026.6.1.7
Journal of Phytonanotechnology and Pharmaceutical Sciences



Original Article : Open Access

Exploring nutrigenomics: Analytical platforms and their role in understanding nutrition-health relationships

Jeneesha Mohammad*, Khagga Bhavyasri◆ and C.A. Sri Ranjani*****
** Department of Pharmaceutical Analysis, RBVRR Women's College of Pharmacy, Barkatpura, Hyderabad-500027, India*
*** Department of Pharmaceutical Analysis, RBVRR Women's College of Pharmacy, Barkatpura, Hyderabad-500027, India*
**** Department of Pharmaceutical Analysis, RBVRR Women's College of Pharmacy, Barkatpura, Hyderabad-500027, India*

Article Info

Article history
Received 1 January 2026
Revised 17 February 2026
Accepted 18 February 2026
Published Online 30 March 2026

Keywords
Nutrigenomics
Gene-diet interactions
Personalised nutrition
Precision nutrition
Genetic variations
Metabolic pathways
Bioinformatics
Bioactive compounds
Chronic diseases
Epigenetics

Abstract

Nutrigenomics is a rapidly advancing discipline that explores how nutrition interacts with an individual's genetic profile. It focuses on understanding how nutrients and bioactive food components influence gene expression, and how genetic variations affect a person's response to diet. By uncovering these complex interactions, nutrigenomics aims to provide personalised dietary recommendations that optimise health and reduce the risk of nutrition-related diseases. The central objective of nutrigenomics research is to identify nutrient-gene interactions that significantly impact physiological functions and disease susceptibility. This is made possible through modern genomic tools such as high-throughput sequencing, transcriptomics, and bioinformatics, which allow scientists to detect genetic variations associated with conditions like obesity, cardiovascular disorders, and type 2 diabetes. Additionally, research investigates how dietary habits modulate molecular pathways, metabolic networks, and cellular processes, including inflammatory responses, lipid regulation, and epigenetic modifications that can alter long-term health outcomes. Scientific evidence demonstrates that diets designed according to an individual's genetic background can positively influence health by targeting specific molecular pathways. Furthermore, bioactive molecules naturally present in foods, such as polyphenols, omega-3 fatty acids, and phytochemicals, have been shown to regulate gene activity and provide therapeutic benefits in managing chronic diseases. Despite its potential, nutrigenomics faces challenges in real-world application. Issues such as data complexity, ethical concerns, cost of testing, and the need for large-scale clinical trials continue to slow its integration into clinical practice. Successful translation will require interdisciplinary collaboration among molecular biologists, nutritionists, healthcare professionals, and policymakers. Looking ahead, nutrigenomics is expected to shift nutrition from broad dietary guidelines to precise, individualised strategies. Such a transformation could revolutionise preventive healthcare by offering targeted nutritional interventions that enhance well-being, reduce disease risk, and support long-term health management.

1. Introduction

Nutrigenomics is a field of science that explores the relationship between nutrition and genes, examining how different foods interact with an individual's genetic makeup. It focuses on understanding how dietary components influence gene expression and how genetic variations affect a person's response to nutrients. This knowledge helps in developing personalised nutrition plans that optimise health, prevent diseases, and improve overall well-being. By integrating genetics, molecular biology, and nutrition, nutrigenomics aims to create targeted dietary recommendations based on an individual's unique genetic profile.

Nutrigenomics is the scientific study of how nutrients and dietary components influence gene expression and how an individual's genetic makeup affects their response to food. This field combines molecular biology, genetics, and nutrition to understand how diet can impact health, disease prevention, and overall well-being at the genetic level. The goal of nutrigenomics is to develop personalised nutrition strategies based on an individual's genetic profile to optimise health and reduce the risk of chronic diseases. Early foundations (1900s-1950s): Research on nutrients and metabolism began, with discoveries of essential vitamins and their role in disease prevention. Rise of molecular biology (1950s-1990s): The discovery of DNA's structure in 1953 paved the way for studying gene-nutrient interactions. Human genome project (1990-2003): The sequencing of the human genome provided insights into genetic variations affecting dietary needs. Modern nutrigenomics (2000s-Present): Advances in bioinformatics and genetic analysis have led to personalised nutrition, improving health through gene-based dietary recommendations (Afman and Müller, 2006; Ordovas and Mooser, 2004).

2. Materials and Methods

Experimental methods in nutrigenomics focus on studying how nutrients interact with genes to influence health. Here are some key approaches:

Corresponding author: Dr. K. Bhavyasri
Professor, Department of Pharmaceutical Analysis, RBVRR Women's College of Pharmacy, Barkatpura, Hyderabad-500027, India
E-mail: bhavya.khagga@gmail.com
Tel.: +91-9963713581

Email: ukaaz@yahoo.com; Website: www.ukaazpublications.com

- **Genotyping and sequencing:** Identifying genetic variations using techniques like SNP genotyping and whole-genome sequencing.
- **Transcriptomics:** Analysing gene expression changes in response to dietary components using RNA sequencing or microarrays.
- **Epigenomics:** Studying DNA methylation and histone modifications influenced by diet using bisulfite sequencing and ChIP-seq.
- **Metabolomics:** Measuring metabolic changes caused by nutrition through mass spectrometry
- **Proteomics:** Investigating protein expression and modifications using techniques like western blotting and mass spectrometry.
- **Cell culture and animal models:** Testing nutrient-gene interactions in controlled laboratory conditions.
- **Human clinical trials**: Assessing dietary effects on gene expression in different populations (Trujillo *et al*., 2006; Kaput and Noble, 2007)

2.1 DNA testing kits

- Personalised genetic insights (*e.g.,* 23 and Me, DNA fit).
- Microbiome tools: Gut health analysis (*e.g.,* Viome).
- Diet tracking apps: Nutrient monitoring (*e.g.,* Cronometer, MyFitnessPal).
- Bioinformatics platforms: Analyse genetic and metabolic data (*e.g.,* PLINK, MetaboAnalyst).
- Lab equipment: Tools like NGS, Mass spectrometry, and HPLC.
- AI solutions: Personalised nutrition *via* machine learning.
- Wearable devices: Activity and nutrition integration (*e.g.,* Fitbit).
- Biomarker tests: Blood or saliva-based nutrient profiling (Mathers, 2007; El-Sohemy, 2007).

2.2 Nutritional diseases

2.2.1 Obesity

Certain genetic variants, such as those in the FTO gene, can affect metabolism and fat storage. Diet and lifestyle choices can modify the impact of these genes.

2.2.2 Type 2 diabetes

Variations in genes like TCF7L2 can influence insulin production and glucose metabolism. A diet high in Fiber and low in refined sugars may help manage the risk (Zeisel, 2007).

2.2.3 Cardiovascular diseases (CVD)

Genes such as APOE influence cholesterol levels. A diet rich in omega-3 fatty acids, fiber, and antioxidants can help regulate

2.2.4 Celiac disease

Individuals with variations in HLA-DQ2 and HLA-DQ8 genes are predisposed to celiac disease, where gluten triggers an immune response. A strict gluten-free diet is the only effective management strategy (Ferguson, 2009).

2.2.5 Lactose intolerance

A mutation in the LCT gene determines lactase enzyme production. Individuals with lactose intolerance benefit from dairy-free or lactase enzyme supplementation.

2.2.6 Cancer

Nutrigenomic research has shown that mutations in genes like BRCA1 and BRCA2 increase the risk of breast and ovarian cancer (Rimbach and Minihane, 2009).

3. Results

This study is of a 52-year-old male patient, John, with type 2 diabetes whose condition was poorly managed despite following a conventional low-carb, high-fibre diet. Genetic testing identified variations in the TCF7L2 and FTO genes, associated with impaired insulin secretion and obesity, respectively. Based on these insights, a personalised mediterranean diet was designed. This plan included high-fiber foods like legumes and oats to enhance insulin sensitivity, healthy fats from olive oil and fatty fish to manage FTO-related metabolic issues, and low-glycemic-index foods like quinoa and sweet potatoes. After six months, the patient's HbA1c dropped from 8.2% to 6.4%, and he experienced an 8 kg weight loss (Corella and Ordovas, 2009; Fenech and El-Sohemy *et al*., 2011).

In a control study, the interaction between folate and vitamin B12 intake and genetic susceptibility in cervical cancer was examined. Researchers compared affected individuals to healthy controls, analysing how deficiencies in these nutrients, critical for DNA methylation and repair, could lead to abnormal cell proliferation and cancer progression (Brennan, 2013).

In a study, it was presented that the regulatory role of vitamin D through the vitamin D receptor (VDR) in gene expression. The study illustrated vitamin D's broad impact on bone, immune, cardiovascular, and neurological health. Genetic variations influenced individual responses to vitamin D supplementation (Ferguson *et al*., 2014; Mohan *et al*., 2017).

Gene expression changes were observed in response to dietary changes using RNA sequencing and transcriptomics, revealing impacts on metabolism, immunity, and development in species such as fruit flies (Bhavyasri and Surekha, 2020; Sree *et al*., 2020).

Nutrigenomics is vital in managing metabolic diseases like obesity and diabetes by analysing gene-diet interactions. It enables personalised nutrition that addresses individual variability in nutrient processing and disease susceptibility (Bhavyasri *et al*., 2022; Sri *et al*., 2022).

It was documented that a clinical case where personalised nutrition based on genetic testing improved atherosclerosis management. A patient with genetic risks linked to lipid metabolism and inflammation responded well to a diet rich in omega-3 fatty acids and antioxidants, leading to better cardiovascular biomarkers (Sharifi-Rad *et al*., 2022).

It was observed that a personalised dietary intervention based on genetic profiling was used for a patient with advanced prostate cancer. The plan emphasised anti-inflammatory foods like cruciferous vegetables, polyphenols, and omega-3s, alongside vitamin D and selenium optimisation. Biomarker monitoring indicated improved stability and quality of life (Sotos-Prieto *et al*., 2022).

Salim *et al*. (2023) emphasised the significance of the TCF7L2 gene, especially the rs7903146 variant, in diabetes development. The variant affects pancreatic beta-cell function and liver glucose regulation, highlighting the need for genetic screening in diabetes risk assessment.

Carlberg (2023) reviewed how genetic variations in genes such as FTO and PPARG influence obesity risk, metabolism, and weight loss outcomes. Personalised diets based on these markers improved weight management, particularly in individuals struggling with traditional interventions .

4. Discussion

These case studies and research findings collectively underscore the transformative role of nutrigenomics in advancing personalised healthcare. By decoding the interaction between genetic profiles and dietary intake, individuals with chronic or complex conditions can achieve better health outcomes than with standardised approaches (Corella and Ordovás, 2025).

John's case, for instance, exemplifies how tailoring macronutrient composition to genetic variations such as TCF7L2 and FTO can lead to substantial improvements in glycemic control and weight management. This supports a broader application of precision nutrition in diabetes care (Krishna and Raghavan, 2025). The exploration of folate and vitamin B12 show the relevance of nutrient-gene interactions in cancer prevention, suggesting that dietary adequacy can offset genetic vulnerabilities. Similarly, vitamin D study reinforces the concept that nutrient bioavailability and efficacy are highly individualised (Kaput, 2025). In non-human models like insects, nutrigenomic tools help dissect adaptation mechanisms to nutritional stress, providing foundational knowledge applicable to pest control, breeding, and ecosystem studies (Horne *et al*., 2025). Further, the potential of genotype-guided nutrition in slowing disease progression and enhancing therapeutic responses in complex conditions such as atherosclerosis and cancer.

The common thread in all studies is the potential of nutrigenomics to move from population-based to individualized dietary strategies. As genetic testing becomes more accessible and affordable, healthcare systems may increasingly incorporate gene-based nutrition plans to combat non-communicable diseases, optimise metabolic function, and improve quality of life.

This emerging field holds promise not only in clinical care but also in public health by enabling early interventions tailored to genetic risk factors. However, broader clinical validation, ethical considerations, and education are necessary before widespread implementation. The molecular pathway from nutrients to disease or health, highlighting the role of genomics, transcriptomics, proteomics, and metabolomics in nutrigenomics (EatingWell, 2025).

Table 1: Common diseases influenced by nutrigenomics

Disease	Genetic factors	Nutritional interventions
Obesity	FTO gene variants	Dietary control, physical activity, nutrient-rich food
Type-2 diabetes	TCF7L2 gene variations	High fiber diet, low refined sugar intake
Cardiovascular disease	APOE gene variants	Omega-three fatty acids, antioxidants
Lactose intolerance	LCT gene mutation	Dairy-free diet/lactase supplements

4. Conclusion

Nutrigenomics is a rapidly evolving field that explores the intricate relationship between nutrition and genetics. It aims to understand how individual genetic variations influence the way nutrients are metabolised and how dietary choices can impact gene expression. This personalised approach to nutrition has the potential to revolutionise health care by promoting targeted dietary recommendations that optimise well-being and prevent chronic diseases. One of the key benefits of nutrigenomics is its ability to tailor diets based on an individual's genetic makeup, reducing the risk of conditions such as obesity, diabetes, cardiovascular diseases, and certain cancers. By identifying genetic predispositions, individuals can make informed dietary choices to improve their health outcomes. The integration of nutrigenomics into clinical practice can lead to more effective nutritional interventions, replacing the traditional one-size-fits-all dietary guidelines. However, challenges remain, including ethical concerns, the complexity of gene-diet interactions, and the need for more extensive research to validate findings. Advancements in technology, such as DNA sequencing and bioinformatics, continue to enhance the precision of nutrigenomic studies. As research progresses, the potential for personalised nutrition to become a mainstream approach in preventive medicine grows stronger. Despite its promise, widespread adoption of nutrigenomics requires addressing affordability, accessibility, and public awareness. Educating healthcare professionals and individuals about the benefits and limitations of nutrigenomics is crucial for its successful implementation. In conclusion, nutrigenomics represents a transformative shift in the field of nutrition and health. While there are challenges to overcome, its potential to offer personalised dietary strategies based on genetic insights is undeniable. With continued research and ethical considerations, nutrigenomics could significantly contribute to a healthier future by preventing diet-related diseases and enhancing overall well-being.

Availability of data and material

All data are provided within the manuscript.

Authorship contribution statement

Jeneesha Mohammad contributed to conceptualization, methodology design, data curation, and drafting of the manuscript. **Khagga Bhavyasri** contributed to supervision, critical review, and final manuscript approval. **C. A. Ranjani** contributed to data analysis, literature review, and editing of the manuscript.

Consent for publication

All authors gave their full consent for publication and submission to this journal.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

Funding

None

Ethics approval

None

Acknowledgements

I would like to express my sincere gratitude to our esteemed Principal, Prof. M. Sumakanth, and the staff of the Department of Pharmaceutical Analysis for providing this valuable opportunity.

References

Afman, L.A. and Müller, M. (2006). Nutrigenomics: From molecular nutrition to prevention of disease. J. Am. Diet. Assoc., **106**(4):569-576.

Bhavyasri, K. and Surekha, T. (2020). Bioanalytical method development and validation of dapagliflozin and metformin hydrochloride in combined dosage form using UV spectroscopy. Gedrag Organisatie Rev., **33**:272-283.

Bhavyasri, K.; Begum, S. and Sumakanth, M. (2022). Two-dimensional gas chromatography-mass spectroscopy: A review. Int. J. Pharm. Sci. Rev. Res., **76**:140-150.

Brennan, L. (2013). Metabolomics in nutrition research: Providing insight into personalized dietary intake and metabolism. Proc. Nutr. Soc., **72**(3):304-310.

Carlberg, C. (2023). Vitamin D: A master example of nutrigenomics. Trends Endocrinol. Metab.

Corella, D. and Ordovas, J.M. (2009). Nutrigenomics in cardiovascular medicine. Circ. Cardiovasc. Genet., **2**(6):637-651.

Corella, D. and Ordovás, J.M. (2025). Nutrigenomics and its impact on lifestyle-associated metabolic diseases. Plants, 11:410-421.

EatingWell. (2025). The best nutrient for insulin resistance. Plos one, 11:210-215.

El-Sohemy, A. (2007). Nutrigenetics and nutrigenomics of tea. Pharmacol. Res., **55**(3):175-184.

Fenech, M.; El-Sohemy, A.; Cahill, L.; Ferguson, L.R.; French, T.A. and Tai, E.S. (2011). Nutrigenetics and nutrigenomics: Viewpoints on the current status and applications in nutrition research and practice. J. Nutrigenet. Nutrigenomics, **4**(2):69-89.

Ferguson, L.R. (2009). Nutrigenomics approaches to functional foods. J. Am. Diet. Assoc., **109**(3):452-458.

Ferguson, L.R.; Chen, H.; Collins, A.R.; Connell, M.; Damia, G. and Dasgupta, S. (2014). Nutrigenomics, gastrointestinal inflammation, and cancer risk. Cancer Res. Front., **1**(2):90-116.

Horne, B.D.; Muhlestein, J.B. and Anderson, J.L. (2025). Intermittent fasting in cardiovascular disorders: An overview. Nutrients, **13**:41-49.

Kaput, J. and Noble, J. (2007). The role of nutrigenomics in modern nutrition. Curr. Opin. Clin. Nutr. Metab. Care, **10**(5):624-629.

Kaput, J. (2025). Nutrigenomics: Opportunities and challenges for public health nutrition. Indian J. Med. Res., **9**:22-31.

Krishna, K. and Raghavan, S. (2025). A case-control nutrigenomic study on folate and vitamin B12 in cervical cancer progression. Cancer, **20**:210-222.

Mathers, J.C. (2007). Nutrigenomics in the developing world: From the dual burden of disease to nutritional genomics. Proc. Nutr. Soc., **66**(1):44-51.

Mohan, T.J.; Varma, D.P.; Bhavyasri, K.; Prasad, K.; Mukkanti, K. and Jogia, H.A. (2017). Development and validation of piribedil in tablet dosage form by HPLC: A QbD and OFAT approach. Asian J. Chem., **29**(5):1113-1116.

Ordovas, J.M. and Mooser, V. (2004). Nutrigenomics and nutrigenetics. Curr. Opin. Lipidol., **15**(2):101-108.

Rimbach, G. and Minihane, A.M. (2009). Nutrigenetics and nutrigenomics: How the genome influences the diet. Proc. Nutr. Soc., **68**(4):367-372.

Salim, A.; El-Baz, A.F. and Saber, H. (2023). Nutrigenomics and microbiome shaping the future of personalized medicine: A review article. J. Genet. Eng. Biotechnol., **10**:101-121.

Sharifi-Rad, J.; Rodrigues, C.F.; Stojanoviæ-Radiæ, Z.; Dimitrijeviæ, M.; Aleksandroviæ, L. and Neffe-Skociñska, K. (2022). Probiotics: Versatile bioactive components in promoting human health. Front. Microbiol., **13**:903142.

Sotos-Prieto, M.; Bhupathiraju, S.N.; Mattei, J.; Fung, T.T.; Li, Y. and Pan, A. (2022). Nutrigenetic approach of atherosclerosis: Clinical case study. Atherosclerosis, pp:42-49.

Sree, V.N.; Bhavyasri, K.; Sumakanth, D.M. and Swethasri, R. (2020). Estimation of dapagliflozin in pure and marketed formulation by validated reverse phase-high performance liquid chromatographic method. Int. J. Life Sci. Pharma Res., **10**(4):P70-P84.

Sri, K.B.; Srija, G. and Sumakanth, M. (2022). Quantification of vitamin C by titrimetric method in different marketed fruit juices. World J. Pharm. Res., **12**(4):1125-1130.

Trujillo, E.; Davis, C. and Milner, J. (2006). Nutrigenomics, proteomics, metabolomics, and the practice of dietetics. J. Am. Diet. Assoc., **106**(3):403-413.

Zeisel, S.H. (2007). Nutrigenomics and metabolomics will change clinical nutrition and public health practice: Insights from studies on dietary requirements for choline. Am. J. Clin. Nutr., **86**(3):542-548.

Citation **Jeneesha Mohammad, Khagga Bhavyasri and C.A. Sri Ranjani (2026). Exploring nutrigenomics: Analytical platforms and their role in understanding nutrition-health relationships. J. Phytonanotech. Pharmaceut. Sci., 6(1):54-57. http://dx.doi.org/10.54085/jpps.2026.6.1.7**