



Food-based approaches to cardiometabolic health: Emerging roles of polyphenols, peptides, fibres and fermented foods

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Abstract

Cardiometabolic disorders including cardiovascular disease, obesity, hypertension, dyslipidemia and impaired glucose regulation constitute a major and interrelated global health burden. Emerging evidence suggests that dietary patterns may affect cardiometabolic risk through multiple biological mechanisms beyond the effects of individual nutrients. This review focuses on the emerging roles of food-derived polyphenols, bioactive peptides, dietary fibers and fermented foods as complementary components of cardiometabolic nutrition. The effects of polyphenols on endothelial function, oxidative stress, inflammation, lipid metabolism and gut microbial transformation are discussed. The antihypertensive, lipid-regulating, antioxidant and metabolic activities of food-derived peptides are reviewed. The role of dietary fibers such as soluble fibers and resistant starches in satiety, blood glucose control, lipid metabolism, microbial fermentation and short-chain fatty acid production is discussed. Fermented foods are complex food matrices that provide microorganisms, metabolites produced during fermentation, modified phytochemicals, organic acids and bioactive peptides. Special emphasis is given to the interaction between food components and the gut microbiota, host metabolic signaling and properties of the food matrix. Mechanistic studies, animal models, observational and human intervention studies are reviewed to try to identify promising biological mechanisms and to distinguish them from clinically established effects. The review also discusses bioavailability, processing, interactions with food matrices, safety, standardization and challenges of translating individual bioactive components into practical functional foods. Emerging opportunities in the area of precision nutrition, multi-omics and computational approaches, and targeted food formulation are also addressed. Current evidence supports a food-based, matrix-aware approach, in which combinations of bioactive-rich foods may contribute to cardiometabolic risk management. Further well-designed long-term human studies are needed to establish dose, efficacy, sustainability and translational relevance.

Keywords: Cardiometabolic health, polyphenols, bioactive peptides, dietary fiber, fermented foods, gut microbiota

Introduction

Cardiometabolic health reflects the dynamic interaction between cardiovascular, metabolic, inflammatory and nutritional processes. Disturbances in blood pressure, lipid metabolism, glucose regulation, adiposity and vascular function often co-occur. The increasing prevalence of obesity and metabolic dysfunction has spurred interest in preventive approaches able to modify several risk pathways simultaneously. Pharmacological interventions remain important, but dietary strategies provide an opportunity to influence cardiometabolic physiology through complex combinations of nutrients, bioactive compounds, and food matrices.

Food-derived polyphenols, bioactive peptides, dietary fibers and fermented foods have been attracting increasing attention because their biological effects go beyond conventional nutritional functions. Polyphenols may affect endothelial signaling, inflammation, lipid metabolism and gut microbial metabolism, while food-derived peptides can modulate pathways involved in blood-pressure regulation, lipid homeostasis and oxidative stress (Kiyimba *et al.*, 2023; Lammi, 2023; Rodriguez-Mateos *et al.*, 2025) ^[1, 2, 3]. Dietary fibers are substrates for microbial fermentation and can affect satiety, glycemic responses, lipid metabolism and short-chain fatty acid production (Deehan *et al.*, 2024; Delzenne *et al.*, 2025) ^[4, 5]. Fermented foods provide another level of complexity, as fermentation can alter food

composition and produce peptides, organic acids, microbial metabolites and transformed phytochemicals (Li *et al.*, 2022; Sampsell *et al.*, 2025) ^[7].

These components do not work independently. Their activity can be influenced by food matrices, gastrointestinal transformation, microbial metabolism, processing and individual variability. Thus, an increasingly relevant perspective is to understand how combinations of bioactive compounds may contribute to cardiometabolic resilience from a food-based perspective. This review brings together recent evidence on polyphenols, food-derived peptides, dietary fibers and fermented foods with a focus on mechanisms, human evidence, bioavailability, food-matrix interactions, translational challenges and future opportunities for functional food development.

Review Methodology

1. Review Design

A structured narrative review was used to critically synthesize contemporary evidence on food-based approaches to cardiometabolic health. The review was designed to integrate evidence across four principal domains; polyphenols, food derived bioactive peptides, dietary fibers and fermented foods. The approach was based on systematic-review principles for literature identification and screening, but was not intended to be a formal systematic review or meta-analysis.

2. Strategy for Literature Search

We searched for literature published from January 2021 to September 2026. Searches were created for PubMed / MEDLINE, Scopus, Web of Science, Science Direct and Google Scholar. Search combinations included terms like:

"polyphenols" AND "cardiometabolic health"

- "cardiovascular" AND "dietary polyphenols"
- "bioactive peptides" AND "heart health"
- "food peptides" AND "blood pressure"
- "bioactive peptides" AND "lipid metabolism"
- "dietary fiber" and "cardiometabolic health"
- 'resistant starch' AND 'metabolic health'
- "dietary fiber" AND "gut microbe"
- "fermented foods" AND "cardiovascular health"
- "fermented foods" AND "blood pressure"
- "fermented foods" AND "metabolic syndrome"
- "fermented food" AND "intestinal microbiota"

"food matrix" AND "bioavailability" AND "bioactive compounds"

We also reviewed the reference lists of recent relevant reviews and meta-analyses to identify key primary studies and recent publications.

3. Inclusion Criteria

Priority was given to peer-reviewed studies published between 2021 and 2026 that investigated food-derived polyphenols, peptides, dietary fibers, resistant starch, fermented foods or fermentation-derived metabolites in relation to cardiometabolic outcomes. Translational conclusions were prioritized from human clinical trials, systematic reviews, meta-analyses and high-quality narrative reviews, with mechanistic, cellular and animal studies included to explain biological pathways.

Studies were excluded if the food source or bioactive was not sufficiently characterized, the publication was unrelated to cardiometabolic outcomes, only non-food pharmaceutical compounds were studied, or adequate methodological information was unavailable.

4. Evidence Organization

Evidence was organized by principal intervention/component, biological mechanism, cardiometabolic outcome and level of evidence. The results were classified as *in vitro*/mechanistic, animal, observational human, controlled human or evidence synthesis. Particular emphasis was placed on the difference between biological plausibility and proven clinical efficacy.

5. Framework Synthesis

The final review was progressively built from: (i) cardiometabolic rationale; (ii) bioactive classes and mechanisms; (iii) gut microbiota and fermentation; (iv) human and translational evidence; (v) food-matrix and bioavailability considerations; (vi) safety and formulation; and (vii) future research opportunities. We selected this framework so as not to treat individual bioactives as discrete pharmaceutical-like agents, but to explore their relevance within realistic food systems.

Food-Derived Bioactives and the Cardiometabolic Nutrition Landscape

A cluster of inter-related abnormalities in vascular regulation, lipid handling, glucose homeostasis, adiposity,

inflammation and oxidative balance define cardiometabolic dysfunction. Thus, there is increasing emphasis on the assessment of food-based interventions in terms of their ability to affect multiple pathways rather than a single disease marker. Polyphenol-rich foods contain a structurally diverse array of compounds that can interact with endothelial, inflammatory and metabolic signaling. Food-derived peptides (from dairy, cereals, legumes, eggs, meat and other proteins) have been shown to have antihypertensive, antioxidant, hypolipidaemic and metabolic activity [8, 2, 9]. Dietary fiber can be seen as a complementary component, as its effects vary from delayed nutrient absorption and increased satiety to microbial fermentation and production of metabolites such as acetate, propionate and butyrate [10, 4]. Fermented foods further modify this nutritional landscape by providing microorganisms and fermentation-derived compounds while potentially modifying the structure, digestibility and bioavailability of existing food constituents [6, 7]. Human evidence suggests that polyphenol-rich foods, adequate fiber intake and certain fermented foods impact a number of cardiometabolic risk markers with effect sizes dependent on food type, dose, population and study duration [1, 11]. It is essential to keep in mind that the same compound may behave differently when taken as an isolated extract versus in its natural food matrix. The structure of food may influence digestion, microbial transformation, absorption and physiological exposure and interactions between fiber, proteins, polyphenols and fermentation products may result in effects that cannot be predicted from the individual ingredients. Thus, cardiometabolic nutrition should increasingly focus on the whole food, matrix, dose, processing method and host context rather than individual bioactive compounds.

Polyphenols, Bioactive Peptides and Dietary Fibres: Molecular Mechanisms

1. Polyphenols and Vascular Metabolic Signalling

Polyphenols are a large and diverse group of chemicals found in fruits, vegetables, cereals, legumes, tea, cocoa, coffee, spices and other plant foods. Traditionally, their cardiometabolic relevance has been attributed to their antioxidant activity, but contemporary evidence suggests that their physiological actions are more complex. Many polyphenols are extensively metabolized in the intestines and liver after ingestion and the circulating metabolites can be very different from the parent compounds [3].

At the vasculature level, polyphenols can modulate endothelial nitric oxide signaling, vascular tone and oxidative stress. Effects of flavan-3-ols, anthocyanins and other subclasses on endothelial function and blood pressure have been studied. Meta-analyses suggest that polyphenol-rich foods and purified polyphenol preparations can potentially affect some cardiometabolic markers, but the response to these interventions is variable [1, 12]. Epidemiological evidence also shows that higher flavonoid intake is associated with lower cardiovascular disease, hypertension and diabetes risk, although observational associations cannot prove causality [13].

Polyphenols may also modulate inflammatory signaling and metabolic pathways that are involved in lipid and glucose homeostasis. This could result in transcriptional regulation, cellular redox signaling, and interactions with pathways such as AMPK, Nrf2 and NF-κB, rather than just direct free-radical scavenging. Therefore, recent evidence has

shifted the interpretation of dietary polyphenols from classical ‘antioxidants’ to bioactive signaling molecules and metabolic modulators ^[14].

2. Polyphenol - Gut Microbiota Interactions

Polyphenol intake is closely associated with cardiometabolic physiology at the gut microbiota interface. Most dietary polyphenols reach the colon, where microbial enzymes convert complex compounds into smaller metabolites. Polyphenols may also affect the growth, metabolism and ecological interactions of gut microbes ^[15, 16].

It is not a one-way relationship. The microbiota composition can affect the metabolites from dietary polyphenols and polyphenols can affect the microbial populations and their metabolic products. This interaction may provide an explanation for the differential cardiometabolic response of individuals to similar diets. Furthermore, several studies on polyphenol metabolites have also highlighted interindividual differences in the microbial conversion of isoflavones and ellagitannins ^[3].

Microbial metabolites can then modulate inflammation, metabolic signaling and vascular function. Human evidence of microbial metabolites from polyphenols is promising, but there is still considerable uncertainty about dose-response relationships, reproducibility and clinical significance of specific metabolites ^[17].

3. Food - Derived Bioactive Peptides and Cardiovascular Regulation

Bioactive peptides can be released from food proteins by gastrointestinal digestion, enzymatic hydrolysis, fermentation or controlled processing. The biological activity of AMPs is influenced by the amino acid sequence, molecular size, charge, hydrophobicity and resistance to gastrointestinal degradation ^[8, 18].

One of the better characterized mechanisms is the inhibition of angiotensin-converting enzyme (ACE) that may affect the renin-angiotensin system and vascular tone. Antihypertensive effects of peptides from milk, cereals, legumes, fish and other proteins have been investigated ^[19]. Other mechanisms include endothelial nitric oxide signaling, renin activity, oxidative stress and modulation of inflammatory pathways.

Food peptides may also modulate lipid metabolism. Some peptides have been experimentally demonstrated to interact with cholesterol metabolism, lipid transport and regulatory signaling pathways ^[9]. Plant-derived peptides have attracted particular interest as peptides derived from soy, lupin, rice, hemp and other plant proteins have been shown to have potential hypocholesterolaemic effects, although relatively few candidates have been subjected to robust human validation ^[2].

4. Peptides, Processing and Gastrointestinal Stability

In vitro assays that determine the biological potency of a peptide do not guaranty that the peptide will be physiologically active when ingested orally. Gastrointestinal enzymes can degrade peptides before they reach their target sites and food processing and storage can alter the structure and activity of peptides ^[20].

This is particularly important for the development of functional foods. Interaction with proteins, carbohydrates, lipids and minerals of peptides incorporated in beverages,

bakery products, protein foods or fermented products may occur. Thermal processing, pH and storage can further alter their stability. Hence, the functionality of the peptides should be evaluated in the final food matrix and not only as purified compounds.

Recent work has increasingly focused on gastrointestinal stability, transport, and bioavailability as critical steps between peptide discovery and clinical application. More sophisticated approaches such as computational screening, structural characterization, simulated digestion, intestinal transport models and controlled fermentation may help identify peptides with higher translational potential ^[18, 19].

5. Dietary Fibres and Metabolic Regulation

Dietary fiber is a heterogeneous group of carbohydrate polymers that have different physicochemical and physiological properties. Soluble, viscous and fermentable fibers can affect gastric emptying, nutrient absorption, satiety and postprandial glycaemia, while fermentable fibers provide substrates for microbial metabolism ^[4].

Fiber may also influence lipid metabolism by several mechanisms, such as bile-acid binding, changed intestinal lipid absorption and microbial transformation. There is clinical evidence to suggest that increased fiber intake may contribute to improvements in blood pressure and cardiovascular risk factors, supporting its role as an important component of cardiometabolic dietary strategies ^[11].

Of particular interest is resistant starch, which resists digestion in the small intestine, but is fermented in the colon. Evidence from randomized trials suggests that resistant starch may improve postprandial glycemic responses, although the effect on fasting metabolic markers is dependent on the type of resistant starch, dose, duration and characteristics of the participants ^[21].

6. Fibre Fermentation and Short - Chain Fatty Acids

Dietary fiber is microbially fermented to short-chain fatty acids (SCFAs), mainly acetate, propionate and butyrate. These metabolites offer a mechanistic link between dietary fiber, gut microbial activity and systemic metabolic regulation ^[10].

SCFAs can affect gut barrier function, immune signaling, appetite regulation and energy metabolism. They may also effect cross-talk with G-protein-coupled receptors and other signaling pathways involved in glucose and lipid metabolism. However, human responses are heterogeneous and may be influenced by baseline microbiota, age, sex, genetics, habitual diet and physicochemical characteristics of the fiber consumed.

Recent research therefore supports a shift from total fiber quantity toward consideration of fiber type, fermentability, viscosity, food source and individual microbial capacity. Such an approach might be especially important for future development of personalized cardiometabolic dietary strategies ^[5].

Fermented Foods, Gut Microbiota and Cardiometabolic Regulation

1. Fermented Foods as Complex Functional Matrices

Fermented foods differ from isolated nutraceutical preparations in that fermentation produces a biologically active food environment. Microbial metabolism can alter proteins, carbohydrates and phytochemicals, and produce

organic acids, peptides, exopolysaccharides, vitamins and other metabolites ^[6, 7].

Examples of matrices where fermentation can change nutritional characteristics include fermented dairy, cereals, legumes, vegetables, tea and traditional mixed foods. The health effects are thus likely due to the combined action of the original food constituents and the compounds derived from fermentation, rather than that of a single microorganism or a metabolite.

2. Fermentation Derived Bioactive Peptides

Proteolytic microorganisms are able to hydrolyze food proteins and produce short peptides with biological activity. Fermented dairy products are of particular interest since microbial fermentation could release peptides able to modulate ACE activity and vascular regulation ^[22].

Thus, fermentation may be considered a biological processing technology that could increase the availability of selected peptides derived from food. However, the peptide profiles are greatly influenced by the microorganism, the fermentation conditions, the substrate composition and the processing history. However, standardization is still needed before certain cardiometabolic claims can be ascribed to a fermented food.

3. Fermented Foods and Blood Pressure Regulation

Several mechanisms have been proposed for the potential effects of fermented foods on blood pressure, including ACE-inhibitory peptides, improved endothelial signaling, mineral interactions and microbial metabolites. Evidence from fermented dairy foods is particularly relevant considering that some observational studies have reported associations between some fermented dairy products and favorable cardiovascular outcomes ^[22].

However, the observed associations may be a proxy for broader dietary patterns and lifestyle characteristics. Thus, the need for controlled intervention studies to determine whether fermentation has independent cardiometabolic benefits.

4. Fermented Foods and Glucose Lipid Metabolism

Fermentation can affect the digestibility of carbohydrate, production of organic acid and bioavailability of phytochemical. These changes in fermented cereal and legume products may affect postprandial glucose responses and substrate availability for microbial fermentation.

Evidence from randomized controlled trials of botanical fermented foods suggests that certain interventions may improve discrete cardiometabolic outcomes including glucose, lipid profile, blood pressure and inflammatory markers, although there is considerable heterogeneity between products and study designs ^[23].

Microbial metabolites, modifications in food composition and interactions with bile-acid metabolism may also mediate effects of fermented foods on lipid metabolism. However, effects are not consistent and are dependent on the category of fermented foods.

5. Fermentation, Polyphenol Transformation and Bioavailability

Fermentation-mediated enzymatic breakdown of glycosides, polymers and other complex structures may enhance the bioavailability of plant polyphenols. Glycosidases and esterases are examples of microbial enzymes that can

produce lower molecular weight metabolites with different solubility and biological properties ^[24].

This transformation may be relevant for cardiometabolic effects, since microbial metabolites may have different absorption features and molecular targets compared to their parent compounds. Thus, fermentation is a biological pre-processing step that can modify the exposure profile of dietary polyphenols.

Increased bioaccessibility does not automatically translate into increased clinical efficacy. This requires the consideration of GI stability, absorption, metabolism and actual biological exposure of the transformed compounds' concentration.

6. Gut Microbiota as A Central Mediator

Dietary fibers and fermented foods can influence the intestinal microbial ecosystem. Fiber is a substrate for fermentation, and fermented foods can provide microorganisms and metabolites that may interact with the resident microbiota.

The resulting microbial ecosystem may affect SCFA production, intestinal barrier integrity, immune signaling and host metabolism. Recent research emphasizes that the response to fiber is highly individual and may depend on baseline microbial composition and functional capacity ^[5].

There are also bidirectional effects between polyphenols and gut microbiota. Their metabolism can generate bioactive metabolites and their ingestion can alter the microbial ecology ^[16, 17].

7. Inflammation, Oxidative Stress and Cardiometabolic Resilience

Chronic low-grade inflammation and oxidative imbalance are common features of cardiometabolic dysfunction. Food-derived bioactives are likely to affect these processes through multiple signaling pathways, not only as direct antioxidants.

Polyphenols may modulate Nrf2-mediated cytoprotective and inflammatory signaling. Metabolites and SCFAs from fermentation may modulate immune and epithelial pathways. Bioactive peptides are also able to modulate oxidative and inflammatory processes ^[8, 10].

This multi-pathway activity underlies the concept of dietary resilience, whereby chronic consumption of a number of bioactive rich foods may help to maintain physiological homeostasis rather than targeting a single abnormal biomarker.

8. Human Evidence and Clinical Relevance

Human evidence remains the main determinant of translational relevance. The intake of polyphenols has been associated with improvements in certain cardiometabolic markers, such as blood pressure, lipid variables, and measures of glucose regulation, as evidenced by meta-analyses, though substantial heterogeneity remains ^[1, 12].

“The evidence base for fermented foods is rapidly expanding. A systematic review of botanical fermented foods found that some randomized controlled trials reported positive changes in discrete cardiometabolic outcomes, however the diversity of food types, length of intervention, and participant characteristics made it challenging to generalize broadly ^[23]. Similarly, recent data on kimchi suggest a growing interest in fermented vegetables as possibly contributing to cardiometabolic health, though as

with all the evidence, this should be interpreted with caution [25].

9. Whole Food Matrix Versus Isolated Bioactive

One of the most important considerations is the question whether the observed effect of a bioactive compound is still relevant when consumed in a whole food. Food matrices affect digestion, release, absorption and microbial metabolism. Protein-polyphenol, fibre-polyphenol and lipid-polyphenol interactions can modify the amount of compound reaching the circulation or colon.

Evidence from comparisons of whole polyphenol-rich foods and purified extracts suggest that the food matrix should not be considered simply as an inert carrier ^[1]. The physiological effects of dietary fiber are also determined by food structure, viscosity, fermentability and microbial accessibility, not just grams consumed.

10. Synergistic Interactions Among Food Components

Polyphenols, peptides, fibers and fermented foods may interact at different levels. Fiber could alter the gut environment in which polyphenols and microbial metabolites are produced. Fermentation can release peptides and modify the phenolic compounds. Polyphenols may modulate microbial populations involved in fiber metabolism, and SCFAs may modulate host signaling.

These interactions suggest that future construction of functional foods should increasingly rely on multi-component food systems rather than the highest possible concentration of single bioactives. This approach might induce physiological coherence without impinging on sensory properties and dietary relevance.

Food Matrix, Translational Challenges, Safety and Future Directions

1. Bioavailability and Food Matrix Effects

Bioavailability is a major hurdle in translating food bioactives into practical interventions. Polyphenols may be extensively metabolized, peptides may be degraded by gastrointestinal enzymes and fibers may have significant effects without entering systemic circulation. Therefore, the systemic concentration may not be an adequate explanation of biological activity.

More and more recent studies support a matrix-aware model where food structure, processing, digestion and microbial metabolism determine the actual exposure to bioactive compounds ^[4, 20]. Such a point of view is of special interest for the development of functional foods.

2. Processing and Formulation

Food processing can maintain or improve the bioactivity or cause losses due to oxidation, thermal degradation, structural modification or interactions with other food components. One of the processing methods that can generate new metabolites and change the bioactive compounds is fermentation.

Therefore, for future product development, processing conditions should be optimized not only for shelf life and sensory quality, but also for the preservation of biological functionality. Controlled fermentation, mild extraction, encapsulation and matrix engineering may be opportunities to improve stability and bioaccessibility.

3. Safety, Standardization and Regulatory Considerations

By definition, derived food is not risk free. Appropriate evaluation is needed for excessive supplementation, concentrated extracts, contamination, allergenicity and drug interactions. Difficulty in reproducibility can also be attributed to variability in polyphenol composition, peptide sequences, fiber characteristics and microbial cultures.

Standardization should therefore encompass raw-material characterization, marker compounds or functional activity, processing conditions, dose and stability. Functional claims should be in line with the strength of the human evidence available, not extrapolated from cellular or animal studies.

4. Translational Gap Between Mechanism and Clinical Outcome

A common limitation in the literature is the disconnect between mechanistic evidence and clinically relevant outcomes. The strong ACE inhibition *in vitro*, antioxidant capacity in chemical assays or microbial changes in experimental models cannot be automatically translated into reductions in cardiovascular events or metabolic disease.

Future studies should focus on well-powered randomized controlled trials with characterized food products, realistic doses and long enough intervention periods. Standardized cardiometabolic endpoints should be supplemented with dietary intake assessment and, where appropriate, microbiome and metabolomic analyzes.

5. Future Directions

Future research should focus on food-first, matrix-aware and precision cardiometabolic nutrition. Multi-omics approaches could identify metabolic responders, and the influence of the gut microbial composition on the response to polyphenols and fibers could be determined. Machine learning and artificial intelligence can be used to identify ingredient combinations, predict sensory acceptance, optimize formulations, and link food composition to biological outcomes.

The next generation of functional foods should not have high concentrations of isolated bioactives. Based on digestibility, sensory acceptability, affordability and sustainability, products should be based on complementary combinations of fibers, polyphenols, peptides and fermentation-derived metabolites.

Long-term research should also explore culturally relevant foods and traditional fermented products by modern analytical and clinical approaches. This combination could link traditional knowledge of diet and mechanistic nutrition science, and also create food products practical for real-world consumption.

Limitations

There are some limitations that need to be kept in mind when interpreting the evidence synthesized in this review. First, the chemical composition, dose, source, processing method, and food matrix of polyphenols, peptides, fibers, and fermented foods are highly heterogeneous, making direct comparisons between studies difficult. Secondly, for some bioactive classes there are many more mechanistic and animal studies than long-term human intervention trials. Thus, promising molecular mechanisms do not always translate into clinically meaningful cardiometabolic outcomes. Third, inter-individual variability of response

may be due to differences in participant characteristics, habitual diets, microbiota composition and metabolic status. Fourth, the studies are often conducted on isolated compounds or extracts, not on realistic whole food matrices, limiting direct applicability to dietary practice. The study of fermented foods is complicated by the variation in microbial strains, fermentation conditions, and product composition. Finally, publication bias, short intervention periods and inconsistent outcome measurements could influence the perceived strength of evidence. These limitations underline the need for standardized food characterization, realistic doses, longer controlled trials, and comprehensive clinical, microbiome, and metabolomic assessment.

Conclusion

Dietary strategies are an appealing component of a holistic strategy pertaining to cardiometabolic health, as they have the potential to impact multiple physiological processes simultaneously. Polyphenols, bioactive peptides, dietary fibers and fermented foods present different biological possibilities but their importance is not restricted to isolated molecular activities. Food structure, processing, digestion, microbial transformation, host metabolism and interaction between dietary components modulate the effects.

There is increasing evidence to support a move from a reductionistic view of individual nutraceutical compounds toward a food matrix view, where combinations of bioactive components are considered within the framework of realistic dietary systems. Polyphenol-rich foods may be involved in vascular and metabolic regulation, peptides have different signaling activities, fibers have metabolic and microbial effects and fermented foods provide a biologically transformed matrix including microorganisms and metabolites produced by fermentation.

Therefore, future cardiometabolic nutrition should not only focus on the identification of the most effective compound, but also on the development of foods that provide biologically relevant combinations at attainable dietary doses. Precision nutrition, microbiome science, metabolomics, artificial intelligence and advanced food processing could accelerate the transition, as well as improve the identification of responders, optimization of formulations and prediction of food–host interactions.

Ultimately, the success of these approaches in practice will be determined by robust human evidence, standardized food products, long-term evaluation, safety assessment, affordability and cultural acceptability. Thus, the future of cardiometabolic nutrition is likely to be driven by whole foods, intelligent food design and personalized dietary strategies, rather than by isolated bioactive compounds alone.

Authors' contributions

NM conceived the review, developed the methodology, conducted the literature search and evidence synthesis, prepared the tables and figures, and wrote the original draft. JW supervised and validated the work and critically reviewed, revised and edited the manuscript. Both authors read and approved the final manuscript and agreed to be accountable for the integrity of the work.

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