



Functional Foods: Types and Health Benefits

Afkar Y. Ahmed¹, Ali M. Saadi^{2*}

¹Department of Food Science, College of Agriculture and Forests, University of Mosul, Mosul, Iraq

²Department of Animal Production Techniques, Technical Agricultural College, Northern Technical University, Iraq

*Corresponding author. Email: ali.mohammed@ntu.edu.iq

DOI: <https://doi.org/10.71428/PJS.2026.0112>

Abstract

This scientific article examines the concept of functional foods as an important area of research focused on providing health benefits beyond basic nutrition, with the aim of promoting healthy lifestyles and preventing disease. The article reviews the conceptual framework of functional foods and their historical development, as they have been receiving increasing attention since the 1990s, with the emergence of scientific evidence to support the health claims of their ingredients.

The article categorizes functional foods into four main types: fortified foods (with added nutrients), whole foods containing bioactive compounds, therapeutic foods that target specific chronic diseases, and nutritional supplements that differ from traditional foods in their form and concentrated doses.

The article discusses the different mechanisms by which these foods improve health, such as their impact on the biological pathways associated with lifestyle diseases. It also reviews health benefits across different populations, including: Cardiovascular health: by modulating risks such as plasma lipids and blood pressure. Metabolic health: By improving blood glucose regulation, insulin sensitivity, and weight control. Digestive Health and Microbiome: By promoting the growth of beneficial bacteria via probiotics and prebiotics. Modulation of immunity and inflammation: By reducing signs of chronic inflammation and boosting immunity. Cognitive function and mental health: through the effect of micronutrients and antioxidants.

Keywords: Health Benefits, Fortified Foods, Bioactive Compounds, Probiotics, Prebiotics, Cardiovascular Health.

1. Introduction

Functional foods have emerged as an important area of research, receiving much attention from the scientific community in recent years (1). This review has focused on the functional food for the younger population and teenagers. The main goal has been to present the current understanding of the state of functional food targeting specifically the younger population, and how effective it can be for them. A combination of various studies and explanations of simple terminologies has been used with the intention to enlighten the base understanding of the functional food for future studies (2). Functional

foods should act as the foundation for numerous healthy eating habits and promote healthy lifestyles across the globe. Therefore, it is essential that the benefits of functional food be promoted and the audience kept well-informed about them (3).

Functional foods are defined as “foods that provide health benefits beyond basic nutrition and reduce the risk of disease.” Currently, a wider range of food products is emerging in the market that target specific consumers and their diverse needs (4). The target audience for achieving the desired functional food product should fall within the age group of 18-

35, as teens aged 13-15 and young adults aged 16-25 form the crucial years during which a youth knowingly engages in unhealthy eating habits (5). Functional foods can be mainstream foods combined with added-value ingredients or food substitutes with usual ingredients serving the purpose of healthy living. Technology is progressing at a rapid pace; therefore, most of the time, opposite things seem to go hand in hand in terms of balance; that also applies to food, where functional foods fit into the main need (6).

2. Conceptual Framework of Functional Foods

Functional foods exhibit the potential to provide health benefits beyond basic nutrition. According to a recent FDA proposal, functional foods “naturally contain substances that are beneficial to health, that enhance the functioning of the human body, and that prevent disease”. The Food and Agriculture Organization similarly defines functional foods as products containing “bioactive molecules that offer health benefits beyond basic nutrition”. In a control system theory framework, functional foods represent measurable non-zero inputs to the human body, defined by bioactive ingredients (or a lack thereof) that substantially influence outcomes such as nutrient status or bodily functions (7). Bioactive components are subsequently divided into primary and secondary factors. Primary factors relate directly to a targeted health outcome, while secondary factors correspond to ancillary benefits that favour, hinder, or have no impact on the primary target. A bioactive’s influence on health also depends on the dose received, the kinetics of delivery, and the characteristics of the human subject, rendering dose-response modelling essential for a thorough understanding of functionality in food (8).

The history of food regulation and development reveals substantial transitions in the functional food concept. Historically, foods have often been regulated according to their core ingredients, additions to which led to a shift in categorization 5. Mixed-level dressings where oil is added to a water

(plaque-like) base pose a similar explanatory challenge, but within a categorization of a type of food. The emergence of fortification, supplements, and functional foods occurred due to an increasing commercial focus on food benefits exceeding mere caloric content. Since the early 1990s, pressure for the European Union to regulate functional food products has accelerated, as research established specific health claims for ingredients including fibre and probiotics, among others. The breadth of contemporary scientific evidence has led to a substantial increase in strict term definition and academic pressure to formalize the concept further (9,10).

3. Classification of Functional Foods

Functional foods can be classified as fortified functional foods, whole-food-based functional foods, medical or therapeutic functional foods, dietary supplements, and other functional food forms (3).

Fortified functional foods contain added nutrients or substances that may provide an additional health benefit (5). Standard fortification or enrichment (the addition of vitamins and minerals at recommended dietary allowance or adequate intake concentrations fixed by regulations) aims to reduce the risk of deficiency in the general population. Nutrient-targeted (the addition of micronutrients to alleviate the risk of chronic diseases) fortified foods address specific health concerns that may not affect the whole population. Health-targeted foods (standard fortification of nutrients of public health concern) respond to regulatory signals that food manufacturers should act in the public interest (7). Examples include products high in calcium (reduced risk of osteoporosis), omega-3 fatty acids (lower triglycerides, heart attack protection), and folic acid (fewer neural-tube defects) (11).

Whole-food-based functional foods contain naturally occurring bioactive compounds or substances that the government endorses as

beneficial if the food is consumed in a specified dietary pattern. Fermented milk (for calcium, probiotics, and protein) and whole grains (for grain-based products leading to cardiovascular health) demonstrate the concept (12).

Medical or therapeutic functional foods specifically target erroneous health claims associated with chronic diseases, such as hypercholesterolemia and hypertension. These foods make disease-targeted claims, measurable clinical and physiological endpoints, and a stronger-than-normal body of scientific evidence. Low-cholesterol, low-saturated-fat, or high-fiber functional foods are proposed to have a lower cholesterol equilibrium and lipoprotein metabolism. Probiotics target the gut as a specific claim to increase beneficial microflora (13).

Dietary supplements, extra-strength functional foods, and other functional food forms differ from functional foods primarily in dosage form, position, comments, and regulation. Cited health benefits are also compliant with health claims for commonly consumed processed foods. Dietary supplements in pill, capsule, powder, or liquid form contain large amounts of nutrients or other dietary ingredients. Safety becomes more crucial in high-dose than normal foods owing to synergy, interactions, special conditions, and other precautionary considerations (14).

3.1. Fortified Functional Foods

Fortification maintains nutrients in foods lost through processing, improves diets lacking supplies, enhances bioavailability, and supports a healthy lifestyle with convenience or appeal. The World Health Organization clarifies the dietary deficiencies epidemic worldwide, especially vitamins A, B, and iron. Fortified foods prevent cognitive impairment, low immunity, blindness, and anemia (5). The Codex Alimentarius standards indicate food specifications from the food safety codex, germination and fermentation knowledge, polysaccharide crystals, and important constituents like vitamins and

minerals (7). Fortification protects against the pandemic, is part of holistic nutrition, and preserves food taste, odour, texture, and colour (15).

Functional foods support primarily dietary supplements, remedy-related preparation, and medication adherence, optional. A narrow definition restricts functional diets to macro, micro, and phytochemical feeding supplements meeting quantitative recommendations close to maximum doses. The Canadian Health Canada Food and Drug Administration distinguishes food and health products by safety and dietary functions (16).

3.2. Whole-Food Based Functional Foods

Bioactive compounds contained in whole foods act as functional foods: when consumed within traditional dietary patterns, these foods contribute to the reduction of certain health risks. Whole-food ingredients exert a broad range of modulating influences that, when cumulative, may impact health; their target organs and resulting biomarkers of activity complement those of fortified products (7). Statistical analyses of habitual diets would tightly around whole-food materials further support health hypotheses (17).

3.3. Medical or Therapeutic Functional Foods

Functional foods, which are enriched or fortified with bioactive compounds, have gained global popularity due to their health benefits. Depending on the food group, consumption, and demonstrable interactions with certain diseases, classes of functional foods can be based on the disease being targeted. Foods marketed for their impact on a well-defined disease and proposed biological mechanisms are called medical or therapeutic functional foods (9). Such foods should cover not only epidemiological and mechanistic approaches, but also clinical endpoints. Based on Japan's tradition of food education policy, therapeutic functional foods with health claims are considered general foods rather than foods for special health use (7). Evidence criteria for specified functions or

biological mechanisms have also been established, where epidemiological studies lack direct evidence. Thus, health-care authorities/foundations might pay attention to therapeutic functional foods when promoting diet for extension of healthy life expectancy and improvement of quality of life (18).

3.4. Dietary Supplements and Other Functional Food Forms

Functional foods are foods that provide health benefits beyond basic nutrition. Dietary supplements, on the other hand, are not traditionally classified as functional foods because they exist in concentrated forms that are usually not consumed as part of a regular diet (19). The functional foods category encompasses a broader spectrum of products, including fortified foods, whole food-based products, and medical foods. Dietary supplements can be considered functional foods only when taken as part of a broader dietary pattern (5). Supplements differ from functional foods in that their active ingredients are consumed in higher amounts. Most dietary supplements on the market contain active ingredients targeted toward specific health concerns or benefits, with dosages concentrated well above the levels typically consumed through the normal diet (20).

Compared to conventional foods, supplementary products generally contain a smaller number of active substances and lack the complex matrices present in whole foods. Most studies of dietary supplements are conducted in animals or cell culture and do not assess food items but rather individual, highly concentrated substances (7). The scientific literature contains relatively few interventional studies on actual dietary supplements concerning health effects. Consequently, safety, tolerability, and the potential for adverse effects associated with dietary supplements are often under-researched (21).

4. Mechanisms Underpinning Health Benefits

Functional foods represent an exciting avenue to fight diseases of affluence. Their key feature is

securing physiological effects that go beyond the normal nutritional contributions of common macro- and micronutrients. As the quintessential reference on this topic puts it, functional foods aim to promote better health and help prevent chronic illnesses through a readily available, good-tasting diet (5).

Health benefits of functional foods are underpinned by a number of mechanisms. When consumed within an adequate amount or dosage, they exert their action through biological pathways or target sites involved in the onset or progression of diet-related diseases (12). These effects are attested by objective biological biomarkers and underpin dose-dependent health outcomes. At the molecular and cellular level, they involve the absorption, metabolism, and ultimate action of functional food components in specific tissues (4). Systemically, functional foods help modulate inflammatory, oxidative, or hormonal status linked to diet-related pathologies. Interactions among bioactive compounds of the food matrix and microbiota-mediated pathways further expand the range of accessibility to host tissues of bioactive compounds (22).

5. Health Benefits Across Population Groups

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) remain the leading cause of global mortality. WHO estimates indicate that approximately 18 million people died from CVDs in 2019, representing 32% of total deaths worldwide, and this burden is anticipated to escalate in the coming decades. Since CVDs are deemed preventable, the WHO has placed great emphasis on primary prevention measures in regulating foods and beverages with health benefits (13,23). The recommendations focus on population-wide interventions and monitoring health-promoting food claims in the product market to identify those that particularly benefit cardiovascular health (5).

The increased availability of energy-dense foods along with sedentary lifestyles has heightened the worldwide prevalence of obesity. The WHO

estimates indicate that over 1.9 billion adults aged 18 years and older were found to be overweight in 2016, and among them, over 650 million were classified as obese. The growing global obesity epidemic, which is often accompanied by the financial crisis, has a special significance to the ongoing krail initiative undertaken by the World Health Organization (WHO) (7).

5.1. Cardiovascular Health

A considerable amount of evidence supports the potential of food and dietary patterns to modulate multiple risk factors associated with cardiovascular diseases (24). Epidemiological studies have revealed that certain food groups and dietary components can affect cardiovascular risk by influencing plasma lipids, blood pressure, inflammatory responses, and endothelial function. Using primary clinical endpoints as efficacy measures, a large body of clinical research documents the beneficial effects of dietary approaches on cardiovascular health. Empirical investigations show that healthy dietary practices can improve numerous risk factors and reduce clinical-endpoint adverse events associated with cardiovascular diseases (25).

A broad spectrum of food items, bioactive compounds, and food matrices exhibits evidence of cardio-protective properties, yet not all foods currently labelled as functional food are backed by sufficient scientific data to warrant such claims. Surmounting scientific literature supports the underlying cardio-protective mechanisms of selected functional foods and bioactive components, together with specific physiological effects and impacts on clinical conditions (14).

5.2. Metabolic Health

Functional Foods can positively affect metabolic health, influencing blood glucose regulation, insulin sensitivity, energy intake, and appetite in individuals who are overweight or obese. A review has shown that the intake of certain functional foods reduced

overall weight and body fat in weight-loss intervention programs (26).

Blood glucose regulation during digestion entails an increase in blood glucose levels, followed by a return to pre-ingestion concentrations. The postprandial state is characterized by elevated glucose levels, which should return to the pre-meal range within approximately two hours after the meal. Maintenance of normal glycaemia is critical for health, and if glycaemic excursions are not well controlled, the risk of developing diabetes increases (19,27). A balanced diet that meets energy needs, is low in saturated fat, and contains fruits, vegetables, legumes, cereals, dairy foods, seafood, nuts, and spices, may reduce glycaemic excursions, especially in the postprandial state (7). Ingestion of particular foods or substances—such as food containing protein, soluble dietary fibre, whole grains, or polyunsaturated fatty acids—has also been shown to correlate with reduced postprandial glucose levels (5). Consumption of low-calorie food items—such as artificial sweeteners, oat bran, wheat bran, psyllium, guar gum, pectin, or mucilage—has been shown to decrease total energy intake across various studies (28).

5.3. Digestive Health and Gut Microbiota

The gut microbiota, the collective genomes of microorganisms residing in the intestinal lumen, contains about 150 times more genes than the human genome (29). These microorganisms are essential for the extraction of useful nutrients from dietary fibers and play a crucial role in maintaining the function of the gastrointestinal (GI) tract. The preservation of gut-friendly microorganisms is important to restore and maintain a healthy gut microbiota. Numerous things can impact the gut microbiota, including diet, environment, lifestyle, medications, and probiotics. The intake of probiotics, prebiotics, and other functional foods strongly influences the composition and activity of gut microbiota. The consumption of probiotic- and prebiotic-containing functional foods can also

prevent numerous intestinal diseases, such as gut inflammation and colon cancer. Gut microbiota-derived metabolites like short-chain fatty acids (SCFAs) influence various biological processes, including nutrient absorption, immune system maintenance, and intestinal permeability (30). A lack of food intake, long-term metabolism on a low diet, and inactivity can imbalance or harm secondary metabolism, resulting in low concentrations of postbiotics as metabolic products in the gut. Foods containing probiotics and prebiotics contribute to the balance and maintenance of intestinal microbiota (31).

5.4. Immunomodulation and Inflammation

The immune system protection, anti-inflammatory, and anti-infectious effects constitute vital health-promoting properties of diet components. Immune system-related enzymes and innate and adaptive immune system markers, such as lysozyme, complement proteins, and immunoglobulins, are indicators of immune status. Nutrients that enhance anti-viral or anti-bacterial activity can reduce the risk of infection and augment anti-infectious immunity (32).

Functional food associations between the immune system and infection have been linked to whole eggs, plant protein, certain bee products, fruits, and fermented foods. Lowering chronic inflammation markers, such as C-reactive protein (CRP), fibrinogen, tissue factors, and interleukin 6 (IL-6), improves well-being. Chronic inflammatory disease risks, including cancers, diabetes, cardiovascular problems, and neurodegenerative issues, can increase inflammatory status. Reduced chronic inflammation improves Alzheimer's and Parkinson's patients (33).

5.5. Cognitive Function and Mental Health

The advantages of functional foods have been associated with various aspects of cognitive function and mental health. A higher intake of micronutrients positively affects cognitive function, mood, and

behavior, while a higher intake of the antioxidant α -tocopherol is related to increased cognitive performance and attention. Foods are also acknowledged as an important determinant of mood, anxiety, and various emotional and affective states (34). Cognitive decline is closely associated with productivity and societal well-being. Fermented foods, classified as functional foods for their health benefits beyond nutrition, have been shown to prevent cognitive decline and enhance cognitive function among older adults (35).

6. Safety, Regulation, and Consumer Considerations

Functional foods can be considered safe for healthy consumers, but available databases, guidelines, and regulations concerning their legal status remain heterogeneous. A range of consumer considerations and uncertainties surrounding their definition, regulations, and associated scientific substantiation, and due diligence needs to be taken into account (5).

In lieu of prohibitive and extensive local laws, fortification of standard foods with functional nutrients remains the predominant functional food category within the European Union (36). Standard food manufacturers voluntarily fortify their products with functional compounds, while specific regulations apply to healthy-diet claims. The national low-calorie list stipulates permitted claims, and health-claim regulations cover the range of health-related endorsements or testimonials. Health claims solely allowed for approved compounds must underline the targeted mechanism(s) of action (37).

7. Methodological Approaches in Functional Foods Research

Research on functional foods has proliferated in recent decades, taking diverse forms that reflect the complexity and multifaceted nature of the subject. Methodological diversity continues to increase, carried by the emergence of numerous sub-disciplines or fields of investigation (38). This proliferation challenges the coherence and integrity

of functional-food research as a whole. The systematization and rationalization of methods are essential for enhancing research quality, clarifying functional-food issues, accelerating meaningful knowledge accumulation, and guiding relevant investments. Without such rationalization, the chances of promoting meaningful progress, developing an integrated understanding, and advancing knowledge of any kind remain slim (39). Studies and their interpretations frequently lead to apparently conflicting conclusions, and a rational foundation for the overall field is still being constructed. The accumulated knowledge remains incomplete and still lacks the underpinning organization that might permit a complete understanding of functional foods and their potential (7).

Refinement of methodology also enhances systematic exploration of basic questions. Considerable practical importance is evident because a multitude of dietary substances and patterns are used or proposed for functional-food enhancement in many populations, emphasizing the potential health impact of such functional substances and formulations. Some of the most pressing problems, therefore, relate to the emphasis placed on specific foods, ingredients, and delivery systems as separate initiatives, rather than a systematic, hierarchical exploration of the whole and its elaborate health-related-functional-food options. A more rational framework and related hierarchy would expand the potential for comprehensive exploration of functional-food topics, including the wide variety of research questions, often ill-defined even within individual investigations (40).

Methodologically, functional-food studies comprise three relatively distinct classes that rely on overlapping or bridging approaches and have a range of research objectives, endpoints, metrics, or resource requirements. Health implications constitute the principal focus among researchers, food scientists, and the food industry. Functional-

food studies commonly serve health objectives, but a strong, explicit rationale for extending attention to this type is still needed (41, 42).

8. Conclusion

Functional foods are becoming increasingly popular in a world where medical doctors prescribe pills in an attempt to manage diet-related diseases and their symptoms. Functional foods aim to help reduce the risk of diseases through a healthy diet rather than just treatment. They contain functional ingredients such as dietary fiber, calcium, prebiotics (oligosaccharides), lactic acid bacteria, and phytosterols that prevent disease, slow aging by nourishing the body, improve skin appearance, and control body weight by removing excess fat and dampness. The definition and regulation of functional foods are established by health authorities to protect consumers and promote confidence. The market for functional foods continues to grow along with consumer awareness of health issues and interest in preventative techniques. Functional foods are rich in bioactive compounds with antioxidant, anti-carcinogenic, and anti-inflammatory properties. Epidemiologic studies suggest that regular consumption of such foods reduces the risks of diseases associated with aging. Once absorbed, they interact with specific molecular targets that initiate cell signalling pathways connected with the modulation of metabolic processes. By influencing these pathways, these foods exert biological activities that modify disease risk and well-being. Concurrently, lifestyle, environment, and eating habits evolve; therefore, a constant supply of healthy and functional food products focused on prevention is needed. In developing countries, where many people still have no access to basic food products, new sources of bioactive phytochemicals are needed so that low-cost functional foods can be created. Education, dissemination of appropriate information, encouragement of private and public cooperation, and alternative approaches are required to achieve such progress.

Conflict of interest: NIL

Funding: NIL

References:

1. Hajzer, Z. E., Alibrahem, W., Kharrat Helu, N., Oláh, C., & Prokisch, J. (2025). Functional foods in clinical trials and future research directions. *Foods*, 14(15), 2675.
2. Sgroi, F., Sciortino, C., Baviera-Puig, A., & Modica, F. (2024). Analyzing consumer trends in functional foods: A cluster analysis approach. *Journal of Agriculture and Food Research*, 15, 101041.
3. Deshmukh, V., & Gutte, R. K. (2024). Sustainable health and functional foods. In *The contribution of universities towards education for sustainable development* (pp. 439-451). Cham: Springer Nature Switzerland.
4. Vlaicu, P. A., Untea, A. E., Varzaru, I., Saracila, M., & Oancea, A. G. (2023). Designing nutrition for health—Incorporating dietary by-products into poultry feeds to create functional foods with insights into health benefits, risks, bioactive compounds, food component functionality, and safety regulations. *Foods*, 12(21), 4001.
5. Lai, R. M. (2000). Functional foods. *Jurnal Teknologi Pangan dan Gizi (Journal of Food Technology and Nutrition)*, 1(1).
6. Süfer, Ö. (2025). Introduction: The evolution of functional foods and novel bioactives. In *Unleashing the Power of Functional Foods and Novel Bioactives* (pp. 1-12). Academic Press.
7. Cozzolino, F., Lecce, L., Frisullo, P., Conte, A., & Alessandro Del Nobile, M. (2012). Functional food: Product development and health benefits. *Recent Patents on Engineering*, 6(1), 2-19.
8. Kussmann, M., Abe Cunha, D. H., & Berciano, S. (2023). Bioactive compounds for human and planetary health. *Frontiers in Nutrition*, 10, 1193848.
9. Dixit, V., Joseph Kamal, S. W., Bajrang Chole, P., Dayal, D., Chaubey, K. K., Pal, A. K., ... & Bachheti, R. K. (2023). Functional foods: exploring the health benefits of bioactive compounds from plant and animal sources. *Journal of Food Quality*, 2023(1), 5546753.
10. Baker, M. T., Lu, P., Parrella, J. A., & Leggette, H. R. (2022). Consumer acceptance toward functional foods: A scoping review. *International journal of environmental research and public health*, 19(3), 1217.
11. Fan, X., Rudel, R., Berger, M., Hershman, M., & Seres, D. S. (2022). General nutritional principles. *Yamada's Textbook of Gastroenterology*, 376-407.
12. Ahmed, F., Maqsood, S., Ahmad, M. F., & Zahir, A. (2025). Optimizing Health and Sustainability: Innovations in Harnessing Phytochemicals for Functional Foods. *Food Science & Nutrition*, 13(9), e71002.
13. Zhang, X., Zeng, Q., & He, W. (2025). From Broad-Spectrum Health to Targeted Prevention: A Review of Functional Foods in Chronic Disease Management. *Molecules*, 31(1), 103.
14. Martirosyan, D., Lampert, T., & Ekblad, M. (2022). Classification and regulation of functional food proposed by the Functional Food Center. *Functional Food Science-Online ISSN: 2767-3146*, 2(2), 25-46.
15. Nag, M., Siddiqua, F., Baruah, N., Das, S., Basumatary, B., Deka, M., ... & Malick, P. (2024). Functional foods: formulation, fortification, and combating COVID-19. In *The Functional Foods* (pp. 117-148). Apple Academic Press.
16. Shah, N. (2025). Regulation of Healthcare Products by the United States Food and Drug Administration and Health Canada. In *Introduction to Basics of Pharmacology and Toxicology: Volume 4: Pharmacology and Therapeutics* (pp. 405-415). Singapore: Springer Nature Singapore.
17. Limketkai, B. N., Yang, J., Chau, L., Noorian, S., & Li, Z. (2025). Randomized Controlled Trial of a Natural Whole Food Diet versus

- Habitual Diet for Crohn's Disease: Is Diet Quality the Key?. *Clinical Nutrition ESPEN*.
18. Kalogerakou, T., & Antoniadou, M. (2024). The role of dietary antioxidants, food supplements, and functional foods for energy enhancement in healthcare professionals. *Antioxidants*, *13*(12), 1508.
 19. Temple, N. J. (2022). A rational definition for functional foods: A perspective. *Frontiers in nutrition*, *9*, 957516.
 20. Chandra, S., Saklani, S., Kumar, P., Kim, B., & Coutinho, H. D. (2022). Nutraceuticals: Pharmacologically active, potent dietary supplements. *BioMed Research International*, *2022*(1), 2051017.
 21. Fekete, M., Lehoczki, A., Tarantini, S., Fazekas-Pongor, V., Csípő, T., Csizmadia, Z., & Varga, J. T. (2023). Improving cognitive function with nutritional supplements in aging: a comprehensive narrative review of clinical studies investigating the effects of vitamins, minerals, antioxidants, and other dietary supplements. *Nutrients*, *15*(24), 5116.
 22. Fekete, M., Lehoczki, A., Kryczyk-Poprawa, A., Zábó, V., Varga, J. T., Bálint, M., ... & Varga, P. (2025). Functional foods in modern nutrition science: mechanisms, evidence, and public health implications. *Nutrients*, *17*(13), 2153.
 23. Yameny, A. Lipid profile metabolism, pathophysiology, clinical correlations, and therapeutic strategies in cardiovascular and metabolic diseases. *Pharaonic Journal of Science*, 2025; *1*(1): 80-91. <https://doi.org/10.71428/PJS.2025.0107>
 24. Alissa, E. M., & Ferns, G. A. (2012). Functional foods and nutraceuticals in the primary prevention of cardiovascular diseases. *Journal of nutrition and metabolism*, *2012*(1), 569486.
 25. Wang, Y. Y., Zhang, J. X., Tian, T., Gao, M. Y., Zhu, Q. R., Xie, W., ... & Dai, Y. (2022). Dietary patterns in association with the risk of elevated blood pressure, lipid profile, and fasting plasma glucose among adults in Jiangsu Province of China. *Nutrition, Metabolism and Cardiovascular Diseases*, *32*(1), 69-79.
 26. Koumpouli, D., Koumpouli, V., & Koutelidakis, A. E. (2024). Functional foods, gut microbiome and association with obesity and metabolic syndrome: A literature review. *Applied Sciences*, *14*(13), 5578.
 27. Yameny, A. Diabetes Mellitus: A Comprehensive Review of Types, Pathophysiology, Complications, and Standards of Care in Diabetes 2025. *Journal of Medical and Life Science*, 2025; *7*(1): 134-141. doi: 10.21608/jmals.2025.424001
 28. Ortuño Sahagún, D., Márquez-Aguirre, A. L., Quintero-Fabián, S., López-Roa, R. I., & Rojas-Mayorquín, A. E. (2012). Modulation of PPAR- γ by Nutraceuticals as complementary treatment for obesity-related disorders and inflammatory diseases. *PPAR research*, *2012*(1), 318613.
 29. Dahiya, D., & Nigam, P. S. (2022). The gut microbiota influenced by the intake of probiotics and functional foods with prebiotics can sustain wellness and alleviate certain ailments like gut-inflammation and colon-cancer. *Microorganisms*, *10*(3), 665.
 30. Koponen, K. K., Salosensaari, A., Ruuskanen, M. O., Havulinna, A. S., Männistö, S., Jousilahti, P., ... & Salomaa, V. V. (2021). Associations of healthy food choices with gut microbiota profiles. *The American Journal of Clinical Nutrition*, *114*(2), 605-616.
 31. Piccioni, A., Covino, M., Candelli, M., Ojetti, V., Capacci, A., Gasbarrini, A., ... & Merra, G. (2023). How do diet patterns, single foods, prebiotics and probiotics impact gut microbiota?. *Microbiology Research*, *14*(1), 390-408.
 32. Pagar, K., Gunjal, S., Surana, K. R., Lokhande, T., Mahajan, S., & Ahire, E. D. (2024). Functional foods for viral infections. In *Applications of Functional Foods in Disease Prevention* (pp. 241-260). Apple Academic Press.

33. Damián, M. R., Cortes-Perez, N. G., Quintana, E. T., Ortiz-Moreno, A., Garfias Noguez, C., Cruceño-Casarrubias, C. E., ... & Bermúdez-Humarán, L. G. (2022). Functional foods, nutraceuticals and probiotics: a focus on human health. *Microorganisms*, 10(5), 1065.
34. Godos, J., Currenti, W., Angelino, D., Mena, P., Castellano, S., Caraci, F., ... & Grosso, G. (2020). Diet and mental health: Review of the recent updates on molecular mechanisms. *Antioxidants*, 9(4), 346.
35. Sivamaruthi, B. S., Kesika, P., & Chaiyasut, C. (2018). Impact of fermented foods on human cognitive function—A review of outcome of clinical trials. *Scientia pharmaceutica*, 86(2), 22.
36. Herring, T., & Albrecht, J. A. (2005). EC05-473 Functional Foods.
37. Mukherjee, A., Gómez-Sala, B., O'Connor, E. M., Kenny, J. G., & Cotter, P. D. (2022). Global regulatory frameworks for fermented foods: a review. *Frontiers in Nutrition*, 9, 902642.
38. Tsoupras, A., Zabetakis, I., & Lordan, R. (2023). Functional foods: Growth, evolution, legislation, and future perspectives. In *Functional foods and their implications for health promotion* (pp. 367-377). Academic Press.
39. Guerra Ayala, M. J., Reynosa Navarro, E., Durand Gómez, E. L., Acero Apaza, Y. R., Florez Lucana, A., Callata Quispe, B., ... & Callejas Torres, J. C. (2023, June). Pre-professional practice systematization and its relationship to research skills. In *Frontiers in Education* (Vol. 8, p. 1185906). Frontiers Media SA.
40. Shan, F., Liu, L., Li, L., Wang, W., Bi, Y., & Li, M. (2025). Management, safety, and efficacy evaluation of nutraceutical and functional food: A global perspective. *Comprehensive Reviews in Food Science and Food Safety*, 24(4), e70222.
41. Chávez-Hernández, J. A., Velarde-Salcedo, A. J., Navarro-Tovar, G., & Gonzalez, C. (2024). Safe nanomaterials: from their use, application, and disposal to regulations. *Nanoscale advances*, 6(6), 1583-1610.
42. Rodriguez, E. B., Flavier, M. E., Rodriguez-Amaya, D. B., & Amaya-Farfán, J. (2006). Phytochemicals and functional foods. Current situation and prospect for developing countries. *Segurança Alimentar e Nutricional*, 13(1), 1-22.