LECTURE 2
BIOACTIVE PHYTOCHEMICALS AND PROBIOTICS: ACTIVATING GLOBAL HEALTH WITH FUNCTIONAL FOODS

Samadhan B. Dahikar[1], Elena G. Kovaleva[2]
[1]Department of Microbiology,
Sanjivani Arts, Commerce and Science College, Kopargaon, 423603, India,
[2]Ural Federal University the First President of Russia B. N. Yeltsin,
620002, Russia, Yekaterinburg, Mira, 19 Street.
E-mail: sbdahikar10@gmail.com

Abstract

Phytochemicals, derived from plants, exhibit diverse bioactivities, including antioxidant, anti-inflammatory, and anticancer properties. Probiotics, on the other hand, contribute to gut health and immune modulation. The integration of these bioactive compounds into functional foods not only enhances nutritional value but also confers health benefits beyond basic nutrition. Functional foods, enriched with bioactive phytochemicals and probiotics, are revolutionizing the concept of nutrition and health promotion. These innovative food products not only provide essential nutrients but also offer additional health benefits, contributing to the overall well-being of individuals. The combination of bioactive phytochemicals and probiotics has the potential to activate global health by improving immune function, promoting gut health, and reducing the risk of various chronic diseases. Bioactive phytochemicals are naturally occurring compounds found in plants, such as polyphenols, flavonoids, carotenoids, and terpenoids. These compounds possess antioxidant, anti-inflammatory, and antimicrobial properties, among others. When incorporated into functional foods, bioactive phytochemicals can help combat oxidative stress, reduce inflammation, and enhance cellular health. They have been associated with a lower risk of cardiovascular diseases, cancer, and neurodegenerative disorders. Probiotics are beneficial live microorganisms, predominantly bacteria, that confer health benefits when consumed in adequate amounts. They are commonly found in fermented foods like yogurt, kefir, and sauerkraut. Probiotics help restore and maintain a healthy balance of gut microbiota, which plays a crucial role in digestion, nutrient absorption, and immune system regulation. Bioactive phytochemicals and probiotics in functional foods have the potential to activate global health by providing additional health benefits beyond basic nutrition. These innovative food products offer opportunities to enhance immune function, promote gut health, and reduce the risk of chronic diseases. By incorporating functional foods into dietary patterns, individuals can proactively improve their overall well-being while potentially reducing the burden on healthcare systems. Embracing the concept of functional foods enriched with bioactive phytochemicals and probiotics is a promising strategy to promote global health and pave the way for a healthier future.

Keywords: Bioactive phytochemicals, Probiotics, human health, and functional foods

Introduction

The integration of bioactive phytochemicals and probiotics into functional foods represents a revolutionary concept in nutrition and health promotion. These innovative products not only deliver essential nutrients but also provide additional health benefits, significantly impacting the overall well-being of individuals. Many new foods contain bioactive functional compounds including fiber, prebiotics, probiotics, oligosaccharides, phytochemicals, antioxidants, and other substances that confer functional properties or beneficial effects on human health (Coelho & Salas-Mellado, 2014). These bioactive compounds have gained significant attention in recent years due to their potential to prevent or manage various chronic diseases, including cardiovascular disease, obesity, diabetes mellitus, and certain types of cancer. Functional foods are a category of food products that have been developed with the intention of providing additional health benefits beyond basic nutrition. These foods are fortified with bioactive phytochemicals and probiotics, among other functional components, to optimize their health-promoting properties (Goggin, 2018; Korhonen, 2002).

Functional foods can be described as "food prepared using scientific intelligence vital for optimal health" and are defined as foods that contain significant levels of biologically active (Bocchi *et al.,* 2020) components, providing specific health benefits beyond traditional nutrients. This emerging category of foods has gained recognition for their potential to improve overall health and prevent various diseases.

One of the key components of functional foods is bioactive phytochemicals, which are natural compounds found in plants. These phytochemicals, such as antioxidants, polyphenols, and flavonoids, have been extensively studied for their health-promoting properties. They have been linked to reducing the risk of chronic degenerative diseases and promoting overall well-being (Korhonen, 2002; Imam *et al.,* 2021; Zhang *et al.,* 2014) Probiotics, on the other hand, are live microorganisms that provide health benefits when consumed in adequate amounts. These beneficial bacteria, typically belonging to the Lactobacillus and Bifidobacterium genera, help maintain the balance of the gut microbiome and support digestion, immunity, and overall gut health. The combination of bioactive phytochemicals and probiotics in functional foods offers a synergistic approach to promote global health (Bousdouni *et al.,* 2022; Goggin, 2018)

The use of probiotics in functional foods has been shown to enhance the nutritional quality and health benefits of these products. Probiotics are another essential component of functional foods. These are living microorganisms that, when consumed in adequate amounts, confer health benefits on the host. Probiotics are known for their role in promoting gut health, improving digestive function, and boosting the immune system (Liu *et al.,* 2018)

The incorporation of bioactive phytochemicals and probiotics into functional foods provides an innovative approach to enhancing the nutritional value of food while delivering

additional health benefits. As the demand for functional foods continues to grow, the exploration of novel delivery systems, such as nanotechnology, holds promise for improving the efficiency and safety of these bioactive components in functional food products (Lu *et al.,* 2022; Bousdouni *et al.,* 2022)

1.1 Understanding Functional Foods

Functional foods have gained recognition for their potential to improve overall health and prevent various diseases (Coelho & Salas-Mellado, 2014). These foods contain bioactive compounds, such as probiotics, prebiotics, phytochemicals, polyunsaturated fatty acids, dietary fiber, and other beneficial substances. These bioactive components offer specific physiological benefits beyond basic nutrition and have shown potential in reducing the risk of chronic degenerative diseases. Functional foods are believed to play a significant role in promoting global health and well-being. (Nardo *et al.,* 2018; Niba, 2002). Bioactive phytochemicals, also known as phytonutrients, are naturally occurring compounds found in plants. They are responsible for the vibrant colors, flavors, and aromas of fruits, vegetables, legumes, and grains. The integration of probiotics and bioactive phytochemicals into functional foods has broadened the scope of health-promoting food products. Fruits, vegetables, legumes, and grains are rich sources of vitamins, minerals, phytochemicals, and fibers. These natural components are essential for maintaining overall health and well-being. Moreover, the consumption of functional foods fortified with bioactive compounds has been linked to reducing the risk of chronic degenerative diseases (Tyagi *et al.,* 2020; Carrera-Quintanar *et al.,* 2018; Xu *et al.,* 2022).

In addition to their nutritional value, functional foods also provide specific health benefits due to their bioactive components. For instance, probiotics, commonly found in dairy products, play a crucial role in supporting gut health and enhancing digestive function. These live microorganisms are known for their ability to modulate the gut microbiome, contributing to improved immunity and overall well-being. The potential of probiotics as functional food components has also extended to products beyond dairy, with attempts to incorporate them into fruit beverages and other food items.(Bocchi *et al.,* 2020). The evolving field of functional foods continues to demonstrate the potential for improving global health through the integration of bioactive phytochemicals, probiotics, and innovative delivery systems. Research and development in this area are essential for harnessing the full benefits of functional foods in promoting health and well-being (Chen *et al.,* 2021).

2.1 Role of Bioactive Phytochemicals in Global Health

Bioactive phytochemicals found in fruits, vegetables, legumes, and grains have been extensively studied for their potential health benefits (Passari *et al.,* 2022). These compounds, such as antioxidants, polyphenols, and carotenoids, possess various biological properties that can contribute to the prevention and management of chronic diseases. For example, antioxidants have been shown to scavenge free radicals and reduce oxidative stress, which is known to contribute to the development of diseases such as cancer, cardiovascular disease, and neurodegenerative disorders (Al-Mijalli *et al.,* 2022; Ardhany *et al.,* 2018; Al-Alawi *et al.,* 2017). Polyphenols, on the other hand, have been linked to

anti-inflammatory and anti-cancer activities, as well as the prevention of cardiovascular diseases. Furthermore, carotenoids have demonstrated their role in protecting against age-related macular degeneration and certain types of cancer. Incorporating bioactive phytochemicals into functional foods can provide a convenient and effective way to increase their consumption and thus reap their health benefits. Probiotics and their Impact on Global Health Probiotics are live microorganisms that, when consumed in adequate amounts, confer health benefits to the host. These beneficial bacteria, typically from the *Lactobacillus* and *Bifidobacterium* genera, can exert positive effects on the gastrointestinal tract by regulating the gut microbiota, enhancing nutrient absorption, and modulating the immune system (Bousdouni *et al.*, 2022; Guerra-Valle *et al.*, 2022).

2.2 Significance of Probiotics in Activating Health

The incorporation of probiotics into functional foods plays a crucial role in activating global health. Probiotics contribute to the overall well-being of individuals by improving gut health, enhancing immune function, and promoting a balanced microbiota. By regulating the gut microbiota, probiotics help maintain a healthy balance of beneficial bacteria in the gut. This balance is essential for proper digestive function, nutrient absorption, and immune system regulation. Furthermore, probiotics have been shown to have a positive impact on mental health by influencing the gut-brain axis and reducing symptoms of anxiety and depression *(Bocchi et al.,* 2020; Goggin, 2018). Functional Foods and the Activation of Global Health Functional foods fortified with bioactive phytochemicals and probiotics have the potential to activate global health by promoting optimal health and preventing various diseases. These foods provide a convenient and accessible way for individuals to incorporate important nutrients and beneficial microorganisms into their daily diet. By consuming functional foods, individuals can enjoy the health benefits of bioactive phytochemicals and probiotics without extensively modifying their diet or relying on supplements (Bocchi *et al.*, 2020; Chen *et al.*, 2021; Guerra-Valle *et al.*, 2022). The bioactive phytochemicals present in functional foods have been extensively studied for their potential health benefits. These compounds, derived from plants, have shown antioxidant, anti-inflammatory, anti-cancer, and antimicrobial properties. Furthermore, they have been linked to the prevention of chronic diseases such as cardiovascular disease, diabetes, and cancer (Korhonen, 2002; Viera *et al.*, 2016).

2.3 Exploring the Interaction between Phytochemicals and Probiotics

Research has shown that the combination of bioactive phytochemicals and probiotics in functional foods can lead to synergistic health effects. The interaction between phytochemicals and probiotics in functional foods involves the modulation of immune function, enhancement of antioxidant activity, and promotion of gut health (Bocchi *et al.*, 2020).

Phytochemicals have been shown to enhance the survival and growth of probiotics, thereby improving their efficacy in promoting gut health. This can be attributed to the fact that phytochemicals have antimicrobial properties, which can help inhibit the growth of harmful bacteria in the gut and create a more favorable environment for the growth of beneficial bacteria. Additionally, the prebiotic effects of phytochemicals can serve as a food

source for probiotics, allowing them to proliferate and exert their beneficial effects in the gut. Specifically, phytochemicals such as polyphenols, flavonoids, and carotenoids have been found to stimulate the growth of probiotics such as *Lactobacillus* and *Bifidobacterium*. Furthermore, probiotics can enhance the bioavailability and absorption of phytochemicals in the gastrointestinal tract (Bocchi *et al.*, 2020; Chen *et al.*, 2021). This can be attributed to the ability of probiotics to produce enzymes that aid in the breakdown and metabolism of phytochemicals, allowing for better absorption and utilization by the body. With the increasing awareness of the potential synergistic effects of phytochemicals and probiotics, the development of functional foods that combine these bioactive components has gained significant attention in the food industry. The utilization of probiotic bacteria as carriers for the delivery of phytochemicals offers a promising avenue to enhance the bioavailability and efficacy of these compounds (Surve *et al.*, 2022; Shinde *et al.*, 2015; Cvetanović *et al.*, 2023; Guerra-Valle *et al.*, 2022; Abdullah *et al.*, 2022).

2.4 Functional Foods as Tools for Global Health Activation

Functional foods, which are enriched with bioactive phytochemicals and probiotics, have gained significant attention in recent years due to their potential to improve overall health and well-being (Yousaf *et al.*, 2009). These foods are designed to go beyond basic nutrition by providing additional health benefits that can help prevent chronic diseases and promote optimal physiological functioning. One of the key components of functional foods is the inclusion of bioactive phytochemicals, which are naturally occurring compounds found in plants that have been shown to have various health-promoting properties, such as antioxidant, anti-inflammatory, and anticancer effects. These phytochemicals can help prevent and manage chronic diseases, as well as support overall health and vitality.

Probiotics, on the other hand, are live beneficial bacteria that when consumed in adequate amounts, can confer health benefits to the host. Probiotics have been extensively studied for their ability to improve gut health, enhance immune function, and support overall digestive health. The inclusion of probiotics in functional foods not only provides direct health benefits but also offers the potential to modulate the gut microbiota, which plays a crucial role in maintaining overall health and preventing various diseases. To fully unlock the potential of functional foods in promoting global health, it is essential to consider innovative delivery systems that can enhance the bioavailability and efficacy of bioactive phytochemicals and probiotics.

3.1 Case Studies: Successful Implementations of Functional Foods

Several studies have demonstrated the successful implementation of functional foods enriched with bioactive phytochemicals and probiotics. For example, in a study conducted by Fahim et al (Fahim *et al.*, 2016)., the researchers used phytoglycogen nanoparticles as carriers for nisin, a bacteriocin with antimicrobial activity. They found that the phytoglycogen nanoparticles effectively delivered nisin and retained its antibacterial activity for an extended period of time, thus improving the efficacy of the functional food in inhibiting bacterial growth. Similarly, Bi *et al* . investigated the encapsulation of probiotics in alginate-pectin microparticles, which improved the survival and viability of the probiotics during storage and passage through the gastrointestinal tract. The researchers

observed that the encapsulated probiotics showed increased resistance to acidic pH and bile salts, allowing for higher survival rates compared to free probiotics. The exploration of bioactive compounds from medicinal plants and functional foods has revealed promising developments in the controlled release of these compounds to enhance their efficacy. Research has shown that the encapsulation of bioactive molecules, such as bacteriocins, phytochemicals, and probiotics, into nanocarriers offers a novel approach to developing functional foods with advanced health benefits.

3.2 Functional Foods: Harnessing the Synergistic Effects

The integration of bioactive compounds from medicinal plants and functional foods, particularly phytochemicals and probiotics, offers a promising avenue for enhancing global health. The antimicrobial properties of phytochemicals, combined with the beneficial effects of probiotics in modulating the gut microbiota, present opportunities for the development of functional foods that promote optimal physiological functioning and prevent chronic diseases.

The utilization of probiotic bacteria as carriers for the delivery of phytochemicals and bioactive peptides presents a promising approach to enhancing the bioavailability and efficacy of these compounds in the gastrointestinal tract. The prebiotic effects of phytochemicals as food sources for probiotics, along with the ability of probiotics to enhance the bioavailability and absorption of phytochemicals, underscore the potential synergistic effects of combining these bioactive components in functional foods.

3.3 Future Directions and Implications for Global Health Activation

The successful implementations of functional foods enriched with bioactive compounds from medicinal plants and probiotics, as demonstrated in studies by Fahim et al., 2016; Bi et al., and da Silva Malheiros et al., highlight the potential for leveraging nanotechnology to enhance the bioavailability, stability, and efficacy of bioactive compounds in functional foods. These advancements have far-reaching implications for global health activation by offering convenient and effective ways for individuals to experience the health-promoting effects of functional foods as part of their daily diet.

3.4 Future Directions: Research and Development in Bioactive Phytochemicals and Probiotics

To further advance the field of bioactive phytochemicals and probiotics in functional foods, several avenues for future research and development should be explored. Firstly, more studies are needed to understand the mechanisms of action and interactions between bioactive compounds, probiotics, and the gut microbiota. This will help in optimizing the selection and combination of phytochemicals and probiotics for maximum health benefits. Furthermore, research should focus on determining the optimal formulation and delivery methods for bioactive compounds and probiotics to ensure their stability, bioavailability, and efficacy in the gastrointestinal tract. Additionally, investigations into the potential synergistic effects of combining bioactive compounds and probiotics in functional foods should be conducted. Moreover, studies should also explore the effects of different processing techniques and storage conditions on the stability and bioactivity of bioactive compounds and probiotics in functional foods.

4.0 Conclusion: Activating Global Health with Functional Foods

In conclusion, the integration of bioactive phytochemicals and probiotics in functional foods has the potential to activate global health by providing convenient and effective ways for individuals to incorporate health-promoting compounds into their daily diet (Nataraj *et al.*, 2020).

These functional foods have shown promising effects in preventing and managing chronic diseases by modulating various physiological processes, such as inflammation, oxidative stress, and gut microbiota composition. Moreover, functional foods offer an alternative approach to traditional pharmaceutical interventions, with fewer side effects and a focus on overall health and well-being. By harnessing the power of bioactive phytochemicals and probiotics, functional foods have the potential to revolutionize the way we approach healthcare and promote a shift towards preventive medicine. Functional foods with bioactive phytochemicals and probiotics have been shown to have numerous health benefits, including reducing the risk of chronic diseases and improving gastrointestinal health (D'Angelo *et al.*, 2019). Furthermore, the combination of bioactive compounds and probiotics in functional foods has shown potential for synergistic effects, enhancing their therapeutic properties (Seke *et al.*, 2022). Overall, the activation of global health with functional foods requires further research and development in terms of optimal formulation, delivery methods, processing techniques, storage conditions, and understanding the interactions between bioactive compounds, probiotics, and the gut microbiota. As the demand for functional foods continues to rise, it is essential that research and development efforts focus on optimizing the formulation and delivery methods of these products (Kim *et al.*, 2010). Additionally, it is crucial to investigate the impact of different processing techniques and storage conditions on the stability and bioactivity of bioactive compounds and probiotics in functional foods.

References

1. Coelho, M S., & Salas-Mellado, M D L M. (2014, May 25). Chemical Characterization of CHIA (<i>Salvia hispanica L.)</i> for Use in Food Products. https://scite.ai/reports/10.12691/jfnr-2-5-9
2. Goggin, L. (2018, August 31). An Investigation in the Key Ingredients in Health and Functional Foods. https://doi.org/10.24966/fsn-1076/100035
3. Korhonen, H J T. (2002, May 1). Technology options for new nutritional concepts. https://doi.org/10.1046/j.1471-0307.2002.00050.x
4. Bocchi, S., Sagheddu, V., Elli, M., Lim, C., & Morelli, L. (2020, January 1). The Synergistic Interaction between Probiotics and Food Affects Their Beneficial Features. https://doi.org/10.37722/anafs.20202
5. Vieira da Silva, B., Barreira, J.C., & Oliveira, M.B. (2016). Natural phytochemicals and probiotics as bioactive ingredients for functional foods: Extraction, biochemistry and protected-delivery technologies. *Trends in Food Science and Technology, 50*, 144-158.
6. Imam, S S., Alshehri, S., Ghoneim, M M., Zafar, A., Alsaidan, O A., Alruwaili, N K., Gilani, S J., & Rizwanullah, M. (2021, November 22). Recent Advancement in

Chitosan-Based Nanoparticles for Improved Oral Bioavailability and Bioactivity of Phytochemicals: Challenges and Perspectives. https://doi.org/10.3390/polym13224036
7. Zhang, W., Huang, W., Chen, W., Lin, H., & Zhang, H. (2014, October 13). Optimization of Extraction Conditions of Areca Seed Polyphenols and Evaluation of Their Antioxidant Activities. https://doi.org/10.3390/molecules191016416
8. Bousdouni, P., Kandyliari, A., & Koutelidakis, A E. (2022, March 2). Probiotics and Phytochemicals: Role on Gut Microbiota and Efficacy on Irritable Bowel Syndrome, Functional Dyspepsia, and Functional Constipation. https://doi.org/10.3390/gidisord4010005
9. Liu, Y., Chen, H., Chen, W., Zhong, Q., & Zhang, G. (2018, September 16). Beneficial Effects of Tomato Juice Fermented by Lactobacillus Plantarum and Lactobacillus Casei: Antioxidation, Antimicrobial Effect, and Volatile Profiles. https://doi.org/10.3390/molecules23092366
10. Lu, Y., Teo, J N., & Liu, S. (2022, August 29). Fermented shellfish condiments: A comprehensive review. https://doi.org/10.1111/1541-4337.13024
11. Nardo, A E., Añón, M C., & Parisi, G. (2018, January 19). Large-scale mapping of bioactive peptides in structural and sequence space. https://doi.org/10.1371/journal.pone.0191063
12. Niba, L L. (2002, April 1). Resistant starch: a potential functional food ingredient. https://doi.org/10.1108/00346650210416985
13. Functional Foods: Benefits, Concerns and Challenges—A Position Paper .... (n.d). https://jn.nutrition.org/article/S0022-3166(22)15007-8/fulltext
14. Tyagi, A., Daliri, E B., Ofosu, F K., Yeon, S., & Oh, D. (2020, November 21). Food-Derived Opioid Peptides in Human Health: A Review. https://doi.org/10.3390/ijms21228825
15. Carrera-Quintanar, L., López-Roa, R I., Quintero-Fabián, S., Sánchez-Sánchez, M A., Vizmanos, B., & Ortuño-Sahagún, D. (2018, January 1). Phytochemicals That Influence Gut Microbiota as Prophylactics and for the Treatment of Obesity and Inflammatory Diseases. https://doi.org/10.1155/2018/9734845
16. Bioactive compounds in functional food and their role as therapeutics. (n.d). https://www.researchgate.net/publication/350603455_Bioactive_compounds_in_functional_food_and_their_role_as_therapeutics
17. Xu, X., Zhang, C., Wang, N., Xu, Y., Tang, G., Xu, L., & Feng, Y. (2022, September 16). Bioactivities and Mechanism of Actions of Dendrobium officinale: A Comprehensive Review. https://doi.org/10.1155/2022/6293355
18. Effectiveness of probiotics, prebiotics, and prebiotic-like components .... (n.d). https://ift.onlinelibrary.wiley.com/doi/10.1111/1541-4337.12565
19. Chen, X., Deng, Z., Zheng, L., Zhang, B., Luo, T., & Li, H. (2021, December 14). Interaction between Flavonoids and Carotenoids on Ameliorating Oxidative Stress and Cellular Uptake in Different Cells. https://doi.org/10.3390/foods10123096

20. Passari, A K., Sharma, M., Usmani, Z., & Gupta, V K. (2022, September 1). Editorial: Biological and biotechnological applications of natural bioactives. https://doi.org/10.1016/j.btre.2022.e00751
21. Al-Mijalli, S H., Assaggaf, H., Qasem, A., El-Shemi, A G., Abdallah, E M., Mrabti, H N., & Bouyahya, A. (2022, June 15). Antioxidant, Antidiabetic, and Antibacterial Potentials and Chemical Composition of *Salvia officinalis* and *Mentha suaveolens* Grown Wild in Morocco. https://doi.org/10.1155/2022/2844880
22. Ardhany, S D., Mulia, D S., & Rosawanti, P. (2018, October 3). Antioxidant Activity of Ethyl Acetate Fraction of *Macaranga Triloba* Leaves From Central Kalimantan. https://doi.org/10.22159/ajpcr.2018.v11s3.30026
23. Al-Alawi, R A., Al-Mashiqri, J H., Al-Nadabi, J S M., Al-Shihi, B., & Baqi, Y. (2017, May 23). Date Palm Tree (Phoenix dactylifera L.): Natural Products and Therapeutic Options. https://doi.org/10.3389/fpls.2017.00845
24. Phytochemicals: Extraction, Isolation, and Identification of Bioactive .... (2017, December 14). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750618/
25. Guerra-Valle, M., Orellana-Palma, P., & Petzold, G. (2022, January 4). Plant-Based Polyphenols: Anti-Helicobacter pylori Effect and Improvement of Gut Microbiota. https://doi.org/10.3390/antiox11010109
26. Probiotics and Phytochemicals: Role on Gut Microbiota and ... - MDPI. (2022, March 2). https://www.mdpi.com/2624-5647/4/1/5
27. Review Natural phytochemicals and probiotics as bioactive ingredients for functional foods: Extraction, biochemistry and protected-delivery technologies. (n.d). https://www.sciencedirect.com/science/article/pii/S0924224415301448
28. Surve, S., Shinde, D B., & Kulkarni, R. (2022, February 4). Isolation, characterization and comparative genomics of potentially probiotic Lactiplantibacillus plantarum strains from Indian foods. https://doi.org/10.1038/s41598-022-05850-3
29. Shinde, T., Brooks, J., & Sun-Waterhouse, D. (2015, February 16). Preparation and use of apple skin polyphenol extracts in milk: enhancement of the viability and adhesion of probiotic Lactobacillus acidophilus (ATCC 1643) bacteria. https://doi.org/10.1111/ijfs.12759
30. Cvetanović, A., Radosavljević, M., Zengin, G., Yan, L., Gašić, U., Kojić, P., Torbica, A., Belović, M., & Zeković, Z. (2023, March 7). New Biological and Chemical Insights into Optimization of Chamomile Extracts by Using Artificial Neural Network (ANN) Model. https://doi.org/10.3390/plants12061211
31. Abdullah., Ahmad, N., Tian, W., Zengliu, S., Zou, Y., Farooq, S., & Xiao, J. (2022, September 30). Recent advances in the extraction, chemical composition, therapeutic potential, and delivery of cardamom phytochemicals. https://doi.org/10.3389/fnut.2022.1024820
32. Yousaf, M S., Yusof, S., Manap, M Y B A., & Abd-Aziz, S. (2009, August 24). Storage Stability Of Clarified Banana Juice Fortified With Inulin And Oligofructose. https://scite.ai/reports/10.1111/j.1745-4549.2009.00419.x

33. Fahim, H A., Khairalla, A S., & El-Gendy, A O. (2016, September 16). Nanotechnology: A Valuable Strategy to Improve Bacteriocin Formulations. https://doi.org/10.3389/fmicb.2016.01385
34. Nataraj, B H., Ali, S A., Behare, P., & Yadav, H. (2020, August 20). Postbiotics-parabiotics: the new horizons in microbial biotherapy and functional foods. https://scite.ai/reports/10.1186/s12934-020-01426-w
35. D'Angelo, S., M, S., & Meccariello, R. (2019, June 3). BPA and Nutraceuticals, Simultaneous Effects on Endocrine Functions. https://scite.ai/reports/10.2174/1871530319666190101120119
36. Seke, F., Manhivi, V E., Guérin, M C., Shoko, T., Akinola, S A., Garcia, C., Remize, F., Slabbert, M., & Sivakumar, D. (2022, July 16). Antioxidant Activities of Co-Encapsulated Natal Plum (Carissa macrocarpa) Juice Inoculated with Ltp. plantarum 75 in Different Biopolymeric Matrices after In Vitro Digestion. https://scite.ai/reports/10.3390/foods11142116
37. Kim, E R., Cho, Y H., Kim, Y H., Park, S O., Woo, G J., & Chun, H N. (2010, February 28). Comparison of Bifidobacteria Selective Media for the Detection of Bifidobacteria in Korean Commercial Fermented Milk Products. https://scite.ai/reports/10.5851/kosfa.2010.30.1.154