A Comprehensive Review on Nutraceuticals: New Era of Medicine and Healthcare

Sakshi Deshmukh, Sumit Kolte, Vaibhav Uplanchiwar, Vinod M. Thakare*

Nagpur College Of Pharmacy, Hingna Road, Wanadongari, Nagpur

Address for Correspondence:

Sakshi Vijay Deshmukh
Assistant Professor
Nagpur College Of Pharmacy, Hingna Road, Wanadongari, Nagpur

Abstract

Nutraceuticals, obtained from natural sources, serve as a bridge between food and medicine, providing therapeutic advantages in addition to basic nourishment. With increased consumer awareness and scientific developments, these bioactive chemicals have a significant impact on preventing disease, administration, and general health. This review looks at the classification, mechanisms, and clinical applications of nutraceuticals in modern healthcare. This research emphasizes their promise in addressing chronic conditions like heart issues, diabetes, as well neurodegenerative ailments, in addition to regulatory difficulties and future prospects. Integrating nutraceuticals into mainstream medicine has the potential to change healthcare, paving the path for a more holistic and preventive approach to wellbeing.

Keywords: *nutraceuticals, functional foods, dietary supplements, preventive medicine, chronic diseases, healthcare innovation, phytochemicals,*

Introduction

A mixture of the terms "nutrition" and "pharmaceuticals," "nutraceuticals". The term "nutraceuticals" pertains to food items or food-derived products that have been linked to health-promoting and medicinal advantages which include preventing and treating disease (Nicoli *et al.,* 1999).

Physiological benefits or protection and prevention of chronic disease are features associated with nutraceuticals. The latest advancements in cellular-level nutraceutical compounds are frequently designated as isolated vitamins and minerals, nutritional supplements, as well as tailored dietary regimens, genetically engineered food items, medicinal products, and processed food items including cereals, soups, and beverages.

In order to integrate and retrieve information from clinical research on alternative and complementary healthcare into moral medical procedures, researchers and practitioners generate templates. (Kapoor and Kaur 2001).

According to (Dillard and German 2000), an effective food is one which has been modified with novel components and has an additional purpose, generally one that is linked to illness prevention or health promotion. A number of civilizations, including the Sumerians, Chinese, Egyptians, and Indians, have produced evidence that food can be utilized as medicine to treat and prevent disease (Adelaja and Schilling, 1999).

Typically, foods linked to health advantages are called "functional foods." "Any food and food ingredients that may provide health benefit behind the traditional nutrition that it contains".The phrase "functional food" is defined by the Institute of Pharmaceuticals the Food and Drug Committee (US) (Pandey *et al.*, 2010). Both plant and animal sources can produce functional meals. The term "nutritraceuticals," which was first used in the USA, refers to foods or food ingredients that may be able to treat particular medical disorders (Maddi *et al.,* 2007; Brower, 1998).

Different standards for foods, food additives, pollutants, colorants, preservatives, and labeling have been created in India previously with a number of laws and regulations.

The Nutritional Security and Standard Regulations Act was adopted by India to regulate food products, including nutraceuticals, functional foods, and dietary supplements in 2006, a modern comprehensive food regulation. In India, examples of these beneficial foods include fruits and vegetables, herbs, extracts of herbs, and foods that have been nutritionally enhanced or that have undergone functional elements altered. The overview's goal is to examine the general idea

and beneficial properties of particular nutritional supplements that could be integrated into a diet.

The term "nutraceuticals" was first used in 1989 by Stephen De Felice, the founder and head of the Institute for Innovation in Medicine (FIM), by combining the terms "nutrition" and "pharmaceuticals."

"Nutraceuticals are "food supplements that offer health or beneficial advantages, such as preventing and treatment of a disease," according to De Felice (Wildman, 2001; Bull, 2000).

According to Dureja *et al.,* (2003) and Malik (2008), nutraceuticals present a diverse array of therapeutic applications, including the management of osteoporosis, blood pressure, cholesterol, depression, diabetes, sleep disorders, coughing, colds, and arthritis, as well as preventing various cancers.

TYPES OF SUPPLEMENTS FOR NUTRITION

Food classification is the most commonly utilized method for nutraceutical classification. chemical composition, source, and mode of action, among other things (Kalia, 2005; Kokate *et al.,* 2002). Every natural food source that is utilized to make nutraceuticals fits into one of the following groups:

- Nutritional fibre
- Prebiotics
- Antioxidant vitamins
- Fatty acids with polyunsaturated chains
- Probiotics
- Polyphenols
- Spices

In general, there are two categories into which nutraceuticals can be divided (Pandey *et al.,* 2010).

(1) Potential nutritional supplement

(2) Prominent nutritional supplement

Some Patents on Nutraceuticals are summarized in Table No. 1

Sr.no	Patent number	Patent title	Assignee	Description	References
1.	US20140274694A1	MOLASSES ASA SOIL AMENDMENT	Robert Rodriguez-Kabana	Compositions containing molasses are disclosed. The disclosed compositions can be used as soil additives to improve plant development and/or reduce weeds and pests.	[Rodriguez-Kabana *et al.,* 2014]
2	CN104262041A	Use of dietary interventions to prevent slow-release agent, fertilizer, and pesticide for for nutritional disease-preventing pesticide fertilizer	Lianbao Crop Technology Co Ltd	pertains specifically to a pesticide fertilizer that prevents nutritional diseases in the field of pesticides and fertilizers.	[Puri *et al.,* 2022]

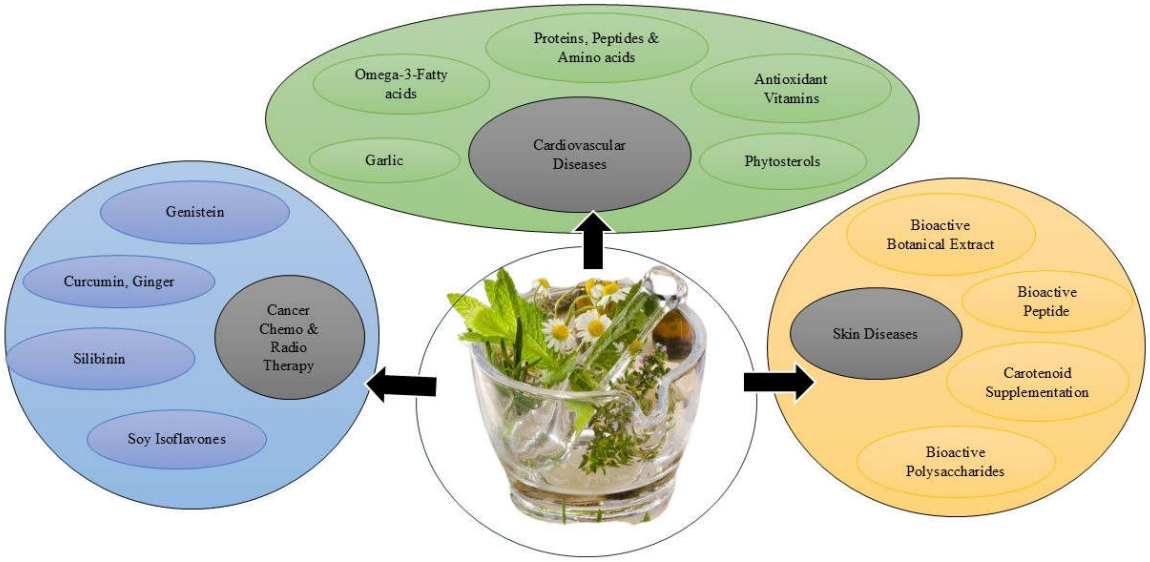

Figure 1: Nutraceuticals in Disease Prevention and Control (Puri *et al.,* 2022)

(1) **Dietry fibres**

The definition of dietary fiber is any plant or food ingredient that is broken down by intestinal microbes rather than digested by digestive system enzymes. It is mostly composed of polysaccharides that don't contain starch (NSP), which include cellulose, gum, the hemicellulose pectins, lignins, resistant starch, and resistance dextrins. Foods that are high in soluble fiber include fruits, barley, oats, and soybeans. According to (Leclere *et al.* 1994), dietary fibers are chemically described as polymers of carbohydrates with a certain level of polymerization of at least three substances that the small intestine is unable to absorb or digest.

Dietary fibers can be categorized into two types according to how soluble they are in water.

(A) Dietary insoluble fibers (IDF),

Examples of insoluble dietary fibers (IDF) that fermented in the colon to a limited degree include cellulose, lignin, and certain hemicellulose.

(B) Soluble dietary fibres (SDF)

These include the colon's fermented hemicellulose, pectins, gums, the mucilage, and beta glucans (Cummings 2001).

Dietary fiber's soluble components can produce bulk and the viscosity which delays the stomach's gastric emptying. It also has an effect on how quickly nutrients get absorbed and digested. Soluble fibers can increase the cellulose tolerance and more readily reduce blood LDL and cholesterol. They further enhance the binding of insulin receptors. Dietary fibers stimulate soluble fiber fermentation, which increases fecal bacterial mass and fecal volume in the colon. Additionally,

the fibers stimulate the gut's bifidobacteria to develop successfully (Glore *et al.,* 1994). Consumption more foods high in fiber helps diabetics better control their blood sugar, lower blood pressure, and increase serum lipoprotein levels and sustains weight loss. Human immunity is enhanced by particular soluble fiber (Anderson *et al.* 2009).

Dietary fibers have several drawbacks, such as reduced calorie, protein, mineral, and vitamin absorption. The recommended daily intake of fiber for an average individual is 20–25 grams. According to (Lairon *et al.,* 2005), adults and children should consume 40 grams of fibre per 1000 kcal.

(2) PUFAs, or polyunsaturated fatty acids

Since polyunsaturated fatty acids can be obtained through diet and are necessary for human systems, they are also referred to as " “crucial fatty acids. Omega-3 fatty acids consist of three primary components: α-linolenic acid (ALA), eicosapentanoic acid (EPA), and docosahexaenoic acid (DHA), according to (Escott-Stump and Mahan 2000). EPA and DHA are found in ALA.

Flax seeds, soybeans, and other foods are the main sources of ALA and red or black currant seeds. Arachidonic acid, γ-linolenic acid, and linolenic acid are the main constituents of omega-6 fatty acids.

Recent research indicates that omega-3 oil offers more benefits. Omega-3 fatty acids have three primary beneficial impacts on cardiovascular disease: hypolipidemia, antiarrhythmic, and antithrombotic, according to reports. Recent research shows that omega-3 oil has numerous beneficial impacts.

which include asthma, bipolar illness, depressive disorders, and premature baby health.

Currently, DHA and ARA are used in infant formulae that closely resemble breast milk. The FDA advises consuming no more than three grams of omega-3 fatty acids each day, Specifically, dietary additives should not exceed two grams (Carlson, 1999).

(3) Probiotics When given in sufficient quantities, a probiotic—a live microbial feed ingredient—improves the intestinal equilibrium of microbes in the host mammal

(Hord, 2008). Probiotics typically contain the following kinds of bacteria:

A) According to (Suvarna and Boby 2005), Lactobacillus includes Casei, Lactobacillus acidophilus.

B) Bifidobacteria, including longum, infantis, adotescentis, bifidun, and thermophilum. There are numerous forms of probiotics, such as liquid, gel, paste, pellets, powder, capsules, and more. Acute diarrhea, lactose intolerance, and intestinal side effects associated with antibiotics are among the digestive problems that are normally treated with certain probiotics.

Probiotics are resistant to stomach acid, non-toxic, and non-pathogenic. They also stick to the gut's membrane tissues to create antimicrobial substances.

(4) Prebiotics

They are short-chain polysaccharides with distinct chemical structures that are indigestible by humans, especially fructose-based oligosaccharides that are either naturally present non food or added to it (Macfarlane *et al.,* 2006; Gibson and Roberfroid, 1995). Fructose oligosaccharides are abundant in vegetables such as chicory roots, bananas, tomatoes, and alliuns. Beans and peas include raffinose and stachyose, two more of these oligosaccharides.

(Hord, 2008; Gibson, 1999). Prebiotics have cancer-fighting qualities, neutralize toxins, enhance the intestinal immune system, improve lactose tolerance, reduce blood lipids and cholesterol, and reduce constipation while used. 5 to 20 grams of the inulin and oligosaccharides per day promote the growth of bifidobacteria. According to (Stranges *et al.* 2006), a high concentration of these oligosaccharides results in flatulence, diarrhoea, and distension of the abdomen.

(5) Selenium

A significant trace element that helps protect against particularly reactive oxygen species is selenium. Brazil nuts are the best source of selenium. Lack of it has serious negative impacts on human health, such as the fatal cardiomyopathy Keshan's disease that predominantly impacts children and young women. The most important form of selenium is found in antioxidants such as thioredosin reductase and glutathione peroxidase. These enzymes are crucial for protecting cells against oxidative damage brought on by reactive nitrogen molecules (RNS), such as nitric oxide. According to (Stranges *et al.* 2006), selenium's antioxidant properties help prevent cardiovascular disease. It maintains immunity. Selenium can induce cell cycle arrest, apoptosis. According to recent studies, selenium-enzymes' antioxidant activity may reduce the risk of heart disease by stopping the oxidized LDL from being produced (Tinggi, 2007). The recommended daily intakes for selenium in the diet range from 20 µg for children to 55 µg for adults. For children, the acceptable daily intake of selenium is 90 µg, whereas for adults, it is 400 µg (Stranges *et al.,* 2006).

(6) Vitamins rich in antioxidants

These vitamins function independently and in combination to prevent oxidative reactions which lead to a number of degenerative illnesses, including as cancer, heart disease, cataracts, and more. These vitamins, which are found in large quantities in a number of fruits and vegetables, work as scavengers of free radicals to provide protection. Tocopherol and tocotrienols, which are components of vitamin E, scavenge singlet oxygen and other reactive species and transfer hydrogen atoms. (Elliot 1999).

They are better at preventing liver oxidation and have more options for recycling. According to reports, selenium and vitamin E work together to increase lipid peroxidation.

Carotenoids such as luteen, zeaxanthin, beta-carotene, and lycopene do not produce any oxidizing chemicals are recognized as the biological system's most efficient singlet oxygen quenchers. Peroxy-free redical gets trapped by β-carotene in tissues with low oxygen concentrations. Accordingly, β-carotene enhances vitamin E's antioxidant qualities (Lee *et al.,* 2004).

(7) Polyphenols

Plants produce polyphenols as secondary metabolic compounds for defense against photosynthesis, stress, and reactive oxygen species. There are almost 8,000 different types of polyphenols, but the most significant ones include anthocyanins, flavones, flavanones, and falavan-3-ols. Flavonoids and phenolic acids are the most prominent polyphenols. Due to important research demonstrating their ability to efficiently affect cellular processes, nutritional antioxidants are currently of special interest like expression, apoptosis, accumulation of platelets, and carcinogenicity (Dulthie *et al*, 2003).

In addition, polyphenols have cardioprotective, antibacterial, anti-inflammatory, and antioxidant properties. They play an essential role in preventing diabetes mellitus and neurodegenerative diseases. Because of their structural chemistry, The primary function of polyphenols is their antioxidant properties. It has been shown that polyphenols are a more potent antioxidant compared to both vitamins C and E on a molar basis when examined in vitro. One important consideration when evaluating the biological activity of polyphenols is their bioavailability. This is dependent on intestinal absorption, polyphenols' chemical characteristics, intestinal conjugation and reconjugation, and the enzymes that are accessible for metabolism. An essential rate-limiting enzyme in glutathione formation, γ-glutamylcysteinesynthetase, has been revealed to be modulated by flavonoids. Endothelin-1 production, a vasoactive peptide crucial to the development of coronary atherosclerosis, has been shown to be significantly reduced by red wines. Proanthocyanidins and reservatrol, a triphenolic that provides red wine its anti-inflammatory and antioxidant properties, are found in the black skin of grapes. (Corder *et al.,* 2001).

Polyphenols like catechins, which are abundant in tea, include (-)-epicatechen, (-) -epigallocatechin, (-)-epicatechen -3-gallate (ECGC), (catechin). Flavonols like myricetin and quercetin are also found in tea.

According to experimental data from animal models, tea may also be important in preventing the development of cancer in the skin, lungs, esophagus, stomach, liver, small intestine, pancreas, colon, and bladders. According to (Lambert *et al*.2005) and (Yang *et al*. 1997), green tea has also been linked to a lower risk of CVS illnesses by reducing triglycerides and blood cholesterol while

shielding the kidneys from lipid degradation. Research indicates that the body receives polyphenols from legumes, including lignans, isoflavones, and flavonoids.The best source of dietary isoflavones is soybean. Even when consumed in excess via diet, polyphenols may result in adverse effects.

Flavonoids may predispose individuals to newborn leukemia since they have been shown to cause cleavage in the NLL gene and block enzymes needed for DNA replication and structure, including topoisomerase.

However, it is still unclear if dietary polyphenols impact the amounts of glutathione in human cells and whether they aid in regulating crucial cellular signaling pathways, which would explain why fruits and vegetables are known to prevent disease (Yang *et al*., 2001).

(8) Spices

Particularly large amounts and varieties of spices are consumed in tropical nations. Tropical foods add distinctive flavor, color, and perfume to meals It makes us more hungry and alters the way food tastes. Recent studies have shown that spices can significantly affect human health even in small amounts due to their anti-inflammatory (Hendrich *et al.,* 1994).

It was shown that in order reduce cholesterol levels in the human body, about 50g of raw onion and 5–6 cloves of garlic must be consumed. Spices are safe for consumption as food, but because they can mix with other pharmaceutical medications, they could be hazardous when used as medicine. Rats who obtain high dosages of onions (500 mg/kg) also develop tissue and lung damage (Rao, 2003).

Herbs and spices are usually accepted to be safe for ingestion by humans (GRAS) under the limited states code of federal laws (Hendrich *et al.,* 1994).

The Future of Nutraceuticals

Most people are adopting healthier lives, exercising more, and eating more nutritious food as a result of growing awareness of fitness and health brought on by media attention. The growing market for nutraceuticals shows that consumers are looking for minimally processed foods with additional organoleptic value and nutritional benefits. The global market for nutraceuticals then grows as a result of this development. Its tremendous expansion impacts the food, medicinal products healthcare, and agricultural sectors. Since enzymes have been underutilized and are expected to become a popular topic in the future, many scientists think that they represent additional emerging frontlines in nutraceuticals. Potential benefits are additionally demonstrated by fermentation technology, which uses microbes to create new food products. It is impossible to reverse the global trend toward healthier products. Businesses that take the initiative and make

strategic investments in marketing, customer education, product development, and science will not go unrewarded.

Conclusion

The growth rate of the nutraceuticals sector has exceeded that of the food and pharmaceutical sectors. These companies offer useful products as components of a broad range of products that meet both traditional and health-related needs and defense mechanisms will probably be the most successful nutraceuticals players in the market of the future. These companies' defense mechanisms will also likely deteriorate significantly with age. Numerous illnesses could arise as a result of them.

Although nutraceuticals have significant potential to improve human health and prevent disease, regulatory toxicologists and nutritionists should work together strategically to design appropriate rules that will deliver the greatest possible therapeutic and health benefits to humanity. To confirm the use of dietary supplements in the scientific treatment of medical diseases, long-term clinical trials are required. It's also important to evaluate how nutraceuticals may interact with drugs and nutrition.

Consuming nutraceuticals will prevent sickness and enable people to maintain general health because of their shown benefits for health.

REFERENCES

1. Adelaja AO, Schilling BJ. Nutraceutical: blurring the line between food and drugs in the twenty-first century. Mag Food Farm Resour. 1999;14:35–40.
2. Anderson JW, Baird P, Davis RH Jr, Ferreri S, Knutdson M, Koraym A, Waters V, Williams CL. Health benefits of dietary fibre. Nutr Rev 2009; 67:188–205.
3. Brower V. Nutraceuticals: poised for a healthy slice of the healthcare market? Nat Biotechnol. 1998;16:728–731.
4. Buchner HC, Hengstler P, Schindler C, Meier G. N-3 polyunsaturated fatty acids in coronary heart disease—a meta analysis of randomized controlled trials. Am J Med 2002;112:298–304.
5. Carlson SE. Long-chain polyunsaturated fatty acids and development of human infants. ActaPaediatrSuppl. 1999;88:72–77.
6. Cummings JH. The effect of dietary fiber on fecal weight and composition. In: Spiller G (ed) Dietary fiber in human nutrition. CRC Press, Boca Raton. 2001; 183–252.
7. Dillard CJ, German JB. Phytochemicals: nutraceuticals and human health. J Sci Food Agric. 2000; 80:1744–1756.
8. Doron S, Snydman DR, Gorbach SL. Lactobacillus GG: bacteriology and clinical applications. GastroenterolClin North Am. 2005;34:483–498.
9. Duthie GG, Gardner PT, Kyle JAM. Plant polyphenols: are they the new magic bullet? Proc Nutr Soc. 2003;62:599–603.
10. Elliot JG. Application of antioxidant vitamins in foods and beverages. Food Technol. 1999;53:46–48.
11. Escott-Stump E, Mahan LK. Krause's food, nutrition and diet therapy, 10th edn. WB Saunders Company, Philadelphia. 2000;553–559.
12. Fuller R. Probiotics: the scientific basis. Chapman and Hall, London Gibson GR Dietary modulation of human gut microflora using the prebiotics Oligofructose and Inulin. J Nutr 1999;129:1438S– 1441S.
13. Gibson GR, Roberfroid MB. Dietary modulation of the human colonic microbiota: introducing the concept of prebiotics. J Nutr. 1995;125:1401–1412.
14. Gibson GR, Wang X Regulatory effects of bifidobacteria on other colonic bacteria. J ApplBacterio 1994;77:412–420.
15. Glore SR, Van Treeck D, Knehans A. J Am Dent Assoc. 1994;94:425–436.

16. Goldbohm RA, Hertog MGL, Brants HAM, van Poppel G, van den Brandt PA. Consumption of black tea and cancer risk: a prospective cohort study. J Natl Cancer Inst. 1996;88:93–100.
17. Hendrich S, Lee K-W, Xu X, Wang HJ, Murphy PA. Defining food components as new nutrients. J Nutr. 1994;124:1789s–1792s.
18. Hord NG. Eukaryotic microbiotic crosstalk: potential mechanisms for for health benefits of prebiotics and probiotics. Annu Rev Nutr. 2008;28:215–23.
19. John B. Natural compounds in cancer therapy. Oregon Medical Press, Princeton Kabara JJ (1991) Phenols and chelators. In: Russell NJ, Gould GW (eds) Food preservatives. Glasgow & London, Blackie. 2001;200–214.
20. Kalia AN. Textbook of Industrial Pharmacognocy. CBS publisher and distributor, New Delhi. 2005;204–208.
21. Kaur C, Kapoor HC. Antioxidants in fruits and vegetables-the millenium's health. Int J Food Sci Technol 2001;36:703–725.
22. Kokate CK, Purohit AP, Gokhale SB. Nutraceutical and Cosmaceutical. Pharmacognosy. 21st edition, Pune, India: Nirali Prakashan, 2002;542–549.
23. Lairon D, Arnault N, Bertrais S, Planells R, Clero E, Hercberg S, Boutron-Ruault MC. Dietary fiber intake and risk factors for cardiovascular disease in French adults. Am J Clin Nutr.2005;82:1185–1194.
24. Lee J, Koo N, Min DB. Reactive oxygen species, aging and antioxidative nutraceuticals. CRFSFS. 2004;3:21–33
25. Macfarlane S, Macfarlane GT, Cummings JH. Review article: prebiotics in the gastrointestinal tract. Aliment PharmacolTher. 2006;24:701–714
26. Malik A. The potentials of Nutraceuticals. Pharmainfo.net 6 Metchinkoff E. The prolongation of life. Putmans Sons, New York.2008;151–183.
27. Meydani M. Effect of functional food ingredients: vitamin E modulation of cardiovascular diseases and immune status in the elderly. Am J Clin Nutr. 2000;71:1665S–1668S.
28. Micallef M, Lexis L, Lewandowski P. Red wine consumption increases antioxidant status and decreases oxidative stress in the circulation of both young and old humans. Nutrition J. 2007;6:27–34.
29. Nicoli MC, Anese M, Parpinel M (1999) Influence of processing on the antioxidant properties of fruits and vegetables. Trends Food Sci Technol.1999;10:94–100.

30. Oboh G. Antioxidant properties of some commonly consumed and underutilized tropical legumes. Nutrition Business Journal. Eur Food Res Technol. 2006;224:61–65.
31. Pandey M, Verma RK, Saraf SA. Nutraceuticals: new era of medicine and health. Asian J Pharm Clin Res. 2010;3:11–15.
32. Rishi RK. Nutraceuticals: borderline between food and drug? Pharma Rev. 2006;51–53.
33. Sahu SC. Dual role of organosulfur compounds in foods: a review. J Environ Sci Health C Environ Carcinog Ecotoxicol Rev 2002;20:61–76.
34. Stranges S, Marshall JR, Trevisan M, Natarajan R, Donahue RP, Combs GF, Farinaro E, Clark CL, Reid ME. Effects of selenium supplementation on cardiovascular disease incidence and mortality: secondary analyses in a randomized clinical trial. Am J Epidemiol. 2006;163:694–699.
35. Suvarna VC, Boby VU. Probiotics in human health: a current assessment. Curr Sci. 2005;88:1744–1748.
36. Tinggi U (2007) Selenium: its role as antioxidant in human health. Environ Health Prev Med 13:102–108
37. Yang G, Wang ZY, Kim S, Liao J, Seril DN, Chen X, Smith TJ, Yang CS. Characterization of early pulmonary hyperproliferation and tumor progression and their inhibition by black tea in a 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanoneinduced lung tumorigenesis model with A/J mice. Cancer Res 1994;57:1889–1894.
38. Yang CS, Landau JM, Huang MT, Newmark HL. Inhibition of carcinogenesis by dietary polyphenolic compounds. Annu Rev Nutr. 2001;21:381–406.
39. Rodriguez-Kabana R, Simmons LJ, Taylor CR, inventors; Auburn University, assignee. Molasses as a Soil Amendment. United States patent application US 14/212,564. 2014 Sep 18.
40. Puri V, Nagpal M, Singh I, Singh M, Dhingra GA, Huanbutta K, Dheer D, Sharma A, Sangnim T. A comprehensive review on nutraceuticals: therapy support and formulation challenges. Nutrients. 2022 Nov 3;14(21):4637.