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"Nutraceuticals: An Emerging Frontier in Disease Prevention and Health Promotion"

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ABSTRACT
Nutraceuticals, which lie between the fields of nutrition and pharmaceuticals, are receiving growing interest for their ability to support health, prevent disease, and serve as complementary therapeutic agents. Sourced from foods, herbs, and various bioactive molecules, these products are being investigated as promising and relatively safe alternatives or supplements to traditional medical treatments.

This review offers a information of nutraceuticals, including their definitions, categories, mechanisms of action, and therapeutic applications, particularly in the management of chronic conditions such as cardiovascular disease, diabetes, neurodegenerative disorders, cancer, and obesity. The paper also discusses recent progress in formulation methods, strategies to improve bioavailability, and the regulatory systems that oversee nutraceutical use worldwide.

Key challenges—such as maintaining product quality, establishing clinical efficacy, and addressing safety concerns—are examined to present an objective analysis. Drawing on findings from laboratory studies, clinical research, and market developments, this work highlights the increasing importance of nutraceuticals in contemporary healthcare and their potential to close the gap between traditional nutrition and modern medicine.

I. INTRODUCTION

The word nutraceutic originates from the combination of "nutrition" and "pharmaceutical science." This expression refers to items obtained from plant-based materials, nutritional additives, specialized eating patterns, and processed food products such as grains, broths, and drinks, which—beyond offering nourishment—are also utilized for therapeutic purposes.[1]In the United States, the phrase "nutraceutical products" is governed under categories such as medications, food additives, and dietary enhancers. The definition changes from country to country, yet it is generally explained as a food-derived product marketed in health-oriented forms not typically linked with ordinary food items. A nutraceutical substance may be described as a compound that delivers physiological advantages or shields the body from long-term illnesses.[1]

Nutraceutical agents may serve to promote overall well-being, slow age-related decline, guard against chronic disorders, prolong lifespan, or support the body's structure and biological functions.[2]In comparison with pharmaceutical drugs, nutraceutical preparations generally lack patent rights. Although both medicines and nutraceutical compounds may be employed to treat or reduce disease risk, only pharmaceutical substances carry official governmental approval.[3] A nutrient supplement is considered a preparation that includes any combination of the following nutritional substances: an essential element, an organic micronutrient, a protein-building compound, a therapeutic plant or plant-derived ingredient, or a nutrition-related component meant to improve a person's diet by increasing overall daily intake. It may also consist of a condensed form, biochemical derivative, structural component, isolated extract, or mixture of these substances. Nutraceuticals represent a group of such nutritional enhancers that are applied for health-supportive purposes extending beyond simple dietary nourishment.[4]

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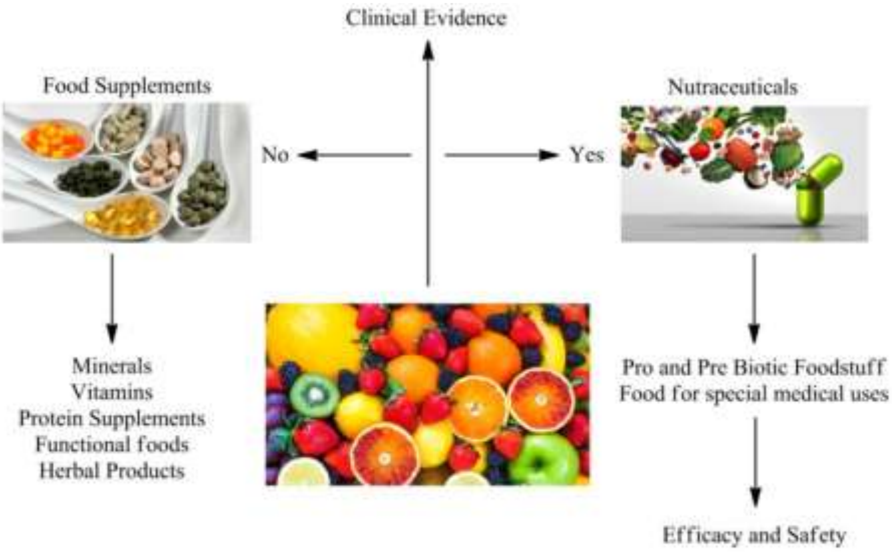

Figure 1:potential roles of neutraceuticals

Categorization of Nutraceuticals

Nutraceuticals may be grouped according to their source, chemical nature, or physiological actions. Generally, they are divided into four major classes: dietary supplements, functional foods, medical foods, and pharmaceuticals. Dietary supplements are concentrated preparations of nutrients obtained from food and are sold in forms like tablets, capsules, liquids, or powders. Although the U.S. Food and Drug Administration (FDA) oversee these products, they are regulated differently from standard foods and medicinal drugs.

A wide range of natural food ingredients is used in producing nutraceuticals. These include carbohydrates and dietary fiber; fats and essential fatty acids; proteins; vitamins and minerals (both major and trace elements), as well as water and other bioactive components. The latter group comprises antioxidants, phytochemicals, beneficial gut microorganisms, and biotechnology-derived recombinant nutraceuticals [5].

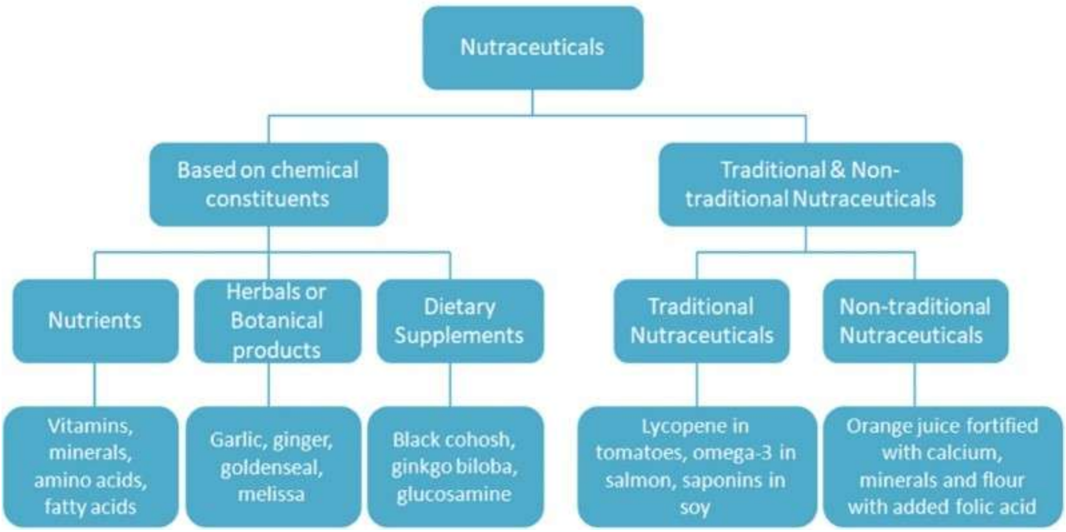

Figure 2: classification of neutraceuticals

1. Non-Traditional Nutraceuticals

Non-traditional nutraceuticals refer to foods or food ingredients that are modified using biotechnological processes. Through biotechnology, natural food materials are enhanced or engineered to include specific bioactive

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compounds that promote human health. This group is generally divided into two subtypes:

A. Enhanced Nutraceuticals
Enhanced nutraceuticals refer to food products upgraded with extra nutrients—typically micronutrients such as vital vitamins and essential minerals—often reaching the full recommended daily allowance. These nutrient boosts can be introduced through selective crop development or by incorporating nutrients directly during manufacturing. Common illustrations include:
• Calcium-fortified citrus beverage
• Morning grain products enriched with assorted vitamins and minerals
• Flour supplemented with folate
• Milk reinforced with vitamin D

B.Bioengineered nutraceuticals
Recombinant nutraceuticals are developed using advanced biotechnological techniques such as genetic engineering, enzymatic processing, and fermentation. These techniques enable the production of probiotics and the extraction of potent bioactive compounds. Common food items produced through these methods include bread, alcoholic beverages, fermented carbohydrates, yogurt, cheese, vinegar, and similar products [6].

2 . Traditional Nutraceuticals
Traditional nutraceuticals refer to naturally occurring substances taken in their unaltered form. These food items contain inherent bioactive elements that deliver well-being advantages beyond basic nourishment—for instance, lycopene in tomatoes, omega-3 lipids in fish such as salmon, and saponins found in soybeans.

They fall under the following categories:
A. Probiotic Microorganisms –
Probiotics are helpful microorganisms that sustain a stable gut ecosystem by restraining harmful agents such as pathogenic bacteria, viruses, and yeasts. They support intestinal wellness by:
Competing with invading microbes for nutritional resources
Preventing harmful organisms from attaching to intestinal tissues
Releasing antimicrobial compounds
Restoring tissue damage resulting from infections
They additionally assist in lactose breakdown by generating β-galactosidase, the enzyme responsible for digesting lactose. Typical foods abundant in probiotics include yogurt and kefir.

B. Prebiotics –
Prebiotics are non-digestible food elements that serve as fuel for beneficial gut microorganisms. By promoting the expansion of these friendly microbes, they help inhibit the growth of unwanted organisms in the gastrointestinal tract.

C. Phytochemical components Herbal Constituents
Many herbs contain natural compounds with therapeutic benefits and are widely used as nutraceuticals.

Examples include:
- **Aloe vera gel** – improves blood circulation, reduces inflammation, and aids wound healing
- **Ephedra** – acts as a bronchodilator and reduces bronchial swelling
- **Garlic** – possesses antibacterial, antifungal, anti-inflammatory, and antithrombotic properties
- **Liquorice** – used as an expectorant and for the treatment of peptic ulcers
- **Ginger** – exhibits carminative, antiemetic, and digestive-enhancing effects

Phytochemicals
Phytochemicals are plant-derived compounds known for their biological activity and health-protective functions. Examples include:
- **Carotenoids** from fruits, vegetables, and egg yolk – known for anti-cancer activity and immune support
- **Non-carotenoid compounds** from legumes, grains, and palm oil – help reduce cholesterol
- **Sulphides** from garlic and onions – boost immune response

D. Nutrient based enzyme
Nutraceutical enzymes are crucial biological catalysts, and taking them as supplements may support people dealing with conditions such as digestive disturbances, low blood sugar, and excessive weight gain. These catalytic proteins are obtained from microbial, botanical, or animal-derived sources.

Illustrative examples include:
Xylanase (derived from Trichoderma strains) – assists in degrading arabinoxylanfibers and enhances the breakdown of nutrients.

Papain – a protein-cleaving enzyme that facilitates the conversion of proteins into absorbable amino acids.
Lactase (sourced from Aspergillus species) – hydrolyzes lactose, aiding digestion for individuals with lactose intolerance.
These enzymatic agents increase digestive capability and boost nutrient uptake. [7][8]

3. Marketed Nutraceuticals

Owing to rising expenditures and challenges related to pharmaceutical innovation, numerous drug manufacturers are shifting focus toward the creation of nutraceutical products. The growing worldwide demand for foods abundant in omega-3 fatty acids, especially sourced from marine products, highlights this movement.
Commercially available nutraceuticals can be categorized as:
A. Nutrient Supplements
B. Functional Edibles
C. Therapeutic Foods
D. Pharmaceutical Products

A. Nutrient Supplements

A nutrient supplement is an orally ingested preparation containing concentrated bioactive components derived from food—available in forms such as tablets, capsules, syrups, soft gels, powders, and others. According to the DSHEA Act (1994), these supplements may include vitamins, minerals, botanicals, amino acids, enzymes, and metabolites.These products are promoted to maintain standard physiological processes rather than to treat or cure ailments, and they must display a statement clarifying that they have not been reviewed by the U.S. FDA.Common examples include vitamin D, vitamin B12, iron, calcium, garlic extracts, and fish oil.

B. Functional Edibles

Functional edibles are ordinary consumables fortified to deliver additional health advantages beyond basic nourishment. Nutrient enhancement—by addition or restoration of bioactive components—is often applied to increase their functional value (for instance, fortifying milk with vitamin D).

In Japan, functional foods are required to:
1. Be consumed in their natural or minimally processed state
2. Be incorporated regularly into a standard diet
3. Contribute to the regulation of bodily functions

C. Therapeutic Foods

Therapeutic foods are naturally derived consumables recognized for their healing properties in traditional healing systems, ethnomedicine, or contemporary biomedical practices. They not only fulfill dietary requirements but also supply bioactive constituents that assist in preventing diseases linked to lifestyle factors.In contrast to nutraceuticals (which may be administered as tablets or capsules), therapeutic foods are ingested as part of a habitual diet.They are frequently recommended by healthcare practitioners to manage disorders such as phenylketonuria, celiac disease, and lactose sensitivity.

Illustrative examples include:
Turmeric (curcumin) – anti-inflammatory and antioxidant properties
Garlic (allicin) – supports lipid metabolism and enhances blood circulation
Peppermint – utilized for gastrointestinal discomfort
Thyme and sage – employed for respiratory and digestive conditions

D. Pharmaceuticals

Pharmaceuticals are chemically formulated drugs created specifically to treat, prevent, or cure diseases. They are far more potent than naturally occurring compounds found in foods and typically exert their effects over a shorter period. Unlike nutraceuticals or functional foods, pharmaceuticals do not naturally occur in the diet and are regulated as medicinal products [9][10].

HEALTH PROMOTING BIOACTIVE

The expression nutrition based is a combined or shortened form of the words nutrition and pharmaceutical. It was originally created in 1989 by DeFelice and the Foundation for Innovation in Medicine. [11] Later, a 1994 press announcement clarified the term, defining it as "any compound that can be viewed as a food or a component of food and offers therapeutic or wellness advantages, including the avoidance and management of illnesses." These items may include separated nutrients, dietary additives, specialized meal plans, and even genetically modified "designer foods."

IFIC defines functional foods as "foods or nutritional elements that deliver a health advantage exceeding ordinary nourishment." [12]

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ILSI of North America describes functional foods as “foods that provide wellness benefits beyond basic nourishment due to physiologically active constituents.” [13]

Health Canada explains functional foods as “products that resemble traditional foods, eaten as part of a regular diet, but proven to offer physiological improvement and/or reduce the risk of long-term disorders beyond basic nutritional roles.”

The Nutrition Business Journal categorizes functional foods as “foods enhanced with added or concentrated components at functional levels that boost health or bodily performance.” [14]

Nutraceuticals and Diseases

Cardiovascular diseases

A number of nutrients—including antioxidants, dietary fiber, omega-3 fatty acids, vitamins, and minerals—play a key role in reducing the risk of cardiovascular diseases. Grape polyphenols support arterial health, while flavonoids present in foods like onions, vegetables,Red wine, apples, and cherries suppress ACE function and reinforce the tiny blood vessels responsible for transporting oxygen and nutrients to body tissues.

Rice bran also contributes to heart protection by lowering total cholesterol, reducing LDL, and raising HDL levels, which helps reduce the risk of coronary heart disease . [15].

Diet related diseases

Disease Diet-related disorders are increasing in Western regions due to the widespread availability of high-calorie foods and poor dietary patterns. Conditions such as obesity, diabetes, atherosclerosis, and neurodegenerative diseases share chronic low-grade inflammation as a common underlying factor. Functional foods and nutraceuticals may help manage or prevent these disorders because of their anti-inflammatory properties. In particular, activating intestinal regulatory T cells and maintaining a balanced gut microbiota can play an important role in reducing this persistent inflammation.[16]

Heart attack and lung cancer

Corn supports heart health not only because of its fiber but also due to its rich folate content. Folate helps regulate homocysteine, a key compound in the methylation cycle that, when elevated, can damage blood vessels and increase the risk of heart attacks, strokes, and peripheral vascular disease. Meeting the full daily requirement of folate is believed to lower heart attack incidence by about 10%. Corn also contains cryptoxanthin, a natural carotenoid that provides additional health benefits.[16]

Diabetes

For individuals with diabetes, omega-3 fatty acid ethyl esters can be highly beneficial. Docosahexaenoic acid (DHA) plays a key role in neurovisual development and helps improve insulin sensitivity. Lipoic acid, a powerful antioxidant, is commonly used to manage diabetic neuropathy. Additionally, psyllium fiber is effective in regulating blood glucose levels in diabetic patients and reducing lipid levels in those with hyperlipidemia.[16]

Cancer

Flavonoids help protect against estrogen-related cancers by blocking the enzymes involved in estrogen production. A wide range of plant-based compounds with hormone-like activity, known as phytoestrogens, are considered beneficial in decreasing the risk of breast, prostate cancers. Cancer-preventive effects are also seen in isoflavones from soy, curcumin found in turmeric, and other soy-derived compounds. Lycopene, which accumulates in tissues such as the skin, prostate, testes, and adrenal glands, further contributes to cancer prevention.[16]

Obesity

Obesity, characterized by an abnormal accumulation of excess body fat, represents a significant health concern worldwide. It is associated with an elevated likelihood of numerous serious medical conditions, including chest pain (angina), cardiac dysfunction, elevated blood pressure, raised lipid concentrations, breathing difficulties, kidney vein blockage, joint degeneration, various types of malignancies, and reduced reproductive ability . [17]

Anti-inflammatory activities

Curcumin (diferuloylmethane), a naturally occurring polyphenolic compound present in turmeric, is recognized for its potent antioxidant, anti-inflammatory, and anti-cancer actions. Various vegetables—such as beetroot, cucumber, spinach, and turmeric—also exhibit notable anti-tumor potentials. Gamma-linolenic acid, found in leafy green plants, almonds, and several vegetable oils

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including evening primrose, blackcurrant seed, and hemp seed oils, as well as in spirulina, aids in managing inflammatory and autoimmune disorders. Glucosamine and chondroitin sulfate are commonly administered for osteoarthritis since they alter genetic expression and lower PGE_2 concentrations. Cat's claw, appreciated for its strong inflammation-reducing capability, is mainly derived from two plant species—Uncariaguianensis and Uncariatomentosa. Traditionally utilized for wound repair and other healing applications, these herbs contain multiple biologically active substances, including alkaloids, glycosides, flavonoids, tannins, and sterols . [18]

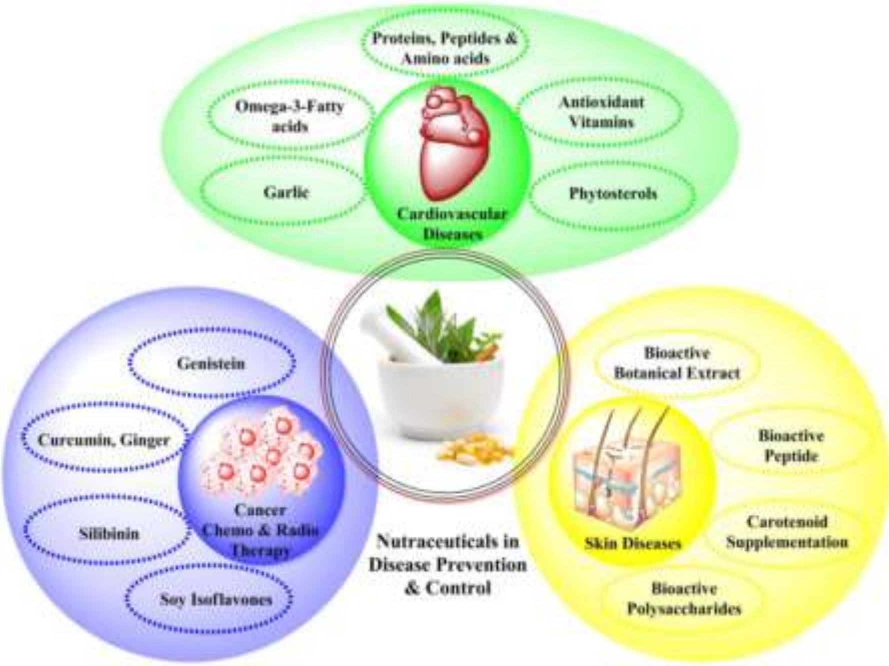

Figure 3:neutraceuticals in Disease Prevention and control

Mechanisms of Action of Nutraceuticals

1. Antioxidant Action

Numerous nutraceutical agents—including vitamin C, selenium, carotenoid compounds, various polyphenolic substances—assist in safeguarding the body against oxidative injury.

They function by neutralizing reactive free radicals and enhancing the body's intrinsic antioxidant defenses, such as catalase, glutathione, and superoxide dismutase [19].

2. Anti-Inflammatory Activity

Bioactive substances such as curcumin, resveratrol, ginger-derived constituents, quercetin, and omega-3 lipids help lower inflammatory responses.

They act by inhibiting pro-inflammatory pathways, specifically by reducing the expression of COX-2, NF-κB, TNF-α, and IL-6 [20].

3. Gut Microbiota Regulation

Probiotic cultures, prebiotic compounds, and dietary fibres assist in restoring balance in the gut microbial community.

They support the proliferation of helpful intestinal microorganisms and enhance the production of short-chain fatty metabolites, which boost metabolic and immune functioning [21].

4. Immunomodulatory Effects

Essential elements like zinc, vitamins C and D, β-glucans, and specific botanical extracts help improve immune functioning.

They reinforce both innate and acquired defense systems by aiding macrophage performance, natural killer cell actions, and antibody synthesis [22].

5. Anti-Carcinogenic Actions

Bioactive substances such as lycopene, sulforaphane, curcumin, EGCG, and resveratrol contribute to reducing the risk of cancer development.

These agents promote apoptosis in malignant cells, obstruct angiogenesis, safeguard genetic material, and modulate detoxification-related enzymes [23].

6. Cardioprotective Mechanisms

Omega-3 fatty acids decrease blood triglyceride levels, diminish the likelihood of irregular heart rhythms, and support healthier vascular performance.

Plant-derived sterols restrict the uptake of cholesterol, whereas polyphenolic compounds inhibit the oxidative damage of LDL particles and promote better dilation of blood vessels [24].

7. Neuroprotective Pathways

Compounds like DHA, curcumin, and ginkgo-derived constituents support the preservation of cognitive function.

Their actions involve minimizing neural inflammation, reducing oxidative injury, enhancing communication between nerve cells, and restricting the accumulation of toxic protein deposits [25].

8. Metabolic and Hormonal Regulation

Cinnamon, chromium, fenugreek, and fiber-rich foods assist in managing blood sugar concentrations and enhancing the body's response to insulin.

Isoflavones function as gentle plant-derived estrogen-like compounds, helping to maintain endocrine equilibrium within the body [26].

II. CONCLUSION

Nutraceuticals offer well-documented wellness advantages, and their intake (when consumed within the recommended dietary limits) can help prevent various illnesses and support overall human well-being. Even though nutraceuticals hold great potential in enhancing public health and reducing disease risks, healthcare experts, dieticians, and regulatory scientists must collaborate to develop suitable guidelines that ensure maximum therapeutic value for society. Therefore, establishing a strong regulatory authority is essential to bring uniformity and quality assurance to the nutraceutical sector. Revisiting and studying this subject is important, as the nutraceutical market is expanding much faster than both the food and pharmaceutical fields. Herbal-based nutraceuticals serve as an effective tool for sustaining good health and combating nutrition-related acute and chronic disorders, ultimately supporting optimal wellness, long life, and improved quality of living.

REFERENCE

[1]. Kalra EK. Nutraceutical – Definition and introduction. AAPS Pharm Sci. 2003;5:E25. doi: 10.1208/ps050325. [DOI] [PMC free article] [PubMed] [Google Scholar]

[2]. Zhao J. Bentham Science Publishers; 2007. [Last accessed on 2012 Mar 24]. Nutraceuticals, Nutritional Therapy, Phytonutrients, and Phytotherapy for Improvement of Human Health: A Perspective on Plant Biotechnology Application. Available from: http://www.benthamscience.com/biot/samples/biot1-1/Zhao.pdf . [DOI] [PubMed] [Google Scholar]

[3]. Chauhan B, Kumar G, Kalam N, Ansari SH. Current concepts and prospects of herbal nutraceutical: A review. J Adv Pharm Technol Res. 2013;4:4–8. doi: 10.4103/2231-4040.107494. [DOI] [PMC free article] [PubMed] [Google Scholar]

[4]. Zeisel SH. Regulation of "nutraceuticals". Science. 1999;285:1853–5. doi: 10.1126/science.285.5435.1853. [DOI] [PubMed] [Google Scholar]

[5]. Chauhan, B., Kumar, G., Kalam, N., & Ansari, S.H. . Current concepts and prospects of herbal nutraceutical: A review. Journal of Advanced Pharmaceutical Technology & Research, (2013)4(1), 4–8.

[6]. Kharb S, Singh V. Nutriceuticals in health and disease prevention. Indian J. Clin. Biochem, 2004; 19(1): 50-53.

[7]. Jeroen Hugenholtz, Eddy J Smid, Victor Ladero, Pascal Hols. Metabolic engineering of lactic acid bacteria for the production of nutraceuticals. Antonie van Leeuwenhoek, 2002; 82: 217–235.

[8]. Vouloumanou EK, Makris GC, Karageorgopoulos DE. Probiotics for the prevention of respiratory tract infections: a systematic review. Int J Antimicrob Agents, 2009; 34:e1-e10.

[9]. Montrose DC, Floch MH: Probiotics used in human studies. J ClinGastroenterol, 2005; 39(6): 469-484.

[10]. N Borkar, SS Saurabh, KS Rathore, A Pandit, KR Khandelwal; An Insight on Nutraceuticals; Pharma Tutor, 2015; 3(8): 13-23.

[11]. Enhancing Nutraceutical Performance Using Excipient Foods: Designing Food Structures and Compositions to Increase Bioavailability David Julian McClements, Liqiang Zou, Ruojie Zhang, Laura Salvia-Trujillo, TahaKumosani, and Hang Xiao, Comprehensive

[12]. E.K. Kalra, AAPS Pharm Sci, 2003, 5,25.

[13]. E.G. Miller, S.A.P. Gonzales, A.M. Couvillon, W.H. Binnie, S. Hasegawa,L.K.T. Lam, Food Technol., 1994,5, 114

[14]. C.H. Fong, S.Hasegawa, Z. Herman and P. Ou, J. Food Sci, 1990, 54, 1505.

[15]. http://www.nibr.novartis.com

[16]. Khosla P, Sharma M, Bhatia R. Effect of rice bran oil on lipid profile: A systematic review and meta-analysis. J Lipid Res. 2016;57(8):1278–1285.

[17]. Wang DD, Li Y, Bhupathiraju SN, et al. Fruit and vegetable intake and mortality: results from two prospective cohort studies and a meta-analysis of 26 cohort studies. Circulation. 2021.

[18]. Hruby A, Hu FB. The epidemiology of obesity: A big picture. Pharmacoeconomics. 2015;33(7):673–689.

[19]. Aggarwal BB, Harikumar KB. Potential therapeutic effects of curcumin against various diseases. Int J Biochem Cell Biol. 2009;41(1):40–59.

[20]. Sies H. Oxidative stress: A concept in redox biology and medicine. Redox Biol. 2015;4:180–183.

[21]. Gupta SC, Patchva S, Aggarwal BB. Therapeutic roles of curcumin: lessons from clinical trials. AAPS J. 2013;15(1):195–218.

[22]. Hill C, et al. ISAPP consensus statement on probiotics. Nat Rev GastroenterolHepatol. 2014;11(8):506–514.

[23]. Calder PC. Nutrition and immunity. BMJ NutrPrev Health. 2020;3(1):74–92.

[24]. Aggarwal BB, Shishodia S. Dietary agents as cancer-preventive molecules. BiochemPharmacol. 2006;71(10):1397–1421.

[25]. Kris-Etherton PM, et al. Omega-3 fatty acids and cardiovascular disease. Circulation. 2002;106(21):2747–2757.

[26]. Gómez-Pinilla F. Nutrition and brain function. Nat Rev Neurosci. 2008;9(7):568–578.

[27]. Anderson RA. Chromium and polyphenols in metabolic regulation. J Am CollNutr. 2003;22(1):63–72.