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Review Article

A Traditional Review: The Utilization of Nutraceutical as a Traditional Cure for the Modern World at Current Prospectus for Multiple Health Conditions

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Abstract

Nutraceuticals refer to food products that have a positive impact on the well-being of individuals. This category includes dietary supplements, herbal products, probiotics, and prebiotics, as well as medical foods designed for disease prevention and treatment. The nutraceutical market is witnessing substantial growth worldwide, primarily due to the growing awareness among consumers about the connection between diet and health. Additionally, there is a rising demand for functional foods and dietary supplements. As consumers prioritize preventive healthcare, they are increasingly looking for products that provide targeted health benefits beyond basic nutrition. The rise of this trend can be attributed to various factors, including the aging population, rising healthcare expenses, and a preference for natural and organic ingredients. Nutraceuticals, as a major force in the industry, offer numerous beneficial effects with minimal undesirable impacts, thus attracting more consumer interest. The increasing shift towards preventive treatments, along with the growth in disposable income and a positive market outlook for the pharmaceutical sector, has primarily contributed to the expanding nutraceutical market in India. However, challenges such as the lack of regulation and awareness, high pricing, marketing, and distribution issues need to be addressed. Nutraceutical market is seeing flowing development chiefly in United States, India, and European nations. This review article primarily focuses on providing a concise overview of nutraceuticals, categorizing them, and discussing their significant roles in various health conditions. Additionally, it delves into the present and future status of nutraceuticals on a global scale.

Keywords: traditional cure; nutraceuticals; remedy; prebiotics; probiotics; regulatory compliance; supplementary diets; nutraceutical ingredients.

1. INTRODUCTION

The term "nutraceuticals" refers to a combination of "Supplement" and "Drugs". According to the Association of American Feed Control Officials (AAFCO), nutraceuticals are products that are derived from food sources and provide additional health benefits beyond basic nutrition. These products are typically consumed as part of a regular diet and are known for their potential to enhance health and prevent or treat diseases. Nutraceuticals encompass a diverse range of products, such as dietary supplements, functional foods, herbal products, and fortified beverages. They may contain bioactive compounds such as vitamins, minerals, amino acids, antioxidants, probiotics, and phytochemicals, which are believed to have physiological benefits beyond traditional nutrients [1-2]. The classification and regulation of nutraceuticals vary by jurisdiction, with some countries treating them as dietary supplements or foods, while others classify them as drugs or medicinal products. The AAFCO plays a crucial role in setting standards and guidelines for the manufacturing, labeling, and marketing of nutraceuticals to ensure consumer safety and product efficacy [3]. These items disengaged or filtered from food are sold in therapeutic structures not generally connected with food. A nutraceutical has a physiological advantage that it gives insurance against ongoing diseases [4-5].

The nutraceutical utilitarian food market in the United States is poised for significant expansion, projected to soar to $583.1 billion by 2027. This forecast indicates a robust compound annual growth rate (CAGR) of 9.3% from 2022 to 2027. This growth trajectory underscores a burgeoning consumer interest in functional foods and supplements, driven by a heightened awareness of health and wellness [6]. Nutraceuticals, encompassing a wide array of products ranging from dietary supplements to fortified foods, are increasingly perceived as essential components of a proactive approach to healthcare. Despite the impressive growth anticipated in the nutraceutical sector, it's noteworthy that the pharmaceutical market dwarfs this figure. As of 2022, the global drug market boasted a colossal size of $1.2 trillion, underlining the enduring dominance and indispensability of pharmaceuticals in the global healthcare landscape [7].

The worldwide market for nutraceutical nutrient ingredients is expected to witness a substantial annual increase in the coming years. With the growing emphasis on preventive

healthcare and the rising demand for functional foods and supplements, the market for nutraceutical ingredients is forecasted to experience a robust compound annual growth rate (CAGR). Industry experts predict that the compound annual growth rate (CAGR) for nutraceutical nutrient ingredients will likely fall within the range of 6% to 8% per year over the next ten years. It is important to note that these projections may vary due to various factors such as regulatory changes, consumer preferences, and technological advancements. This projected growth highlights the changing dynamics of the global nutraceutical industry, which is influenced by factors like growing consumer consciousness, aging populations, and a growing preference for holistic well-being approaches [8]. Notoriety of Indian Ayurvedic treatments support the commodity amazing open doors for plans in view of ashwagandha, haldi, ginger, tulsi and so on. Vitamin D will see the quickest development sought after because of expanding clinical proof of pig influenza, malignant growth, and other preventive medication benefits. Worldwide interest for natural and non-home grown extricates is expanding persistently. Green tea for weight reduction and disease treatment, while Ginkgo biloba for working on mental capability, has been broadly utilized as nutraceuticals. Glucosamine creates most grounded development popular because of its helpfulness on treatment of Arthritis [9, 10].

The nutraceutical industry is experiencing growth worldwide, with various countries standing out as key consumers of these products. Leading the pack are the United States, Japan, China, Germany, and India. In the U.S., the nutraceutical market is thriving due to a health-conscious population and high demand for dietary supplements, functional foods, and herbal products. Japan has a well-established market for nutraceuticals, focusing on functional foods and beverages for an aging population seeking longevity. China's nutraceutical market is rapidly expanding, driven by rising disposable income, urbanization, and increasing awareness of health and wellness [11]. In Germany, consumers prioritize quality and efficacy, driving demand for premium nutraceutical products, especially vitamins and minerals. India's nutraceutical market is buoyed by traditional systems of medicine such as Ayurveda, with consumers showing interest in herbal supplements and natural remedies. While the cost of nutraceuticals varies depending on factors such as formulation, ingredients, and brand reputation, consumers across these countries are willing to invest in products that offer perceived health benefits and quality assurance [12, 13].

This review discusses the introduction of nutraceuticals and their different categories for treatment purposes, followed by their applications in various diseases such as cardiovascular and kidney diseases. Lastly, it provides a summary of the current status of nutraceuticals and their regulatory aspects.

2. NUTRACEUTICALS

Nutraceuticals in pharmacy combine pharmaceuticals and nutritional science to provide therapeutic benefits that go beyond basic nutrition. This category includes dietary supplements, functional foods, and herbal remedies designed to enhance health, prevent illness, or target specific health issues. In pharmacy, nutraceuticals are essential for supplementing traditional pharmaceutical treatments and offering alternative or additional methods for managing health. Pharmacists, as medication specialists, are instrumental in advising patients on choosing, using, and potential interactions of nutraceutical products [14]. They provide valuable information and counseling to patients regarding the safety, efficacy, and appropriate dosage of nutraceuticals, ensuring optimal health outcomes. Pharmacists are involved in the quality control, regulation, and distribution of nutraceutical products, ensuring compliance with industry standards and regulatory requirements. Within the pharmacy setting, nutraceuticals represent a burgeoning field that bridges the gap between conventional medicine and holistic health approaches, offering patients a holistic and personalized approach to wellness [14, 15]. Nutraceuticals are bioactive compounds derived from food sources that provide health benefits beyond basic nutrition, often exhibiting physiological effects and potentially contributing to disease prevention or treatment.

Fortified foods infused with Ayurvedic nutraceuticals represent a fusion of traditional wisdom and modern nutritional science, offering a holistic approach to health and wellness. These foods are enriched with key Ayurvedic ingredients known for their therapeutic properties, aiming to enhance both nutritional content and medicinal benefits [16, 17]. For example, curcumin-fortified turmeric milk not only serves as a soothing drink but also possesses anti-inflammatory and antioxidant properties, which contribute to overall well-being. Similarly, amla candies fortified with Indian gooseberry not only provide a delicious snack but also enhance immunity due to their high levels of vitamin C and antioxidants. Additional fortified foods with similar benefits are listed in **Table 1.** These fortified food options are specifically designed for individuals who prefer natural remedies for addressing different health concerns. They align with the principles of Ayurveda, which emphasize the importance of maintaining balance and harmony within the body.

Table 1: The fortified foods with their Ayurvedic nutraceuticals[17-19]

Fortified Food	Ayurvedic Nutraceuticals
Turmeric Milk	Curcumin: Anti-inflammatory, antioxidant properties
Ashwagandha Tea	Ashwagandha: Adaptogenic herb, stress reduction, immune support
Amla Candy	Amla (Indian Gooseberry): High in vitamin C, antioxidant properties, supports immune health
Triphala Churna Bread	Triphala (Amalaki, Bibhitaki, Haritaki): Digestive support, antioxidant properties
Brahmi-infused Water	Brahmi (Bacopa monnieri): Cognitive support, memory enhancement
Shatavari-infused Yoghurt	Shatavari (Asparagus racemosus): Hormonal balance, reproductive health support
Neem Leaf Cookies	Neem: Antibacterial, antifungal properties, supports oral health
Ghee with Ashwagandha	Ashwagandha-infused ghee: Promotes vitality, supports overall health and well-being
Trikatu Spiced Crackers	Trikatu (Ginger, Black Pepper, Long Pepper): Digestive aid, metabolism booster, supports respiratory health

The nutritional benefits of fortified foods with the healing properties of Ayurvedic nutraceuticals, these products offer consumers a convenient and effective way to support their health while honoring ancient traditions [16-19].

3. NUTRACEUTICAL CATEGORIES

The nutraceutical category of dietary supplements encompasses a diverse range of products that provide health benefits beyond basic nutrition. Within this category, three significant subcategories are dietary supplements with botanicals, functional foods, and medicinal foods. Nutraceuticals play a crucial role in managing gastrointestinal disorders due to their ability to support digestive health and alleviate symptoms. For instance, probiotics, which are beneficial bacteria found in certain foods and supplements, can restore the balance of gut microbiota, thereby improving digestion and reducing symptoms of conditions like irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD) [20]. Additionally, certain herbal extracts such as peppermint oil and ginger have been shown to alleviate symptoms of gastrointestinal discomfort, including bloating and nausea. Furthermore, dietary supplements like glutamine and deglycyrrhizinated licorice (DGL) can help in protecting the integrity of the gastrointestinal lining and reducing inflammation.

3.1. Dietary Supplements with Botanicals: These are supplements derived from plants or plant extracts that are consumed to enhance health or provide medicinal benefits. Botanicals have been used for centuries in traditional medicine systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Indigenous healing practices. The examples of botanical dietary supplements include:

- ***Turmeric Curcumin:*** Derived from the turmeric plant, curcumin is known for its anti-inflammatory and antioxidant properties.
- ***Ginseng:*** Used in traditional Chinese medicine, ginseng is believed to improve energy levels, reduce stress, and boost immune function.
- ***Echinacea:*** Often used to prevent or treat the common cold, echinacea is believed to stimulate the immune system.
- ***Ginkgo Biloba:*** Extracted from the leaves of the ginkgo tree, ginkgo biloba is thought to improve cognitive function and circulation[21, 22].

3.2. Functional Foods: Functional foods are everyday food products that have been fortified or enriched with additional nutrients, vitamins, minerals, or bioactive compounds to provide specific health benefits beyond basic nutrition. These foods are formulated to promote health, prevent disease, or improve overall well-being. The several examples of functional foods include:

- ***Fortified Breakfast Cereals:*** Often fortified with vitamins and minerals such as iron, calcium, and vitamin D to support overall health.
- ***Probiotic Yogurt:*** Contains live beneficial bacteria that promote gut health and support the immune system.
- ***Omega-3 Enriched Eggs:*** Eggs enriched with omega-3 fatty acids, which are believed to support heart health and brain function.
- ***Fiber-Enriched Bread:*** Bread fortified with added fiber to promote digestive health and regulate blood sugar levels [23].

3.3. Medicinal Foods: Medicinal foods are traditional food products or ingredients that have been used for their therapeutic properties in various cultures around the world. These foods are consumed not only for their nutritional value but also for their potential health benefits. The different examples of medicinal foods include:

- ***Amla (Indian Gooseberry):*** Rich in vitamin C and antioxidants, amla is used in Ayurveda for its immune-boosting and rejuvenating properties.
- ***Moringa:*** Known as the "miracle tree," moringa is packed with vitamins, minerals, and antioxidants and is used to combat malnutrition and promote overall health.
- ***Seaweed:*** Rich in iodine, vitamins, and minerals, seaweed is used in traditional Asian cuisine and is believed to support thyroid function and promote detoxification.
- ***Garlic:*** They used in various cuisines worldwide, garlic is known for its immune-boosting, antimicrobial, and cardiovascular benefits [23, 24].

These categories of nutraceutical products offer consumers a variety of options to support their health and well-being. These products may offer potential benefits, they should not be viewed as replacements for a balanced diet and a healthy lifestyle. These ingredients are meticulously selected and formulated to target specific health concerns or promote overall well-being. Examples include antioxidants like vitamin C and E, which neutralize harmful free radicals and protect cells from oxidative damage, and omega-3 fatty acids found in fish oil, renowned for their anti-inflammatory properties and cardiovascular benefits [25]. Probiotics, another category of nutraceutical ingredients, consist of beneficial bacteria that support gut health and immune function and some others are listed in **Table 2** as below discussed description:

Table 2: The list of nutraceutical ingredients with their therapeutic applications[24-26]

Nutraceutical Ingredient	Therapeutic Applications
Probiotics	Gut health improvement, immune system support, alleviation of digestive issues such as diarrhea and IBS
Prebiotics	Promotes the growth of beneficial gut bacteria, aids in digestion, supports immune function
Vitamins	Vitamin A: Vision health, immune support ;Vitamin C: Antioxidant, immune support ; Vitamin D: Bone health, immune function ; Vitamin E: Antioxidant, skin health
Antioxidants	Neutralizes free radicals, protects cells from damage, may reduce the risk of chronic diseases such as heart disease and cancer
Soy-based Ingredients	Isoflavones in soy may support heart health, may help alleviate menopausal symptoms, provides plant-based protein
Minerals	Calcium: Bone health, muscle function; Iron: Oxygen transport, energy production; Zinc: Immune support, wound healing
Nutritional Lipids/Oils	Omega-3 fatty acids: Cardiovascular health, anti-inflammatory properties; MCT oil: Energy source, may aid in weight management
Fibre	Supports digestive health, regulates bowel movements, may help with weight management
Carbohydrates	Energy source, supports brain function and physical performance
Dairy-based Ingredients	Calcium and vitamin D in dairy products support bone health, protein for muscle building and repair

Nutraceuticals, with their therapeutic properties, have the potential to address modern challenges associated with reduced physical activity and sedentary lifestyles, often attributed to factors such as desk jobs and decreased walking. These lifestyle changes have contributed to a rise in health issues like obesity, cardiovascular diseases, and metabolic disorders. Nutraceuticals offer a holistic approach to counteracting these problems by providing bioactive compounds that support various physiological functions. Individuals with sedentary lifestyles often face challenges related to weight management. Nutraceuticals such as green tea extract, conjugated linoleic acid (CLA), and Garcinia cambogia extract have been studied for their potential to promote weight loss and fat metabolism. These supplements may help mitigate the negative effects of reduced physical activity by enhancing metabolism and supporting fat loss, thereby aiding in weight management efforts. [26].

In a scenario where physical activity is significantly reduced due to various factors such as decreased walking, jogging, and participation in recreational sports, and an increase in sedentary desk jobs, nutraceuticals can play a crucial role in maintaining health and mitigating the negative effects of a sedentary lifestyle. With less physical activity, individuals may be at risk of weight gain, muscle weakness, cardiovascular issues, and overall decline in physical fitness. Nutraceuticals offer a potential solution by providing targeted nutritional support to help counteract these effects [27].

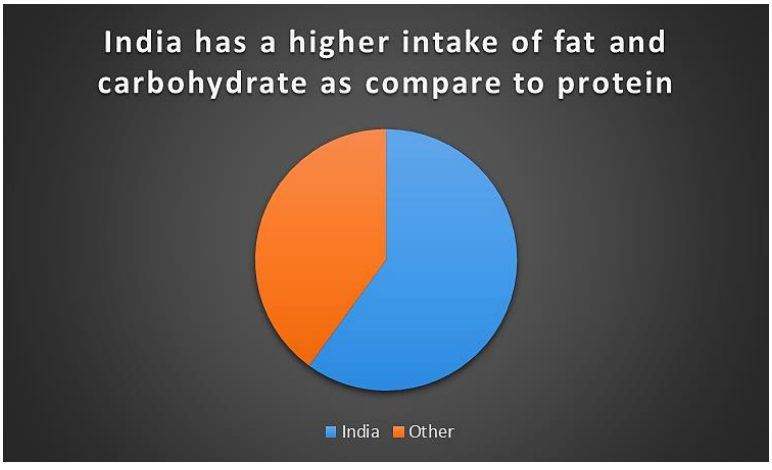

Figure 1: The consumption of protein in India intake overview

Protein is an essential macronutrient with a multitude of benefits for overall health and well-being. It plays a crucial role in building and repairing tissues, making it essential for muscle growth, maintenance, and recovery. Protein is involved in the synthesis of enzymes, hormones, and neurotransmitters, contributing to various physiological processes such as metabolism, immune function, and neurotransmission. Including an adequate amount of protein in the diet can help promote satiety and regulate appetite, making it beneficial for weight management and reducing cravings. Protein-rich foods often contain essential amino acids that the body cannot produce on its own, making them vital for overall health and functioning. Incorporating sources of protein into meals and snacks can help stabilize blood sugar levels, support energy levels, and maintain lean body mass [28, 29]. Prioritizing protein in the diet can contribute to improved muscle health, enhanced metabolism, better appetite control, and overall vitality.

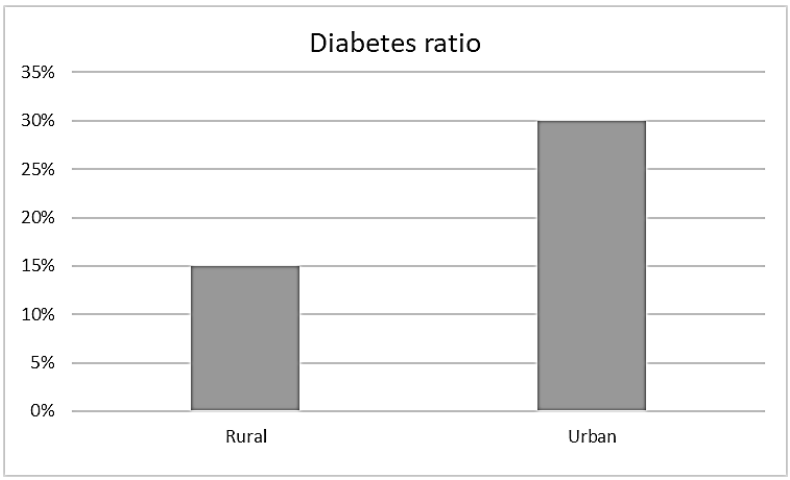

Figure 2: The diabetes ratio within India

Diabetes is a significant public health concern in India, affecting millions of individuals across urban and rural areas. The prevalence of diabetes in India has been rising steadily, fuelled by factors such as urbanization, sedentary lifestyles, and changes in dietary habits. When comparing diabetic patients in urban and rural areas, several differences in daily food intake and dietary patterns can be observed. In urban areas, diabetic patients often have greater access to process and convenience foods, which are high in refined carbohydrates, sugars, and unhealthy fats. These foods contribute to elevated blood sugar levels and increase the risk of obesity and metabolic complications. Urban diabetic patients may also consume more restaurant meals and fast food, which are typically high in calories and low in nutritional value. Additionally, urban lifestyles may be more sedentary due to desk jobs and reliance on motorized transportation, further exacerbating the risk of weight gain and insulin resistance. On the other hand, diabetic patients in rural areas may have a more traditional diet based on locally grown, whole foods such as grains, pulses, vegetables, and fruits [30]. These foods tend to be lower in processed sugars and unhealthy fats, and higher in fibre, vitamins, and minerals.

Furthermore, access to healthcare and diabetes education may be limited in rural areas, leading to challenges in managing the condition effectively. While both urban and rural diabetic patients face dietary challenges, the nature of these challenges may differ based on access to resources, socioeconomic factors, and cultural practices. Regardless of location, it is essential for diabetic patients to adopt a balanced diet that emphasizes whole, nutrient-dense foods, limits processed and sugary foods, and incorporates regular physical activity [31]. Access to healthcare, diabetes education, and community support are also critical in effectively managing diabetes and reducing the risk of complications in both urban and rural settings.

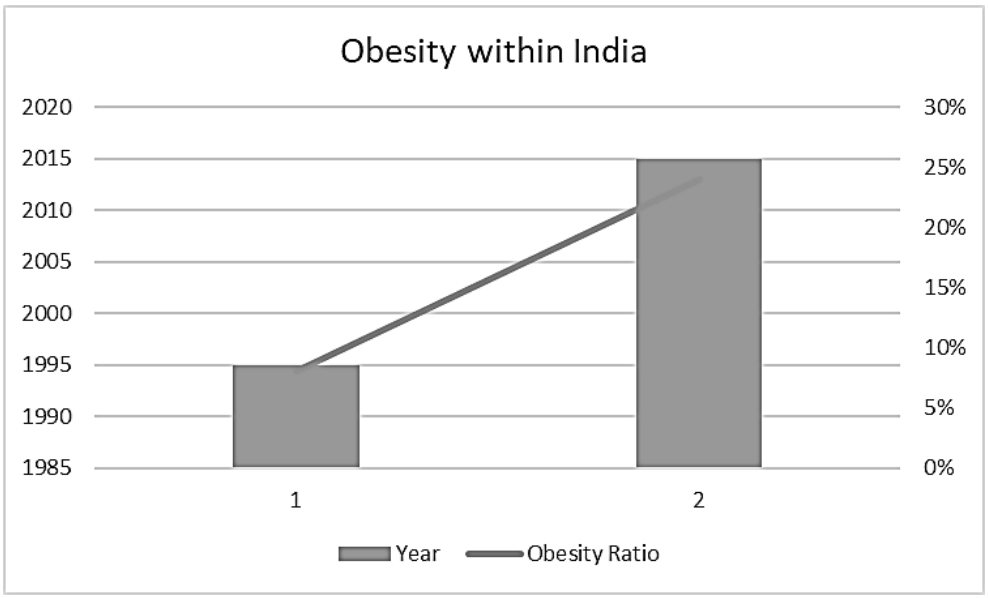

Figure 3: The obesity within India view representation

In recent years, India has experienced a worrisome surge in obesity rates, indicating a notable change in eating patterns, lifestyle preferences, and socioeconomic elements. From 1995 onwards, the process of urbanization, economic advancement, and alterations in food availability and accessibility have all played a role in the escalating prevalence of obesity throughout the nation. The adoption of Westernized diets that are rich in refined carbohydrates, sugars, and unhealthy fats, combined with a decline in physical activity due to sedentary jobs and dependence on motorized transportation, has greatly contributed to the obesity epidemic [32]. The few factors such as increased consumption of processed and convenience foods, reduced intake of fruits and vegetables, and changes in cultural norms surrounding body image and ideal weight have further exacerbated the problem.

4. THE APPLICATIONS OF NUTRACEUTICAL AGENTS

Nutraceutical agents, which include vitamins, minerals, herbal extracts, and other dietary supplements, have a wide range of applications in promoting health and preventing diseases. They are utilized in various sectors such as pharmaceuticals, food, cosmetics, and agriculture. These agents are known for their antioxidant, anti-inflammatory, immune-modulating, and neuroprotective properties. They play a significant role in managing chronic conditions like cardiovascular diseases, diabetes, obesity, and cancer [33]. Additionally, they support overall well-being by enhancing energy levels, improving cognitive function, and promoting healthy aging. The several conditions in which the nutraceuticals widely used **Fig. 4** as below followings:

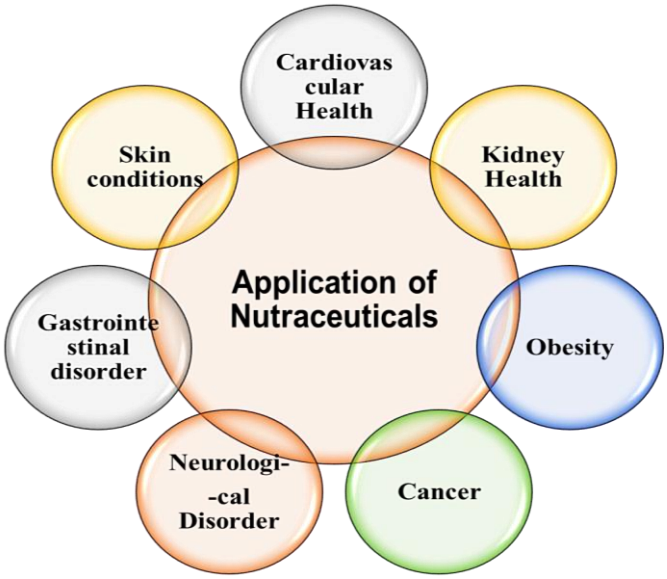

Figure 4: The several applications of nutraceuticals in various disease

Nutraceuticals also have applications in sports nutrition for enhancing performance and aiding in recovery. Their versatility and effectiveness make them valuable additions to healthcare and wellness practices worldwide. The brief discussion about the nutraceutical in disease treatment as below **Table 3** as below description.

4.1. Cardiovascular Diseases: Nutraceutical agents play a significant role in cardiovascular disease management, offering a complementary approach to traditional pharmaceutical interventions. These agents often contain bioactive compounds such as omega-3 fatty acids, antioxidants, plant sterols, and fiber, which have been shown to support heart health by reducing inflammation, lowering cholesterol levels, improving blood pressure, and enhancing overall cardiovascular function. Marketed products such as Omega-3 supplements like Lovaza and Vascepa have demonstrated efficacy in reducing triglyceride levels, while plant sterol-enriched margarines like Benecol and Becel ProActiv have been shown to lower LDL cholesterol levels. Additionally, antioxidant-rich supplements like Coenzyme Q10 (CoQ10) and vitamin E may help improve endothelial function and reduce oxidative stress associated with cardiovascular diseases [34, 35]. By incorporating nutraceutical interventions alongside lifestyle changes and traditional medications, individuals who are at risk of or currently dealing with cardiovascular issues can receive holistic support.

Table 3: The list of several diseases and their treatment with nutraceuticals[33-37]

Diseases	Nutraceutical Example	Proposed Mechanism of Action	Evidence & Limitations
Cardiovascular Disease (CVD)	Omega-3 fatty acids (fish oil), Curcumin and Coenzyme Q10	Reduce inflammation, improve blood lipid profile, decrease blood pressure	Promising results in some studies, but further research needed for definitive conclusions.
Neurodegenerative Diseases	Turmeric (curcumin), Vitamin E, Ginkgo biloba	Reduce inflammation, protect brain cells from damage, may improve cognitive function	Some studies show promise, but more research needed to confirm efficacy and identify effective dosages.
Osteoporosis	Vitamin D, Calcium, Magnesium	Increase bone mineral density, support bone health	Important for bone health generally, but may not be sufficient for treatment alone.
Arthritis	Glucosamine, Chondroitin, Turmeric	Reduce inflammation, protect cartilage, improve joint function	Mixed evidence on effectiveness, may benefit some individuals but not others.
Immune System Function	Vitamin C, Zinc, Elderberry	Boost immune response, fight infections	Can support immune function, but not a substitute for vaccination or other preventive measures.

This table only provides a few examples, and there are many other nutraceuticals with potential health benefits.

4.2. Probiotics in kidney health: Probiotics have gained attention for their potential role in supporting kidney health, particularly in individuals with chronic kidney disease (CKD) or those at risk of kidney stones. Probiotics, comprising beneficial bacteria like Lactobacillus and Bifidobacterium strains, may help modulate gut microbiota composition, reduce uremic toxin production, and mitigate inflammation, thereby exerting protective effects on renal function. Marketed products such as Renadyl™ and Urocit-K® contain specific strains of probiotics aimed at promoting kidney health. Renadyl™ utilizes a patented formulation of probiotics to help metabolize and eliminate nitrogenous waste products, potentially slowing the progression of CKD. Urocit-K®, while primarily used for managing kidney stones, contains citrate, which can alkalinize urine and prevent stone formation, and may also indirectly benefit kidney health by modulating gut microbiota [36]. While further research is needed to elucidate the precise mechanisms and optimal dosages of probiotics for kidney health, these products represent promising adjunctive therapies in the management of renal conditions.

4.3. Obesity: Nutraceuticals like green tea extract, conjugated linoleic acid (CLA), and soluble fibers such as glucomannan have demonstrated potential in supporting weight management by increasing metabolism, promoting satiety, and inhibiting fat absorption. These compounds offer diverse mechanisms for managing weight and promoting metabolic health. For instance, green tea extract, containing catechins and caffeine, has been shown to increase energy expenditure and fat oxidation, aiding in weight loss. Fiber-rich supplements like glucomannan promote satiety and reduce calorie intake by delaying gastric emptying. Additionally, conjugated linoleic acid (CLA) supplements have demonstrated potential in reducing body fat mass and improving body composition. Moreover, natural appetite suppressants such as Garcinia cambogia extract, containing hydroxycitric acid (HCA), may help in controlling food cravings and reducing calorie consumption [37].

4.4. Cancer: Some nutraceuticals possess anti-cancer properties due to their antioxidant and anti-inflammatory effects. Examples include curcumin (from turmeric), resveratrol (found in red grapes), and green tea catechins, which may help in reducing the risk of certain cancers and supporting conventional cancer treatments.

4.5. Neurological Disorders: Nutraceuticals like omega-3 fatty acids, phosphatidylserine, and certain vitamins and minerals have been studied for their neuroprotective effects, potentially aiding in conditions like Alzheimer's disease, Parkinson's disease, and cognitive decline.

4.6. Gastrointestinal Disorders: Probiotics, prebiotics, and certain herbal extracts like peppermint oil and ginger have been used as nutraceuticals to support gut health, alleviate symptoms of irritable bowel syndrome (IBS), and maintain digestive function. The probiotics, which are beneficial bacteria found in certain foods and supplements, can restore the balance of gut microbiota, thereby improving digestion and reducing symptoms of conditions like irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD). Additionally, certain herbal extracts such as peppermint oil and ginger have been shown to alleviate symptoms of gastrointestinal discomfort, including bloating and nausea. Furthermore, dietary supplements like glutamine and deglycyrrhizinated licorice (DGL) can help in protecting the integrity of the gastrointestinal lining and reducing inflammation [36-39].

4.7. Skin Conditions: Nutraceuticals like collagen peptides, antioxidants (e.g., vitamins A, C, E), and certain botanical extracts (e.g., green tea, pomegranate) are utilized to improve skin health, hydration, and elasticity, and may help in managing conditions like acne, aging, and UV damage.

The applications of nutraceuticals in various diseases are vast and promising. These agents, derived from natural sources, offer a complementary approach to traditional medicine in managing and preventing illnesses. Their diverse properties, including antioxidant, anti-inflammatory, and immune-boosting effects, make them valuable in addressing a wide range of health conditions. From cardiovascular diseases to diabetes, obesity, and cancer, nutraceuticals have demonstrated their efficacy in improving outcomes and enhancing quality of life for many patients. Furthermore, their potential to support overall well-being and promote healthy aging underscores their significance in modern healthcare.

5. THE CURRENT STATUS & PROSPECTUS

As of the last update in January 2022, the global nutraceutical industry continues to experience robust growth driven by several factors including increasing consumer awareness of health and wellness, rising disposable incomes, and advancements in research and development. The COVID-19 pandemic further accentuated the importance of preventive healthcare, leading to heightened interest in nutraceuticals that support immune function and overall well-being. There's a growing trend towards personalized nutrition, with consumers seeking tailored solutions to address their specific health needs. Technological innovations such as encapsulation techniques and novel delivery systems are enhancing the efficacy and bioavailability of nutraceutical products. Regulatory frameworks are evolving to ensure product safety and efficacy, with authorities placing greater emphasis on quality control and labelling transparency. The global nutraceutical market remains dynamic and poised for continued expansion as it intersects with broader trends in health, wellness, and sustainability. For the most current information, it's advisable to consult recent market reports and industry analyses [39-41].

The Indian shopper's mindfulness about traditional nutraceutical fixings is seriously restricted and nutraceutical assembling's need to take up the reason and spread mindfulness about their items to the Indian masses. The worldwide nutraceutical market has seen greatest development in last ten years. In India, drinks and useful food are supposed to observe a lot higher development rates when contrasted with dietary enhancement over the course of the following five years [42].

The current status of the nutraceutical industry worldwide reflects a robust and growing market driven by increasing consumer awareness of health and wellness, alongside a shift towards preventive healthcare practices. Countries such as the United States, Japan, China, and several European nations lead in both consumption and production of nutraceuticals. In the United States, the market is fuelled by a combination of factors including a health-conscious population, widespread availability of dietary supplements, and a favourable regulatory environment. Similarly, Japan boasts a rich culture of functional foods and supplements, driven by an aging population seeking products for longevity and vitality. China, with its expanding middle class and rising disposable incomes, presents significant growth opportunities for nutraceutical companies, particularly in urban areas where health trends are evolving rapidly. The future of the nutraceutical industry appears promising, with anticipated growth driven by factors such as technological advancements in product development, expanding distribution channels, and increasing adoption of personalized nutrition solutions [41-43]. With ongoing research into the health benefits of nutraceutical ingredients and formulations, including advancements in areas

such as gut health, cognitive function, and immune support, the industry is poised to continue its upward trajectory, offering novel solutions to global health challenges.

6. REGULATORY ASPECTS

The regulatory environment for nutraceuticals is intricate and varies by region, with key regulatory frameworks established by bodies like the U.S. Food and Drug Administration (FDA), the Dietary Supplement Health and Education Act (DSHEA) in the U.S., and the Food Safety and Standards Authority of India (FSSAI). In the U.S., the FDA is responsible for overseeing nutraceutical regulation, categorizing them as dietary supplements under DSHEA. These regulations mandate that manufacturers ensure product safety and accurate labeling. Unlike pharmaceuticals, dietary supplements do not need FDA approval prior to market release, unless they contain new dietary ingredients not previously sold in the U.S. [42]. The several form number filled under the regulatory aspects on nutraceuticals in the given **Table 4** as below followings:

Table 4: The list of regulatory aspects, form number and regulatory bodies[38-43]

Regulatory Aspect	Form Number	Regulatory Agency
Product Approval	Form 10-1 (Application Form)	Food Safety and Standards Authority of India (FSSAI)
Licensing of Manufacturing Units	Form C	State Food and Drug Administration (FDA)
Product Labeling	Form A	Food Safety and Standards Authority of India (FSSAI)
Import License	Form 8	Central Drugs Standard Control Organization (CDSCO)
Registration of Importers	Form 41	Central Drugs Standard Control Organization (CDSCO)
Import Clearance	Form 9	Central Drugs Standard Control Organization (CDSCO)
Good Manufacturing Practices (GMP)	Not Applicable	State Food and Drug Administration (FDA)
New Product Approval	Form 10-2	Food Safety and Standards Authority of India (FSSAI)
Label Review	Not Applicable	Food Safety and Standards Authority of India (FSSAI)

The DSHEA also prohibits the marketing of supplements making claims to treat or prevent specific diseases without FDA approval. In India, the FSSAI regulates the safety and quality of nutraceuticals, including functional foods and dietary supplements [43]. The FSSAI sets standards for ingredients, labelling, and claims, ensuring that products meet safety and quality requirements before they can be marketed. Compliance with FSSAI regulations is mandatory for manufacturers, importers, and sellers of nutraceuticals in India [42-45].

CONCLUSION

In conclusion, the surge in the consumption of nutraceuticals signifies a fundamental shift towards proactive health management and personalized wellness solutions. As consumers become increasingly knowledgeable about the potential advantages of nutraceuticals in promoting overall health and addressing specific health concerns, the demand for these products continues to rise. This growing consumption highlights a growing recognition of the significance of nutrition, supplementation, and natural remedies in optimizing health outcomes and preventing diseases. The progress in research, formulation technologies, and regulatory frameworks are poised to further propel the growth of the nutraceutical industry, providing innovative solutions tailored to individual needs and preferences. With the global population prioritizing health and well-being, the trajectory of nutraceutical consumption is expected to maintain its upward trend, shaping the future of healthcare towards a more comprehensive and proactive approach.

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All authors made equal contributions to this study. They all conducted a thorough literature search, collected and analyzed the data. Furthermore, all authors have given their approval for the final version of the manuscript to be submitted.

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