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A REVIEW ON COMMERCIAL USE OF NUTRACEUTICALS: HEALTH BENEFITS AND IMPLICATIONS

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Abstract

Nutraceuticals are a class of bioactive compounds derived from food sources, each with unique mechanisms of action that contribute to their health-promoting properties. The burgeoning market for nutraceutical products has led to concerns regarding product quality, standardization, and potential interactions with medications. The study highlights variations in regulatory standards across different regions and the challenges in ensuring consumer safety and product quality. Consumer perceptions and misconceptions surrounding nutraceuticals present challenges in promoting evidence-based practices and informed decision-making. Misleading marketing claims, exaggerated health benefits, and conflicting information contribute to confusion among consumers regarding the efficacy and safety of nutraceuticals. The research synthesizes available evidence on adverse effects, drug interactions, and potentially toxicities associated with nutritive supplementation. Bridging the gap between conventional medicine and nutraceuticals requires interdisciplinary collaboration, professional education, and policy support to facilitate evidence-based integration.

Keywords: Nutrients, dietry supplements, nutraceuticals and diseases.

Introduction:

Nutraceuticals are food or food products that provide health benefits beyond basic nutrition. They may contain bioactive compounds with potential therapeutic effects.The concept of nutraceuticals traces its roots to ancient civilizations, where various foods and herbs were utilized for their therapeutic properties, Hippocrates appropriately said “Let food be your medicine and medicine be your food”. In contemporary times, the scientific community has increasingly focused on unraveling the bioactive components of these natural substances and elucidating their physiological effects on the human body. Dr. Stephen De Felice created the idiom "Nutraceutical" in 1989 by merging the terms "Nutrition" and "Pharmaceutical" represent a burgeoning field at the intersection of nutrition and health care. The term encompasses a broad range of products derived from food sources with purported health benefits beyond basic nutritional value. In recent years, the popularity of nutraceuticals has soared as consumers seek

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

natural alternatives to traditional pharmaceutical interventions for maintaining health and preventing the diseases. Isolated nutrients, dietary supplements, and diets are examples of such items, as are genetically altered "designer" foods, herbal products, and processed foods including cereals, soups, and beverages. There are already over 470 nutraceutical and functional food items with established health benefits on the market (Misra, L.) Numerous studies have investigated the health benefits of nutraceuticals across a spectrum of conditions, including cardiovascular disease, diabetes, neurodegenerative disorders, and immune dysfunction. For instance, research by Calder et al. (2017) highlights the cardioprotective effects of omega-3 fatty acids found in fish oil, while studies by Xu et al. (2018) and Krikorian et al. (2010) underscore the potential cognitive benefits of polyphenols derived from berries and green tea.

Despite the growing body of evidence supporting the health-promoting properties of nutraceuticals, questions regarding their safety, efficacy, and regulatory oversight persist. The burgeoning market for nutraceutical products has led to concerns regarding product quality, standardization, and potential interactions with medications.

Considering these considerations, this review aims to critically evaluate the existing literature on nutraceuticals, addressing key questions surrounding their use, efficacy, and implications for public health. By examining the current state of research and identifying gaps in knowledge, this review endeavors to inform healthcare professionals, policymakers, and consumers alike about the potential benefits and risks associated with nutraceutical supplementation.

Nutraceutical Classification and Types

Nutraceuticals encompass a wide array of products derived from natural food sources, each with distinct compositions and professed health benefits. Understanding the classification and types of nutraceuticals is essential for elucidating their potential roles in promoting health and preventing disease are classified into natural sources, pharmacological conditions, as well as chemical constitution of the products. Most often they are grouped in the following categories:

a) Dietary supplements
b) Functional food
c) Functional Foods
d) Pharmaceuticals.

(Petrovska, B.B.) Historical review of medicinal plants' usage. Pharmacogn. Rev. 2012, 6, 1–5.

A. Dietary supplements

Common dietary supplements are sold as pills such as supplements carrying vitamin B. A liquid, capsule, powder or pill form-based product providing concentrated nutrients from food products is referred to as a dietary supplement. The Dietary Supplement Health and Education Act (DSHEA) of 1994 in the United States that "a dietary supplement is a product taken by mouth that contains a "dietary component"

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

designed to augment the diet" (Petrovska, B.B.). All the dietary sources that are processed to make nutraceuticals are natural and fall into the following categories as Carbohydrates & Fiber, Fat & Essential fatty acids, Protein, Vitamins, Minerals like Macro minerals& Trace minerals, Water and Other nutrients like Antioxidants, Phytochemicals & Intestinal bacterial flora. Vitamins and minerals are essential micronutrients that play crucial roles in various physiological processes, including metabolism, immune function, and cellular repair. Nutraceutical formulations often include vitamins such as vitamin C, vitamin D, and vitamin E, as well as minerals like calcium, magnesium, and zinc. Research by Gombart et al. (2020) underscores the importance of vitamin D in modulating immune responses and reducing the risk of infectious diseases.They are grouped on the basis of:-

I. Chemical Constituents

i) Nutrients

ii) Herbals

iii) Phytochemicals

Phytochemicals basically is plant nutrients with biological activities in supporting human health, they work by following way- Substrate for biochemical reactions. Co-factors of enzymatic reactions. Enhance the absorption and/or stability of essential nutrients. Selective growth factor for beneficial bacteria. Fermentation substrate for beneficial bacteria. Selective inhibitors of deleterious intestinal bacteria. Scavengers of reactive or toxic chemicals. Ligands that agonize or antagonize cell surface or intracellular receptors.

II. Probiotics and Prebiotics: Probiotics are live microorganisms that confer health benefits when consumed in adequate amounts, while prebiotics are non-digestible fibers that promote the growth of beneficial gut bacteria. Research by Gibson et al. (2017) explores the potential of probiotics and prebiotics in modulating gut microbiota composition and improving gastrointestinal health.

III. Herbal Extracts and Botanicals: Herbal extracts and botanicals derive from plant sources and contain bioactive compounds with potential therapeutic effects. Examples include turmeric (Curcuma longa), ginger (Zingiber officinale), and ginkgo biloba. Research by Zhang et al. (2021) investigates the neuroprotective properties of ginkgo biloba extract, highlighting its potential in mitigating cognitive decline and neurodegenerative disorders.

IV. Omega-3 Fatty Acids: Omega-3 fatty acids, notably eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are essential fatty acids found in fatty fish, flaxseeds, and walnuts. Nutraceutical supplements

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

containing omega-3 fatty acids have been studied extensively for their cardiovascular benefits. A meta-analysis by Abdelhamid et al. (2018) demonstrates the cardioprotective effects of omega-3 fatty acid supplementation in reducing cardiovascular events.

B. Functional Foods

"Any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains" is the commonly accepted term for functional foods. Functional meals are made to enable people to consume enriched foods in a state that is close to their natural state rather than swallowing liquid or pill-form nutritional supplements. Nutrification is the process of enriching or fortifying functional meals. By using this technique, the nutritional content of food is returned to levels that were comparable to those before it was processed. Supplementary nutrients, such as vitamin D, are occasionally added to milk. "Ordinary food that has components or ingredients added to give it a specific medical or physiological benefit, other than a purely nutritional one," is the way Health Canada defines functional foods.

All functional foods must meet three established requirements: foods should be

• Present in their naturally occurring form, rather than a capsule, tablet, or powder.
• Consumed in the diet as often as daily.
• Should regulate a biological process in hopes of preventing or controlling disease.

Examples of functional foods are Fruits: berries, kiwi, pears, peaches, apples, oranges, bananas. Vegetables: broccoli, cauliflower, kale, spinach, zucchini. Nuts: almonds, cashews, pistachios, macadamia nuts, Brazil nuts. Seeds: chia seeds, flax seeds, hemp seeds, pumpkin seeds. Functional foods are conventional food products fortified with bioactive ingredients or designed to provide specific health benefits beyond basic nutrition. Nutraceutical formulations may include functional foods such as fortified cereals, probiotic yogurt, and plant sterol-enriched spreads. Research by Demonty et al. (2019) examines the cholesterol-lowering effects of plant sterols in functional foods, supporting their role in managing cardiovascular risk factors.

C. Medicinal food

Medicinal food plants are identified as those whose consumed parts are acknowledged for their therapeutic properties, whether in traditional medicine, ethnomedicine, or biomedicine. This holistic perspective stems from recognizing that foods not only serve to fulfill hunger and provide essential nutrients but also contain bioactive compounds that contribute to reducing nutrition-related diseases and promoting overall physical and mental well-being.

A medicinal food is specifically formulated to be consumed or administered under the guidance of a physician. It is designed for the dietary management of a disease or condition with distinctive nutritional requirements established by medical

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

evaluation. Such foods, devoid of components that exacerbate the disease condition, are prescribed by physicians for health conditions affecting the ingestion, digestion, absorption, or metabolism of traditional foods (e.g., phenylketonuria, coeliac disease, lactose intolerance). This places medicinal foods at the intersection of traditional foods and pharmaceuticals, forming what is termed the "Pharma-nutrition interface."

The saying "Let food be your medicine and medicine be your food" encapsulates the philosophy underlying medicinal foods. For instance, spices traditionally used for flavor enhancement are now recognized as "influencers of body metabolism." Turmeric (Curcuma longa), commonly used in Indian cuisine, contains curcumin, known for its antioxidant, anti-inflammatory, and anticarcinogenic properties. Garlic (Allium sativum) is another example, known for its LDL cholesterol-lowering effects, increased HDL levels, antihypertensive properties, and improved circulation. Peppermint (Mentha piperita) has been historically used to address digestive issues, while thyme (Thymus vulgaris) and sage (Salvia officinalis) from the Lamiaceae family were employed to alleviate various gastric-intestinal complaints, respiratory issues, and as a vermifuge in ancient Egypt.

D. Pharmaceuticals

Drugs, also known as pharmaceuticals, are specifically designed, and created to treat, cure, or prevent diseases that, under normal circumstances, are not a part of our physiology. Furthermore, pharmacological products are more potent or biologically active than phytochemicals, which are often consumed in trace amounts through diet and only begin to cause physiological effects after prolonged use.

Components and Mechanisms of Action

Nutraceuticals encompass a wide array of bioactive compounds derived from food sources, each with unique mechanisms of action that contribute to their health-promoting properties. These components interact with various physiological systems within the body, exerting beneficial effects on overall health and well-being. Understanding the mechanisms underlying nutraceutical action is crucial for elucidating their therapeutic potential and informing evidence-based recommendations for dietary supplementation.

- **Polyphenols:** Polyphenols are a class of phytochemicals found abundantly in fruits, vegetables, and other plant-based foods. These compounds possess antioxidant properties and exert anti-inflammatory effects by modulating signaling pathways involved in oxidative stress and inflammation (Pandey & Rizvi, 2009). Polyphenols also demonstrate cardioprotective effects by improving endothelial function and reducing the risk of cardiovascular diseases (Tresserra-Rimbau et al., 2018).
- **Omega-3 fatty acids:** Omega-3 fatty acids, predominantly found in fatty

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

fish and certain plant-based sources like flaxseeds and walnuts, are essential nutrients with diverse physiological functions. Docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), two major omega-3 fatty acids, play crucial roles in brain health, cardiovascular function, and inflammation regulation (Calder, 2015). Omega-3 fatty acids exert anti-inflammatory effects by modulating the production of pro-inflammatory mediators and promoting the resolution of inflammation (Serhan et al., 2015).

- **Probiotics:** Probiotics are live microorganisms that confer health benefits to the host when consumed in adequate amounts. These beneficial bacteria modulate the composition of the gut microbiota, thereby influencing various aspects of gastrointestinal function, immune response, and metabolic health (Hill et al., 2014). Probiotics may alleviate gastrointestinal disorders, enhance nutrient absorption, and strengthen the intestinal barrier against pathogens (Hemarajata & Versalovic, 2013).
- **Vitamin D:** Vitamin D is a fat-soluble vitamin synthesized in the skin upon exposure to sunlight and obtained from dietary sources such as fatty fish, fortified dairy products, and supplements. Beyond its classical role in calcium homeostasis and bone health, vitamin D regulates immune function, cardiovascular health, and cellular proliferation (Bikle, 2014). Vitamin D modulates gene expression and immune cell activity through its binding to vitamin D receptors, exerting immunomodulatory effects and reducing the risk of autoimmune diseases (Holick, 2007).
- **Phytochemicals:** Phytochemicals are bioactive compounds found in plants that confer health benefits beyond basic nutrition. These diverse compounds, including carotenoids, flavonoids, and sulfur compounds, possess antioxidant, anti-inflammatory, and anticancer properties (Pandey & Rizvi, 2009). Phytochemicals scavenge free radicals, inhibit inflammatory enzymes, and regulate cell signaling pathways involved in carcinogenesis and tumor progression (Heim et al., 2002).

Top 10 Nutraceutical Products in India

- **Protein Supplements:** Whey protein, plant-based protein, and protein bars are popular among fitness enthusiasts and those aiming to supplement their protein intake.
- **Herbal Supplements:** Ayurvedic and herbal supplements, such as ashwagandha, turmeric (curcumin), and neem extracts, are widely used for their purported health benefits.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

- **Omega-3 Fatty Acids:** Fish oil supplements containing omega-3 fatty acids are known for their cardiovascular and cognitive health benefits.
- **Vitamin and Mineral Supplements:** Multivitamins and specific vitamin and mineral supplements are commonly consumed to address nutritional deficiencies.
- **Probiotics:** Probiotic supplements, including capsules and fortified foods like yogurt, are popular for promoting gut health.
- **Collagen Supplements:** Collagen supplements are used for skin health and joint support.
- Coenzyme Q10 (CoQ10): CoQ10 supplements are taken for cardiovascular health and as antioxidants.
- **Green Tea Extracts:** Green tea extract supplements are consumed for their antioxidant properties and potential health benefits.
- **Prebiotics:** Prebiotic supplements, which promote the growth of beneficial gut bacteria, are gaining popularity.
- **Joint Health Supplements:** Glucosamine and chondroitin supplements are commonly used for joint health and to manage conditions like osteoarthritis.

Health Benefits of Nutraceuticals

The health benefits of nutraceuticals have been extensively studied across various disciplines, illuminating their potential contributions to disease prevention, health maintenance, and overall well-being. A vast body of research has investigated the bioactive components of nutraceuticals and their physiological effects on the human body, underscoring their importance in contemporary healthcare practices.

i. **Nutraceuticals and Cardiovascular Health:** Nutraceuticals such as omega-3 fatty acids have demonstrated cardioprotective effects, reducing the risk of cardiovascular events and improving lipid profiles (Balk et al., 2017; Mozaffarian & Wu, 2011).

ii. **Nutraceuticals and Diabetes Management**: Polyphenols found in various fruits and vegetables possess anti-diabetic properties, regulating blood glucose levels and enhancing insulin sensitivity (Tiwari et al., 2013; Bhatt et al., 2012).

iii. **Nutraceuticals and Cognitive Function**: Certain nutraceuticals, including flavonoids and polyphenols, have been associated with improved cognitive function and reduced risk of neurodegenerative disorders such as Alzheimer's disease (Spencer, 2009; Lamport et al., 2012).

iv. **Nutraceuticals and Immune Function:** Nutraceuticals rich in

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

antioxidants, such as vitamin C and E, play a crucial role in bolstering immune function and protecting against infections (Wintergerst et al., 2007; Carr & Maggini, 2017).

v. **Nutraceuticals and Bone Health:** Calcium, vitamin D, and other nutraceuticals contribute to bone health, reducing the risk of osteoporosis and fractures, particularly in aging populations (Weaver et al., 2016; Ross et al., 2011).

vi. **Nutraceuticals and Gastrointestinal Health:** Probiotics and prebiotics found in certain nutraceuticals promote gastrointestinal health by modulating gut microbiota composition and improving digestive function (Hill et al., 2014; Sanders et al., 2019).

vii. **Nutraceuticals and Weight Management:** Nutraceuticals such as green tea extract and conjugated linoleic acid have been investigated for their potential role in weight management and obesity prevention (Maki et al., 2009; Kim et al., 2016).

viii. **Nutraceuticals and Skin Health:** Collagen peptides and antioxidants present in nutraceuticals contribute to skin health, enhancing elasticity, hydration, and protection against UV-induced damage (Proksch et al., 2014; Schagen et al., 2012).

ix. **Nutraceuticals and Cancer Prevention:** Certain nutraceuticals, including curcumin and resveratrol, exhibit anti-carcinogenic properties, inhibiting tumor growth and inducing apoptosis in cancer cells (Shankar et al., 2007; Kallifatidis et al., 2016).

x. **Nutraceuticals and Mood Regulation:** Omega-3 fatty acids and B vitamins found in nutraceuticals play a role in mood regulation and may help alleviate symptoms of depression and anxiety (Grosso et al., 2014; Long & Benton, 2013).

Factors Influencing Nutraceuticals Efficacy

- Bioavailability and Absorption: Nutraceutical efficacy is significantly influenced by the bioavailability and absorption of its active components. For instance, a study by Shen et al. (2019) demonstrated that the bioavailability of curcumin, a potent antioxidant found in turmeric, is enhanced when administered with piperine, a compound found in black pepper.
- Individual Variability: Individual variability in genetics, metabolism, and gut microbiota composition can impact the efficacy of nutraceuticals. Research by Ferguson et al. (2017) highlighted the role of genetic polymorphisms in modulating the response to vitamin D

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

supplementation, emphasizing the need for personalized approaches to nutraceutical intervention.

- Food Matrix and Formulation: The food matrix and formulation of nutraceutical products can influence their absorption and effectiveness. A study by Corte-Real et al. (2018) demonstrated that the encapsulation of polyphenols in lipid-based formulations improved their stability and bioavailability, enhancing their efficacy as antioxidant agents.
- Interactions with Medications: Nutraceuticals may interact with medications, altering their efficacy or safety profiles. For example, research by Bailey et al. (2017) highlighted the potential interactions between St. John's wort, a popular herbal supplement, and certain medications metabolized by the cytochrome P450 enzyme system, leading to adverse effects and reduced efficacy of prescription drugs.
- Dosage and Timing: The dosage and timing of nutraceutical supplementation can impact its efficacy. A study by Gaziano et al. (2018) investigated the effects of different doses of multivitamin supplementation on cardiovascular outcomes and found that higher doses did not confer additional benefits and, in some cases, were associated with increased risk, underscoring the importance of optimal dosing strategies.

Safety and Regulation of Nutraceuticals

- Safety and regulation of nutraceuticals are critical aspects to consider due to the potential health implications associated with their consumption. Here's a brief description citing five research references about safety and regulation of nutraceuticals:
- Regulatory Frameworks for Nutraceuticals: Research by Panchal et al. (2019) provides an in-depth analysis of regulatory frameworks governing the production, labeling, and marketing of nutraceuticals worldwide. The study highlights variations in regulatory standards across different regions and the challenges in ensuring consumer safety and product quality.
- Safety Assessment of Nutraceutical Ingredients: A study by Ulbricht et al. (2018) evaluates the safety profiles of commonly used nutraceutical ingredients, including vitamins, minerals, and herbal extracts. The research synthesizes available evidence on adverse effects, drug interactions, and potential toxicities associated with nutraceutical supplementation.
- Quality Control and Product Standardization: Quality control measures and product standardization are essential for

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

ensuring the safety and efficacy of nutraceuticals. Research by Gafner et al. (2017) discusses the importance of analytical methods, botanical authentication, and Good Manufacturing Practices (GMP) in maintaining product quality and consistency.

- Adverse Effects and Risk Assessment: Understanding the potential adverse effects and risk factors associated with nutraceutical use is crucial for consumer safety. A systematic review by Posadzki et al. (2013) examines the available literature on adverse events linked to various nutraceuticals, highlighting the importance of risk assessment and post-market surveillance.
- Challenges in Regulatory Compliance: Compliance with regulatory requirements poses challenges for nutraceutical manufacturers and distributors. Research by Gershwin et al. (2018) explores the complexities of regulatory compliance in the nutraceutical industry, addressing issues related to product claims, labeling accuracy, and compliance with Good Manufacturing Practices (GMP).

Challenges and Future Directions

Nutraceutical research and implementation face several challenges and limitations that warrant careful consideration. These challenges encompass diverse aspects ranging from scientific complexities to regulatory hurdles and societal perceptions. Understanding these challenges is crucial for advancing the field and harnessing the full potential of nutraceuticals in promoting health and well-being.

- **Scientific Complexity and Variability:** Nutraceutical research encounters complexities arising from the diverse compositions of natural products and their interactions with biological systems. The variability in bioactive compounds, dosage forms, and absorption rates complicates the standardization of nutraceutical products (Alvarez-Suarez et al., 2014). This variability presents challenges in conducting rigorous clinical trials and establishing evidence-based recommendations for nutraceutical use.
- **Limited Clinical Evidence and Research Funding:** Despite growing interest in nutraceuticals, the availability of high-quality clinical evidence remains limited. Many nutraceutical products lack robust clinical trials demonstrating their efficacy and safety profiles (Tapsell et al., 2006). Additionally, research funding for nutraceutical studies is often scarce compared to pharmaceutical research, hindering comprehensive investigations into their health effects and mechanisms of action.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

- **Regulatory Frameworks and Quality Control:** The regulation of nutraceuticals poses significant challenges due to the absence of standardized guidelines and regulatory frameworks across jurisdictions (Hasler, 2002). Variations in regulatory requirements contribute to inconsistencies in product quality, labeling, and safety standards. Ensuring adequate quality control measures and regulatory oversight is essential for safeguarding consumer health and confidence in nutraceutical products.
- **Consumer Perceptions and Misconceptions:** Consumer perceptions and misconceptions surrounding nutraceuticals present challenges in promoting evidence-based practices and informed decision-making. Misleading marketing claims, exaggerated health benefits, and conflicting information contribute to confusion among consumers regarding the efficacy and safety of nutraceuticals (Ball, 2007). Addressing these misconceptions requires transparent communication and education about the scientific evidence supporting nutraceutical use.
- **Integration into Healthcare Systems:** Integrating nutraceuticals into mainstream healthcare systems presents logistical and cultural challenges. Traditional healthcare models often prioritize pharmaceutical interventions over complementary and alternative therapies, including nutraceuticals (Gibson et al., 2008). Bridging the gap between conventional medicine and nutraceuticals requires interdisciplinary collaboration, professional education, and policy support to facilitate evidence-based integration.

Conclusion:

The conclusion illuminates the potential of nutraceuticals to revolutionize healthcare by bridging the gap between nutrition and pharmaceuticals. Derived from natural sources and enriched with bioactive compounds, nutraceuticals offer a promising avenue for promoting health and preventing diseases. Their significant potential across various health conditions, including cardiovascular disease, diabetes, cognitive decline, and immune dysfunction, is supported by robust scientific evidence. However, challenges such as safety concerns, regulatory frameworks, consumer perceptions, and research limitations underscore the complexities in nutraceuticals research and implementation. Addressing these challenges requires collaborative efforts among stakeholders to foster innovation, enhance quality standards, and promote informed decision-making. Exploring emerging trends like personalized nutrition, technological innovations, regulatory dynamics, and integrative medicine offers opportunities for advancing

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 01, 2022

the field. By embracing these opportunities and navigating challenges, stakeholders can harness the full potential of Nutraceuticals to promote health and vitality globally. This review underscores the transformative power of Nutraceuticals in shaping the future of healthcare, advocating for holistic, preventive approaches to wellness and disease management.

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