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Nutraceuticals and its Impact on Health

[1]Saksham Gupta, [2]Shailesh Vishwakarma, [3]Deepak Tiwari, [4]Srashty, [5] Dr. Abhishek Pandey, [6] Dr. Sunisha Kulkarni, [7] Rajendra Chauhan, [8]Dr. Suman Jain

[1,2,3,4] B. Pharm Student, Jiwaji University Gwalior

[5,6,7] Counsellor and Guider, Jiwaji University Gwalior

[8] HOD S.O.S. in Pharmaceutical Science Jiwaji University Gwalior)

ABSTRACT

In the current scenario people are deeply concerned about their health because of lifestyles have changed drastically due to increase in working hours and various psychological pressures, which have led to an increased incidence of various life- threatening diseases. In addition to this they are frustrated with the expensive, high-tech, disease-treatment and management approach. The demand for nutraceuticals and phytonutrients has increased over the past few years and they are being used by people for various therapeutic outcomes. The nutraceutical products are recognized not only for their health benefits to reduce the risk of cancer, heart diseases and other related ailments, but also to prevent or treat hypertension, high cholesterol, excessive diabetes, degeneration, cataracts, menopausal symptoms, insomnia, diminished memory and concentration, digestive upsets Nutraceuticals weight, osteoporosis, arthritis, macular and constipation. have also found considerable trust in treating headaches and migraines resulting from stress. Other related nutraceutical products are touted as cures for thinning hair, lack of confidence, poor complexion, varicose veins, alcoholism, depression, and lethargy. In this chapter we made an attempt to classify all types of nutraceuticals with examples followed by their applications in Furthermore, the implementation of the designing and development of dosage forms for offering better delivery carrier of the nutraceuticals, the importance and challenges have also been enumerated.

Keywords: Lifestyles; Life-threatening diseases; Disease- treatment; Nutraceuticals; Health benefits; Therapeutic outcomes.

INTRODUCTION:

Nutraceuticals have been defined as the phytocomplex if they derive from a food of vegetal origin, and as the pool of the secondary metabolites if they derive from a food of animal origin, concentrated and administered in the more suitable pharmaceutical form [1]. As an example, the recent European Regulation EU 2015/2283 on novel foodstill does not recognize the term nutraceutical, and include them in the category of the food supplements [2] It should be remarked that while nutraceutical beneficial effect on a health condition must be supported by clinical studies to assess that they capable of providing beneficial health effects, including the prevention and/or the treatment of a disease, the same consideration is not a must for food supplements. Food supplements should be, as per their micro-nutrients content, addressed to improve health if appropriately targeted to those in need but cannot be considered nutraceuticals since there is lack of clinical tests substantiating their efficacy [3].

Nutraceuticals is derived from the amalgamation of terms nutrition and pharmaceutical and was coined by Stephen De Felice in 1989. He defined nutraceutical as, "a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease" [1]. However the terminology is not very popular globally and mostly substituted by the term "dietary supplements" to meet the stringent regulatory requirements. But microscopically cross-sectioning of both the terms reveals some basic differences like nutraceuticals should always aid in disease prevention or treatment rather than only supplementing the diet.

US FDA do not support term nutraceutical and is generally referred as a food derived product which add some extra value to the basic nutritional component present in that specific food. Another term which is often used as a misnomer for nutraceuticals is "functional foods". It can defined as any food which is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used [2] Nutraceuticals include a huge product bouquet ranging from isolated nutrients, plant products, diet supplements, processed cereals/ drinks to genetically modified products [3]. Apart from life-style disorders nutraceuticals are used in diverse array of clinical conditions like inflammation, immuno-deficiency, allergy, arthritis, malignancies, indigestion, depression, sleep dysfuctions, hypertension and blood cholesterol control [4].

Mostly nutraceuticals are associated with more than clinically beneficent effects and this makes them more attractive to consumers. A drug traverses a series of clinical trials involving expenditurein both time and money before reaching the market but nutraceuticals are exempted from such regulatory issues. Thus it is a major attraction for many manufacturers even though they cannot assert that their product can cure/prevent a disease. Besides it is a common belief across the world that all natural products are efficacious and devoid of side effects. This built-in mindset also contributes to great extent to the expanding global market for nutraceuticals which is expected to touch USD

722.49 billion by 2027 with a CAGR of over 8% .Market for nutraceuticals has witnessed significant transformations in recent times with advent of newer technologies like nanotechnology as well as development of advanced procedures/ instruments which favour both quantitative and qualitative analysis. Although most nutraceuticals supply vital nutrients to the body, many details such as dose, drug-drug interaction, nutraceutical-drug interaction, and their effects on individuals under certain clinical conditions remain indescribable. Besides many patients do not reveal that they are consuming nutraceuticals while in drug therapy so this enhances chances of nutraceutical-drug interactions which may significantly affect their treatment. Biotechnologists are putting lots of effort to engineer plants and crops in order to improve their nutritional value in order to maintain homeostasis. Products marketed as functional foods/ dietary supplements/ nutraceuticals may exhibit highly variability in quality and needs to pass through stringent analysis to ensure proper standards. The present work gives an overview of the history, classification, chemistry, regulations of nutraceuticals and also provides an insight to their role in drug delivery and therapy.

The difference between nutraceuticals and functional food is that the first is made up of bioactive elements derived from natural sources and obtained from various food grids, whereas the latter is defined as any new or processed food that has a healthy impact and prevents diseases in additionto having a healthy capacity (Chávarri, 2020). Therefore, the objectives of this review are to assess key facts concerning nutraceuticals, their classification, and their possible potential roles in the prevention and treatment of human diseases.

Nutraceuticals are natural medically beneficial foods or bioactive phytochemicals that are health- promoting, illnessdefeating, rehabilitative, functional foods and beverages that contain specific components (vitamins, lipids, proteins, carbohydrates, minerals, etc.) that have healthful profits (Sharma et al., 2016). In 1989, the term "nutraceutical" was coined by combining the words "nutrition/nutrients" a nourishing dietary component and "pharmaceutical" a medicine or a chemical used as a drug and implying use for illness prevention and/or therapy (Pastor et al., 2021)

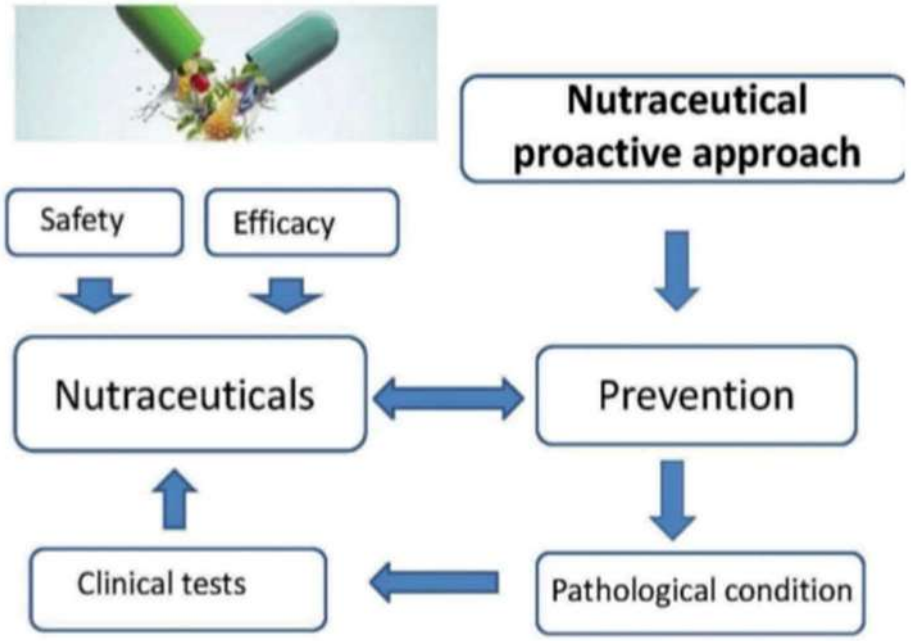

Figure 1 : Nutraceutical Practice Approach

HISTORICAL BACKGROUND:

Father OF Nutraceuticals Dr Stephen de Felice {in 1989} Hippocrates (460–377 BC), the father of modern medicine paved the foundation stone for modern day nutraceuticals through his epic statement “Let food be thy medicine and medicine be thy food”. He was the pioneer to bring forward the concept that specific food can also be the solution for the prevention/ treatment of a disease apart from drug moieties.

Roman Physician Galen enforced trust in the expertise and knowledge base of his profession to design and formulate diet regimen which would maintain health standards of the entire population. Early nineteenth century marked the initiation of nutrition research by François Magendie. His research based on experimental evidences provoked the question that whether foods devoid of nitrogen do provide nutrition [5]. This modulated scientific minds to think beyond proteins, carbohydrates, fats, and minerals to achieve proper nutrition. This hypothesis was supported by experiments on mice by Nicolai Lunin which produced interesting results. He proved that certain component present in milk was essential for nutrition of mice which cannot be classified as proteins, carbohydrates, fats, and minerals [6,7]. This fact and similar research findings by several researchers ultimately led to the discovery of the vital nutrient vitamin.

From the birth of human race we are depended on offerings of Mother Nature to manage our physiological dysfunctions. One such finding presents the botanicals obtained from plants like Vinca Rosea and Taxus brevifolia which are used in cancer management till date. Ginseng has been another such traditional drug used as chemotherapeutic even today but its history as herbal medicine in China is beyond 2000 years.

Ayurveda, the bible of Indian healthcare science also provides substantial evidence of food being used for prevention/ treatment of disease [8]. Egyptians valued the medicinal importance of different spices like coriander, fennel, cumin, garlic, turmeric etc. and even considered equivalent to precious metals like gold. Honey is a popular natural antioxidant with multiple pharmacological effects like wound healing, antibacterial, anti-inflammatory, antifungal, antiviral, and antidiabetic but its reference can be traced back to Bible (Old Testament, proverb 24:13). People learned from their experiences and slowly clinical problems were provided with scientific explanations. On many occasions dietary alterations became the remedy instead of medicines. Ship crew reported high mortality due to scurvy and this problem was solved by vitamin C rich diet. Similar findings were also observed with goitre affected patients where iodine rich salt did the trick. In a nutshell it can concluded that with the passage of time as scientific knowledge developed, food habits were intelligently modulated for prevention/treatment of disease and this may spark which produced the modern.

BIOTECHNOLOGY AND NUTRACEUTICALS

The most ancient form of biotechnology is fermentation, which involves use of microorganisms such as yeasts for the production of wine, vinegar, and bread. Dairy products such as yogurt and cheese were produced by lactic acid bacteria and molds. Although these techniques are still used, the cultures that were used in ancient times have been modified to provide high-quality products with increased yield.

Modern food or nutraceutical biotechnology has evolved into a billion-dollar industry, with the promise of producing foods that provide functions beyond the basic nutrients they contain. These functional foods or nutraceuticals have become increasingly important to consumers who are interested in the health benefits of functional foods for prevention of illness and chronic conditions.

Recent development of nanotechnology and its limited application has revolutionized the entire chain of food and nutrition, particularly in the field of delivery and packaging systems.

The reported benefits of the new biotechnologies span from reducing environmental damage to improvements in animal welfare, farm productivity, product quality, and human health but there seems to be hesitancy in adoption of such technologies by farmers and food companies.

Biofortification of staple crops through modern biotechnology can potentially help in alleviating malnutrition in developing countries. Several genetically modified crops, including rice, potatoes, oil seeds, and cassava, with elevated levels of essential nutrients; reduced levels of anti- nutritional factors; and increased levels of factors that influence bioavailability and utilization of essential nutrients are advancing through field trial stage and regulatory processes towards commercialization. The successful introduction of the biofortified crops would have a significant impact in reducing malnutrition and the risk of chronic disease in developing countries. Biotechnology and genetic engineering have aided in the development of recombinant nutraceuticals, which are used in the making of resource foods (yogurt and cheese, or the extraction of bioactive components) using enzymatic or fermentation technologies (Srivastava, 2018).

Modern biotechnology, also known as nutraceutical biotechnology, has the promise of generating foods that perform tasks other than those provided by the essential nutrients they contain. Consumers interested in the health advantages of functional foods for the prevention of illness and chronic conditions have been more interested in these functional foods, also known as nutraceuticals (Ghosh, 2012).

Biotechnology is used in the manufacture of desired food components. These include traditional fermented foods, as well as providing vitamins, polysaccharides, pigments, glycolipids, enzymes, and improving the safety and functionality of a range of common foodstuffs (Maryam etal., 2017).

Traditional genetic development ("traditional biotechnology") techniques such as classical mutagenesis and conjugation, as well as biotechnological processes, are vital for the improvement of microbial cultures used in food processing (Sundarraj et al., 2018). Grading biological responses is a barrier in the manufacture of nutraceuticals and the development of biotechnology and/or genetically modified microorganisms, both of which may need to be addressed (Asif and Mohd, 2019).

Increased Demand for Nutraceuticals:

Modern day work profile has led to the development of a new set of diseases popularly termed as life–style disorders. The common causative agents of these types of disorders are improper diet and dependence on fast foods, lack of physical inactivity, non-alignment with biological clock, incorrect body posture, excessive stress and inadequate rest.

Nutraceuticals represent a unique blend of modern science and natural agents and perhaps the best possible solutions for management of life style diseases. Besides these lifestyle disorders are also considered responsible for the predisposition of several complex clinical conditions [17].

Diverse marketed nutraceuticals variants can also help to block the transformation of life style disorders into fatal diseases. Consumer acceptance of nutraceuticals started gaining from 1980 onwards when scientists started indulging into efficacy evaluations of such products followed by their representation in mass media . Other factors like steep rise in medical management costs, increased life expectancy, increased health awareness and available scientific data confirming health benefits of nutraceuticals have also contributed to consumer acceptance of such products.

Global nutraceutical market which was approximately 400 billion USD in 2019 is expected to cross 700 billion USD with a CAGR of 8.3% by 2027. Fast expansions of nutraceuticals product bouquet along with a healthy pipeline of innovative products booming the market are all contributors to the predicted growth. The entry of generic products may cause a dip in nutraceutical product costs but because of high consumer acceptance, the overall market for such products is expected to remain stable [18].

CLASSIFICATION OF NUTRACEUTICALS ;

Classification based on food sources

Nutraceuticals are classified as traditional/conventional or no traditional nutraceuticals based on natural food sources (Ruchi, 2017). [19]

Traditional nutraceuticals:

To protect themselves. Phytochemicals obtained from plants are used in the diet and give health advantages such as Substrate for biochemical reactions, enzymatic reaction cofactors, enzyme Traditional nutraceuticals are manufactured food that has not been altered in any way, and its components are all natural and have the potential to provide health advantages (Srivastava, 2018). Several natural ingredients, such as lycopene in tomatoes, omega-3 fatty acids in salmon, and saponins in soy, are found in a variety of fruits, vegetables, grains, fish, dairy, and meat diets. Tomatoes and salmon are two foods that researchers have shown to provide health advantages beyond basic nutrition (lycopene and omega-3 fatty acids, correspondingly)

These classes are usually derived completely from nature, with no modifications to the original form. Various elements, such as lycopene found in tomatoes, omega-3 fatty acids found in salmon, and saponins found in soy, are available and ingested for a variety of health benefits (Chanda et al., 2019) [20].

Chemical components, probiotic microbes, and nutraceutical enzymes are all examples of classic nutraceuticals.

Chemical constituents include the following classifications:

Nutrients: Strokes, cataracts, osteoporosis, diabetes, heart disease, and cancer can all be treated with nutrients. Minerals derived from plant, animal, and dairy diets are beneficial in the treatment of osteoporosis and anemia. Omega 3-PUFAs, found in flaxseed and salmon, are potent regulators of the inflammatory process, brain function preservation, and cholesterol accumulation reduction.

Herbals: Herbs, often known as botanical foods, are as old as human civilization and provide a wealth of remedies to treat both acute and chronic illnesses. Several nutraceuticals are found in medicinal herbs of important components, providing a whole storage facility of medicine to treat severe and persistent ailments (Khan et al., 2016; Prabu et al., 2012) [21]. Some examples are: Parsley (Petroselinum cripsum) is a diuretic, carminative, and antipyretic herb that includes flavonoids (apiol and psoralen). Willow bark (Salix nigra) contains salicin, an anti-inflammatory, analgesic, antipyretic, astringent, and antiarthritic active component. Lavender (Lavendula Angustifolia) contains tannins, which aids in the treatment of depression and anxiety. Phytochemicals: Non-nutritive plant compounds with defensive or disease-protective capabilities are known as phytochemicals. They are nonessential nutrients that plants make primarily inhibitors, enzyme intestinal absorbents that bind to and remove unwanted constituents and enhance the absorption and/or stability of important nutrients by scavenging reactive or harmful molecules. Phytonutrients/phytochemicals are found in a wide range of foods, including whole grains, beans, fruits, vegetables, and herbs. These phytochemicals, alone or in combination, have enormous therapeutic promise in the treatment of a variety of illnesses (Prakash et al., 2012; Patil et al., 2016) [22].

Glucose and insulin regulation are important characteristics of phytochemicals, and there is a promising reconsideration of traditional diabetes treatment. Mushrooms' nourishing, tonic, and restorative powers have long been recognized, as have their therapeutic capabilities such as anticancer, antiviral, and hypolipidemic properties. Lentinan boosts the immune system's ability to fight infections caused by bacteria, fungi, parasites, and viruses, including the AIDS virus.

Probiotic microorganisms :

Probiotics are live bacteria that are given to the host in sufficient quantity to provide a health benefit. They exist in powder, liquid, gel, paste, or granule form, as well as capsule form, and are commonly used to treat gastrointestinal (GI) disorders such as lactose intolerance, acute diarrhea, and antibiotic-related gastrointestinal side effects.

Lactobacillus and Bifidobacterium species are the most commonly utilized probiotics, however the yeast S. cerevisiae, as well as several E. coli and Bacillus species are also used. Lactic acid bacteria, such as Lactobacillus species, which have been used for thousands of years to preserve food through fermentation, can serve a dual purpose by acting as agents for food fermentation and having the potential to impact health profits.

Probiotic treatment has a variety of important effects, including improving intestinal wellbeing through microbiota guidance, relaxing and improving the immune system, delivering and expanding the bioavailability of supplements, reducing the side effects of lactose influence, and decreasing the risk of various illnesses (Nagpal et al., 2012) [23].

Nutraceutical enzymes :

Enzymes are essential components of life; without them, our bodies would not function correctly. Anyone suffering from digestive issues such as hypoglycemia, blood sugar abnormalities, or obesity might alleviate their symptoms by adding enzyme supplements to their diet obtained from microbial, plant, and animal sources (Singh and Sinha 2012).

- Non-traditional nutraceuticals: Non-traditional nutraceuticals are obtained from agricultural breeding by adding nutrients and/or ingredients,

such as calciumfortified orange juice, vitamin- and mineral-fortified cereals, and folic acid-fortified flour. Agricultural experts have successfully developed strategies to increase a crop's nutritional content (Singh and Sinha 2012). They are further subdivided into recombinant and fortified nutraceuticals.

- Recombinant nutraceuticals: Biotechnology techniques have been successfully employed in a fermentation process to extract enzymes suited for providing critical nutrients at an optimal level in a variety of foods such as cheese and bread (Chanda et al., 2019). Biotechnology assists in the formation of energy-delivering foods such as bread, wine, fermented starch, yogurt, cheese, vinegar, and others. Biotechnology allows for the production of probiotics and the extraction of bioactive components using enzyme/ fermentation technologies, as well as genetic engineering (Singh and Sinha 2012) [24].
- Fortified nutraceuticals: Fortified nutraceuticals are made by fortifying dietary components and then adding micronutrients (trace elements or vitamins) to the final product. The process of adding crucial minor components and nutrients to food to improve the efficiency and nutritional value of the food is known as fortification . In children with diarrhea, respiratory infections, and serious illnesses, prebiotics, and probiotics, preserved milk containing Bifidobacterium lactis HN019 are ingested. Persistent bananas could be developed as effective foods to combat iron deficiency caused by malnutrition.

Classification by chemical nature :

As shown in Figure 2, nutraceuticals are classified according to their primary and secondary metabolite sources, which include isoprenoid derivatives, phenolic substances, amino acid-based substances, carbohydrates and derivatives, fatty acids and structural lipids, and minerals.

Classification by mode of action

To distinguish and evaluate their function and roles, nutraceuticals have been divided into antibacterial, antifungal, antioxidant, anti-inflammatory, and antiobesity groups based on therapeutic properties.

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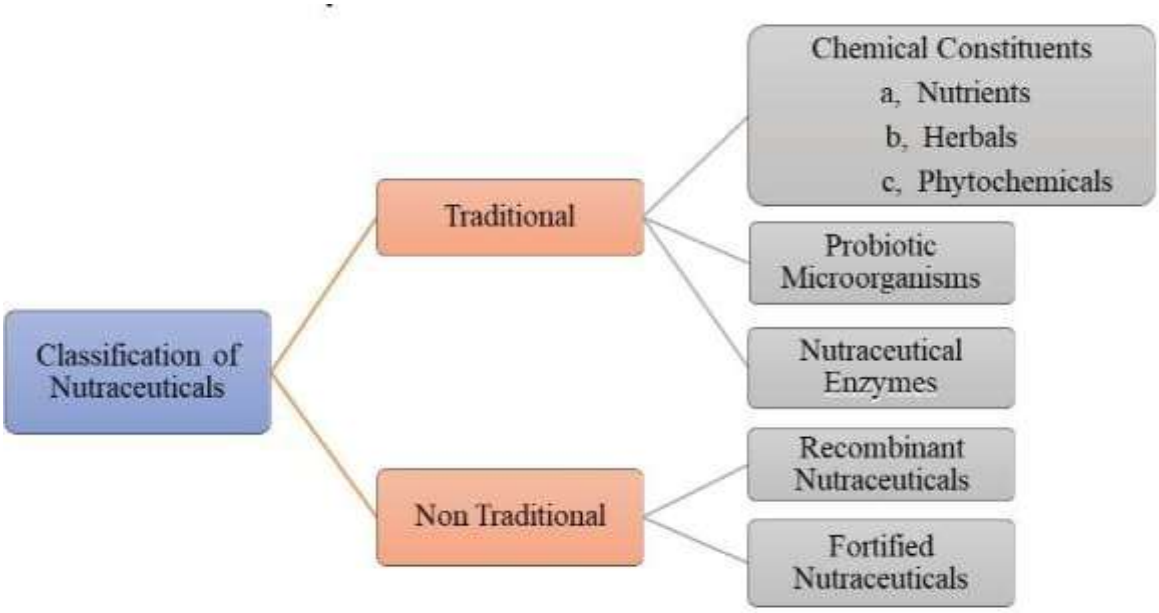

Figure 2 : Classification of nutraceuticals based on their source

THERAPEUTIC POTENTIAL OF NUTRACEUTICALS IN HUMAN HEALTH:

Nutraceuticals in Cardiovascular Diseases (CVD): Heart disorders, such as hypertension (high blood pressure), coronary heart disease (heart attack), and various forms of cerebrovascular disease (stroke), are all associated with cardiovascular diseases (Arora, 2019). Overconsumption of calorie- dense, nutrient-deficient, deeply processed, and easily absorbable meals can result in systemic inflammation, decreased insulin sensitivity, including several metabolic abnormalities, including obesity, hypertension, dyslipidemia, and glucose intolerance (Taiwo et al., 2017).

Polyphenols present in grape and grape derivatives, cocoa, and tea have been studied for their potential to reduce cardiovascular disease. By altering cellular metabolism, vitamin D, coenzyme Q10, folic acid, omega-3 fatty acids, and polyphenols help to prevent artery disease.

Flavonoids found in onion, grape, apples, and cherries inhibit the Angiotensin Converting Enzyme (ACE), lowering blood pressure and reducing the risk of coronary artery disease and myocardial infarction (Swarupananda and Sohini, 2019; Taiwo et al., 2017) [25].

HEALTH BENEFITS OF NUTRACEUTICALS:

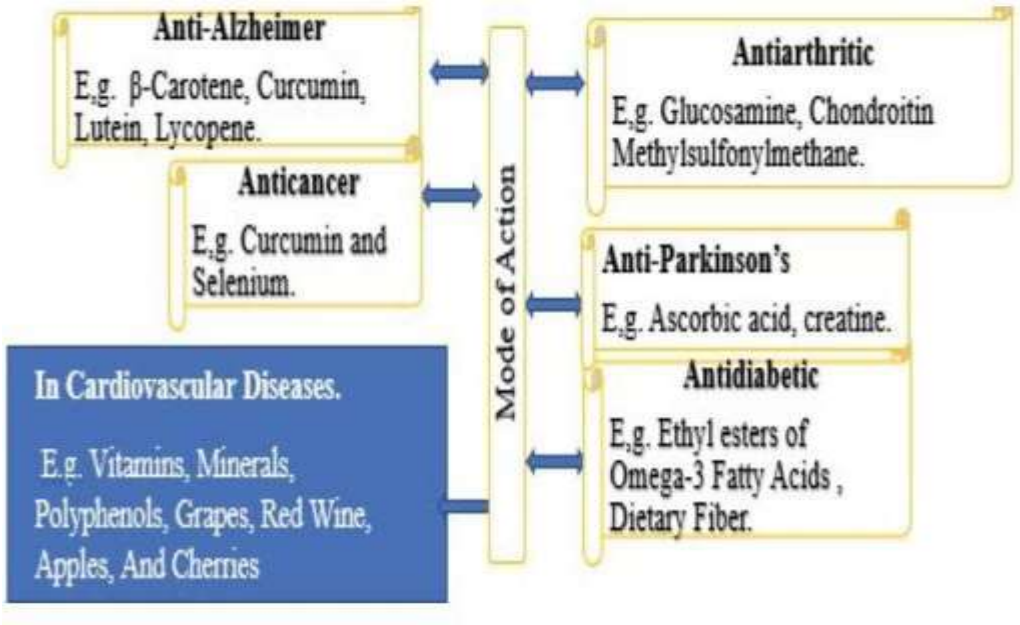

Figure 3: Classification of nutraceuticals based on their action

Flavonoids prevent platelet stickiness and accumulation (by opposing the "suicide" enzyme cyclooxygenase that breaks down prostaglandins), and they also keep the vascular system and support small capillaries that carry oxygen and necessary nutrients to the entire cell.

Nutraceuticals in cancer:

Cancer is defined as abnormal cell division in any part of the body, and malignant cells can influence our normal cells. Cancer is caused by a combination of complicated elements that develop in a stepwise manner, eventually leading to the uncontrolled spread and proliferation of malignant cells throughout the body, a process known as metastasis. It is one of the most important global health firms, with continuing increases in revenue and mortality.

Oxidative stress and redox waving, in addition to environmental variables, are important in the origin and spread of cancer. Cancer cells' receptivity to therapeutic interventions is also harmed by reactive oxygens (Roy et al., 2019) [26]. Chronic inflammation is linked to a higher risk of cancer. Chronic inflammation has also been linked to immunological suppression, which is a cancer risk factor. At the molecular level, free radicals and aldehydes produced by chronic inflammation can promote gene alterations and posttranslational modifications of cancer-related proteins.

Natural products or antioxidants (e.g., microbial and plant secondary metabolites) are employed as adjuvants to chemotherapy medications to increase their effectiveness, rather than other pharmaceutical drugs. Ginger, garlic, flaxseed, cabbage, soybeans, fenugreek, green tea, and umbellifers vegetables are examples of foods and herbs with high anticancer activity.Nutraceuticals, especially phytochemicals, play a role in cancer recovery. To date, all widely used cancer medications have come from natural sources. Cancer patients should eat foods that have a low carbohydrate content and a moderate amount of protein, dietary fiber, and fat (Roy et al., 2019).

Nutraceuticals in diabetes mellitus:

Diabetes mellitus is a chronic metabolic illness in which the body's ability to utilize carbohydrates is harmed due to an absolute or relative lack of the hormone insulin produced by the -islets of Langerhans in the pancreas. Diabetes mellitus is characterized by abnormally high levels of blood glucose, either due to inadequate insulin production or its ineffectiveness. Nutraceuticals and a wide range of bioactive components, such as phenolic compounds, sulfur compounds, herbs, and natural antioxidants, are all involved in glucose metabolism and may help to prevent the development of diabetes and other complications. Some dietary supplements, such as L-carnitine-lipoic acid, omega- 3 fatty acids, berberine, chromium, soy, and phytoestrogens, are currently available in markets and are widely prescribed by clinicians (Roy et al., 2019).

Nutraceuticals in obesity:

Obesity develops as a result of excessive consumption of high-fat and energy-dense foods, which leads to the formation of fatty plaques on the inside surface of arteries, which restrict blood flow to various sections of the body. Angina pectoris, heart attack, cardiac arrest, transient ischemic attacks, and stroke can all be caused by a lack of blood supply in certain organs.

It is characterized by an excess of body fat; however, the threshold value that defines what amount of body fat is "unhealthy" is unclear, and the ability to reliably degree body fat mass necessitates specialized equipment that is not readily available in most clinical settings. Following that, body mass index

(BMI) records are used to define people as "normal weight" (BMI 18.5-24.9 kg/m2), "overweight" (BMI 25-29.9 kg/m2), or "obesity" (BMI 30 kg/m2), which stratifies health risk based on the link between weight and height.

Fortified margarine (Plant sterol and stanol esters), oolong tea (catechins), green tea (Organosulfur compounds), garlic (Organosulfur compounds), Psyllium (Soluble fiber), and soybean (protein) are all beneficial in the treatment and prevention of obesity. These functional foods remove excess fat from the body by a variety of processes, including inhibiting pancreatic lipase, increasing thermogenesis, limiting adipocyte differentiation, improving lipid metabolism, and decreasing hunger (Emmanuel et al., 2020) [27].

Nutraceuticals in Alzheimer's disease:

Alzheimer's disease is the most common form of dementia and a degenerative neurological illness. This sickness has no cure and will ultimately kill everyone (Sachdeva et al., 2020). Necrobiosis in Alzheimer's disease results from the mass of beta-amyloid protein fragments forming solid plaques that affect the ability of acetylcholine to affect synaptic communication and initiate inflammatory progression and variations in the chemical nature of the specific proteins and also leads to necrobiosis in Alzheimer's disease wherein neuron's microtubules couples with other tubules creating neurofibrillary tangles that cause tubule.

β -carotene, curcumin, lutein, lycopene, and turmeric have antidisease Alzheimer's properties by neutralizing the negative effects of oxidative stress, mitochondrial malfunction, and neuronal degeneration (Verma and Mishra, 2016)[28].

Nutraceuticals in osteoporosis:

Low bone mass, thinning bone tissue, and disruption of bone microarchitecture are all symptoms of osteoporosis . Many factors that influence low bone mass are divided into two categories: those that cannot be changed and those that can. Gender, age, body size, and race are unchangeable, whereas hormonal status, lifestyle factors such as food, smoking, and alcohol consumption patterns, and physical activity levels can be changed.

Nutraceuticals such as herbs, minerals, and dairy products are increasingly being utilized to combat this condition. Calcirol D-3 is a popularly marketed nutraceutical product that contains calcium and vitamins to aid in the treatment of osteoporosis. Probiotics are effective in alleviating osteoporosis symptoms and lowering osteoporosis risk.

Nutraceuticals in osteoarthritis:

Osteoarthritis is characterized by articular cartilage loss, synovial membrane inflammation, and subchondral bone resorption. It is the most well-known form of arthritis, afflicting millions of individuals all over the world. When the protecting cartilage on the extremities of the bones breaks down over time, it causes this condition. It can cause pain in any joint in the body. It most usually affects the joints of the hands, knees, hips, and spine. Although there is no cure for osteoarthritis, there are therapies that can help with pain relief and joint mobility.

Chondroitin Sulfate (CS) and Glucosamine (GLN), also known as 2-amino-2-deoxy-d-glucose ($C_6H_{13}NO_5$), are widely utilized to alleviate the symptoms of osteoarthritis. MSM (Methyl Sulfonyl Methane) is a synergistic combination of glucosamine and chondroitin that is used to treat osteoarthritis and joint problems. Glucosamine (GLN) is an amino monosaccharide that is found in the exoskeletons of crustaceans and mushrooms. It is a component of glycosaminoglycan (GAG) chains. GAG is made up of two sugars that alternate: glucuronic acid and acetyl-d-galactosamine sulfate.

Nutraceuticals in Parkinson's disease:

It is a neurodegenerative disease characterized by a shortage of dopaminergic neurons in the substantia nigra, resulting in striatal dopamine exhaustion. Numerous nutraceuticals have been proven to provide neuroprotection in animal settings and may be useful as alternatives to synthetic pharmacological molecules such as L-Dopa, which has a long list of negative side effects. Iron chelation, modulation of cell signaling pathways, Reactive Oxygen Species (ROS)/free radical scavenging, anti-inflammation, anti-apoptosis, and mitochondrial homeostasis are some of the mechanisms by which they work, although several nutraceuticals essentially work through a slew of unthinking pathways rather than a single mechanism. Plant polyphenols, stilbenes, soybeans, and other phytoestrogens, as well as vitamins C, D, E, coenzyme Q10, and unsaturated fatty acids, have been shown to protect against Parkinson's disease progression (Dutta et al., 2018)[29].

Nutraceuticals in COVID-19:

SARS-CoV-2 has affected global health and economic well-being since its emergence in early 2020. The virus infection was initially reported in Wuhan by the World Health Organization's (WHO) regional office in China on December 31, 2019, and the infection was declared an epidemic on March 11, 2020 (Savant et al., 2021). SARSCoV-2, also known as COVID-19, is a coronavirus with high pathogenicity. It is a single-stranded positive-sense RNA virus, which means its RNA can be immediately translated into viral proteins in infected cells. Fever, gastrointestinal problems, and memory loss are just a few of the symptoms that SARS-CoV-2 infection can cause (Akula et al., 2020).

The current COVID-19 virus has increased the demand for immune-boosting foods, vitamins, and nutraceuticals. Food bioactive and nutraceuticals have been suggested as an alternative therapy for COVID-19 disease based on their anti-inflammatory properties as well as their capacity to inhibit virus activity (e.g., SARS-CoV, MERS-CoV, and SARSCoV-2) by disrupting their protein envelopes (Pandhi and Gupta, 2021).

Functional foods containing various functional components such as vitamins (A, B, C, and D), minerals (selenium, zinc, and iron), and polyphenolic compounds (quercetin, resveratrol, catechins, and anthocyanins) can act as natural therapeutic agents against SARS-CoV-2 or preventive therapy for COVID-19 patients, in addition to enhancing the body's immunity to fight COVID-19 infection (Hamid et al., 2021)[30].

Scope And Types of Products Available in the Market :

Nutraceutical from Nutrition and Pharmaceutical, in 1989 refers to foods having a medicinal effect on health of human beings. It consists of food supplements, herbal products, probiotics and prebiotics, medical foods meant for prevention and treatment of diseases. Major Nutraceuticals possess multiple therapeutic effects with lacking of unwanted effects. A Nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease. I try to redefine functional foods and Nutraceuticals. When food is being cooked or prepared using scientific intelligence with or without knowledge is called functional food. Thus, functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, etc., needed for its healthy survival when functional food aids in the prevention, treatment of disease and disorder other than anemia, it is called a Nutraceutical. Nutraceuticals are non-toxic food components which claimed to possess multiple therapeutic benefits. Some popular Nutraceuticals include glucosamine, ginseng, Echinacea, folic acid, cod liver oil, omega-3 fatty acid (MUFA, PUFA), calcium-enriched orange juice, green tea, plant phenols etc. Nutraceuticals can be organized in several ways depending upon its easier understanding and application, i.e. for academic instruction, clinical trial design, functional food 0 50 100 150 200 250 300 350 400 450 India Japan Europe US development or dietary recommendations. Some of the most common ways of classifying Nutraceuticals can be based on food sources, mechanism of action, chemical nature etc

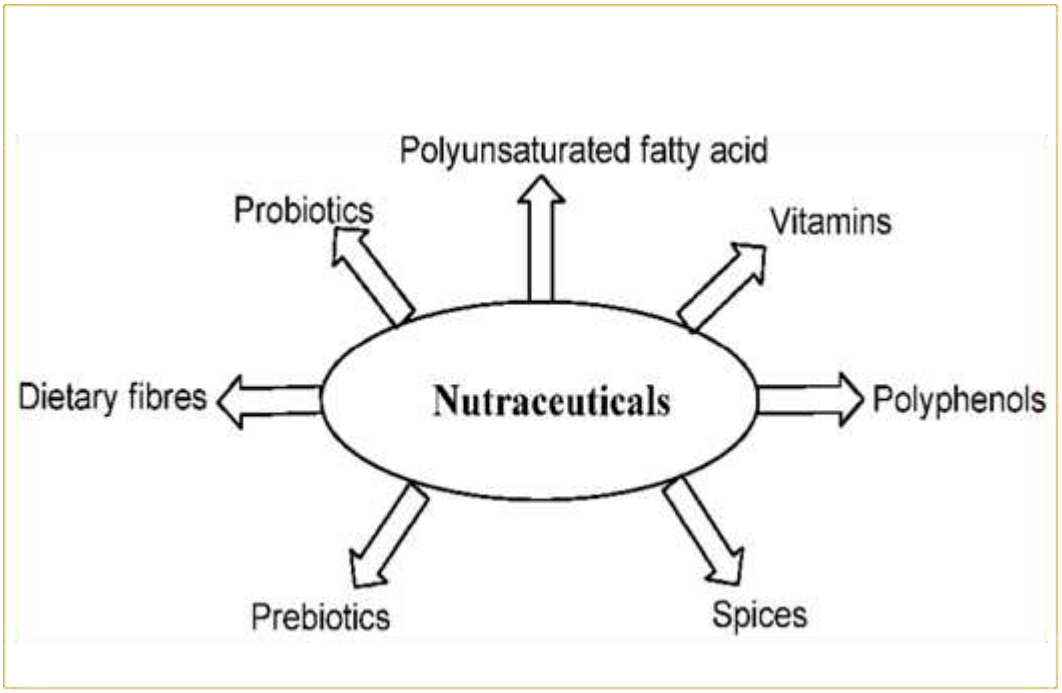

Figure 4 :Types of Nutraceuticals available in market

DEVELOPMENT OF NEUTRACEUTICALS :

Identification of components:

Numerous nutraceuticals currently are on the market. Table1 represents some of available nutraceuticals, their components and their potential human health benefits[31].

Sr No.	Components	Sources	Health Benefits
1.	CAROTENOIDS Beta-carotene	Carrots, various fruits	Neutralizes free radicals, which may damage cells; bolsters cellular antioxidant defences
2.	DIETARY FIBER Insoluble fiber	Wheat bran	May contribute to maintenance of a healthy digestive tract
3.	FATTY ACIDS	Tree nuts	May reduce risk of coronary heart disease

	Monosaturated fatty acids		
4.	FLAVONOIDS Flavonols	Onions, apples, tea, broccoli	Neutralize free radicals, which may damage cells; bolster cellular antioxidant defences
5.	PHENOLS Caffeic acid, ferulic acid	Apples, pears, citrus fruits, some vegetables	May bolster cellular antioxidant defences; may contribute to maintenance of vision & heart health
6.	PLANT STANOLS/STEROLS Stanols/sterol esters	Fortified table spreads, stanol ester dietary supplements	May reduce risk of heart disease
7.	POLYOLS (Sugar, alcohol, mannitol, sorbitol, lactitol)	Some chewing gums and other food application	May reduce risk of dental caries (cavities)
8.	PHYTOESTROGENS Isoflavones (daidzein, genistein)	Soyabeans and soy-based foods	May contributes to maintenance of bone health, healthy brain and immune functions for women, maintenance of menopausal health
9.	SOY PROTEIN Soy protein	Soyabeans and soy-based foods	May reduce risk of coronary heart disease

Table 1

PRESENT MARKET SCENERIO IN INDIA AND ABROAD :

Global market of nutraceutical is very huge. Nutraceuticals are hugely popular among consumers in the U.S. and other parts of the world. In Japan, England and other countries, nutraceuticals already have become part of the dietary landscape. Indian nutraceutical market is in infant stage but growing at very fast rate. Indian society has always been open to new concepts and quick to adapt. Due to increased physician acceptance of the medical benefits of nutritional products increased market demand of nutraceuticals. Consumers dissatisfied with drug costs and conventional healthcare are turning to unproven and untested natural products for treatment and prevention.

The expanding nutraceutical market indicates that end users are seeking minimally processed food with extra nutritional benefits and organoleptic value. This development, in turn, is propelling expansion in the nutraceutical markets globally. Future demand of nutraceutical depends on consumer perception of the relationship between diet and disease.

FOCUS ON INDIA :

India has a long heritage of traditional medicine, which includes a conglomerate of Ayurveda, Siddha and Unani. It is one of the greatest living traditions and maintains a highly respectable place in the officially recognized healthcare system of the country. In recent times, the Indian healthcare market has emerged as a new and profitable growth avenue for both existing players and new entrants.

The Indian healthcare industry has been seen to offer investors a cheap entry into the relatively stable consumer and retail segment, which is benefiting from rising consumer sentiments and affluence. According to Cygnus estimates, nutraceutical market in 2007 was INR

18.75 billion [10]. Total market for nutraceutical in India is valued at INR 44 bn in 2009; it is estimated to reach INR 95 bn in 2013.

India has now become a centre of attraction for everyone because of its huge population. In fact, India is currently experiencing massive internal consumption, due to a prosperous middle class, which has the money to invest in "nutraceutical" products. The middle class has doubled and today is the fastest growing portion of the population. In the last 60 years of independence India has met remarkable educational goals and today has moved beyond basic food security issues. India has also evolved from a savings economy to consumption economy.

Also called the "Fast Moving Consumer Goods" (FMCG) category, the "mainstream market" for India includes most personal care products, cosmetics and toiletries, but few healthy product options. This class of consumers is indeed a primary target for many companies. Also India has untapped market of Ayurveda and other medicinal plants, and because of these reasons everyone is rushing to India.[32]

MARKET GROWTH :

In India, functional foods are expected to see increased consumption over the next five years resulting in functional foods and beverages garnering greater product share in the market as opposed to dietary supplements. The total Indian Nutraceuticals market in 2015 is expected to be roughly US $ 5 billion

.In each product segment, manufacturers can expect a minor shift in consumption, driven by the demand for new and improved product as well their health claims. Interestingly, in the Indian market, the consumption of alternative herbal medicines and supplements (usually Ayurvedic and Homeopathic) is expected to have a detrimental effect on the Nutraceutical market and is considered as a loss to the unorganized market by manufacturers. This segment promises huge potential to Nutraceutical product manufacturers, through customization of their products to include natural and herbal ingredients. The success of the chyawanprash supplements market being case in point. Increased life expectancy, globally, has led to an increase in the incidence of lifestyle (age related) diseases such as diabetes, high blood pressure and cholesterol, obesity etc. As a result, there has been a significant increase in the deaths due to lifestyle diseases worldwide. Consumers worldwide are looking to follow healthy lifestyles to obtain optimum nutrition to keep these diseases at bay, leading to an increase in Nutraceutical consumption by health conscious consumers.

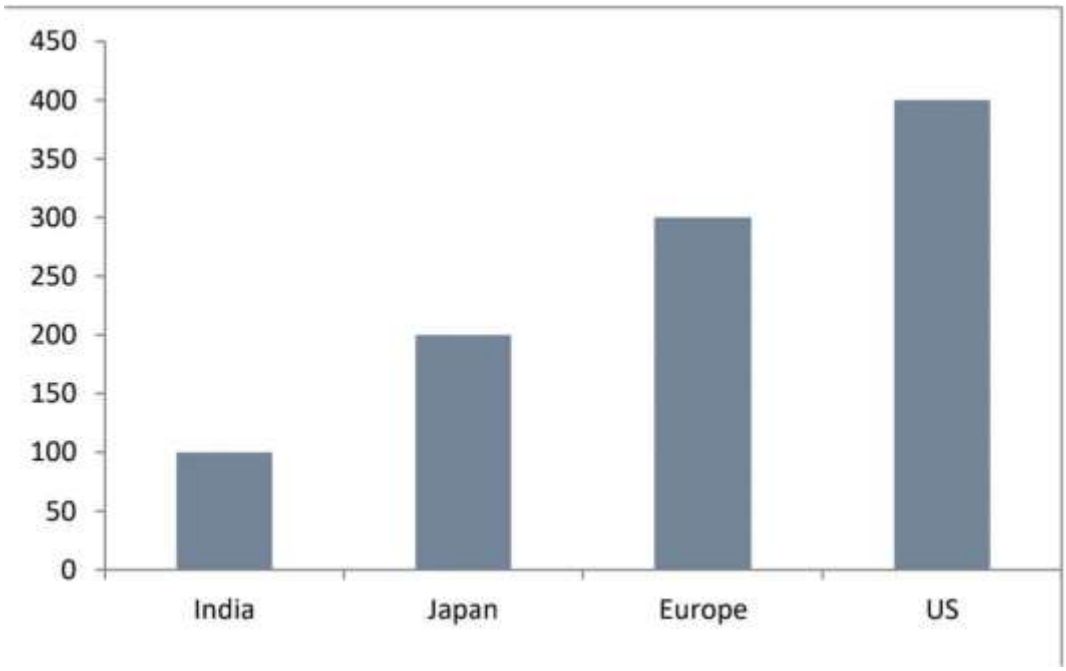

Figure 5 : Nutraceuticals Market in different Countries

KEY ISSUES :

- It is necessary to redefine the concept of nutraceuticals and to differentiate them clearly from food supplements, botanicals, and pharmaceuticals.
- A shared regulation will benefit both food supplements and nutraceuticals since they have a different approach and regulation in different countries over the world.
- The possibility of nutraceuticals to be used in prevention, and, in some cases, also in therapy for patients who do not qualify for the conventional pharmacological therapy, has the potential to make them grow faster in the coming years as a result of research in the area which is addressed nowadays on clearing their mechanism of action and potential use to face different pathological health conditions [33].
- The recent approach to nutraceuticals must include the pathological target identification the safety and efficacy assessment by clinical evidences substantiated by clinical data. One proposed approach to clear and define the role of nutraceuticals as tools in preventive proactive medicine could be similar to the one used for pharmaceuticals.
- Nutraceutical formulations are evolving, including the use of micro and nano-delivery systems, with the aim of better targeting the pathological condition to treat. They can bridge the gap between prevention of diseases using all natural sustainable environmentally friendly substances, and management of pathological long-term chronic diseases focusing on prevention better than on pharmacological approach when possible [34].

CONCLUSION:

There is a long history of nutraceutical use in the treatment of illness, and these chemicals have a position in current and future medicine. However, additional research is needed to ensure the items' safety, enhanced quality, purity, efficiency, health-promoting, and disease-curing effects, as well as a greater awareness of the various methods that go into item development. When taking supplements, extreme caution is very essential. As a result, there is a need for basic discussion and studies on the benefits, suggested, daily consumption, and potential side effects of supplement use. After that, we can replace the ancient proverb "an apple day keeps the doctor away" with "nutraceutical day may keep the doctor away." Nutraceuticals will be promoted in

the future to promote healthy health. When ingested as part of a well-balanced and healthy diet, it has been demonstrated to be beneficial for its intended purpose. Anticipation and treatment with nutraceuticals are now considered by public health authorities to be effective functional foods for maintaining health and combating nutritionally induced acute and chronic diseases, as well as for improving quality of life. Because nutraceuticals play such an important role in the promotion and care of human health and disease prevention, health experts, nutritionists, biotechnologists, and industrialists should collaborate strategically to develop regulations that will ensure high-quality health care.

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