



Nutraceuticals Used In Diabetes prevention

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ABSTRACT –

Globally, the use of *nutraceuticals*, *herbal remedies*, and *natural products* in therapies has grown significantly in recent years. The needs of therapeutic care for managing various health conditions are often not fully addressed by conventional treatment options such as *synthetic drugs*. In the context of *diabetes* and plant-based treatments, *nutraceuticals* present a more promising therapeutic alternative with fewer adverse effects. Nutraceuticals are defined as *non-specific biological agents* that utilize natural substances to support and enhance health, prevent disease development, and manage symptoms. It has been claimed that *dietary supplements* possess strong disease-preventing, healing, and health-enhancing capabilities.

Diabetes is a chronic and complex condition marked by *persistent high blood sugar levels* due to inadequate insulin production, impaired insulin function, or both. Several nutraceuticals currently used in clinical practice have shown the ability to positively influence a range of biochemical and clinical outcomes in individuals with diabetes. Many *traditional healing systems* use *blood sugar-lowering agents* derived from plants to help prevent, control, and treat diabetes mellitus. These agents are sourced from plants such as *Momordica charantia* (Bitter melon), *Nigella sativa* (Black seed), and *Cinnamomum cassia* (Cinnamon). These herbal extracts have shown significant clinical benefits in maintaining healthy *cholesterol levels* and *blood glucose levels*. This paper aims to review and discuss some of the most commonly used nutraceuticals in diabetes prevention.

Introduction-

Diabetes Mellitus is a complex, long-term disorder characterized by elevated blood sugar levels (hyperglycemia), resulting from insufficient insulin production, impaired insulin function, or both. Diabetes has become a serious global health concern, reaching alarming levels. Currently, type 2 diabetes affects over 500 million people worldwide. The global diabetic population is projected to double by 2030, rising from 171 million in 2000 to 366 million, with India expected to witness the highest increase.

Estimates suggest that up to 79.4 million Indians may be living with diabetes by 2030. According to the World Health Organization (WHO), the economic burden will fall disproportionately on developing countries. These metabolic disturbances often lead to long-term complications, including microvascular and macrovascular issues, as well as nerve damage (neuropathy), eye disease (retinopathy), kidney damage (nephropathy), and other health conditions that negatively affect quality of life and increase mortality rates.

Types of Diabetes Mellitus

There are three main types of diabetes:

1. Type 1 Diabetes
2. Type 2 Diabetes
3. Gestational Diabetes

Type 1 diabetes (also known as insulin-dependent diabetes) results from a lack of insulin due to the destruction or dysfunction of beta cells in the pancreas. Individuals with this type are completely reliant on external insulin administration for survival.

In contrast, Type 2 diabetes (often referred to as non-insulin-dependent diabetes) occurs when the body's cells do not respond effectively to insulin. It can often be managed through lifestyle modifications such as healthy eating, physical activity, and oral medications. Type 2 is the most prevalent form, accounting for nearly 90% of all diabetes cases.

Symptoms common to both types of diabetes may include:

- I. Elevated blood glucose levels
- II. Excessive thirst
- III. Frequent need to urinate
- IV. Intense hunger and unintended weight loss
- V. Blurred or impaired vision
- VI. Nausea and episodes of vomiting
- VII. Severe fatigue and lack of energy
- VIII. Irritability and emotional instability, among others.

If a woman does not already have diabetes, she may *develop gestational diabetes* during pregnancy. Approximately *50% of women* who experience gestational diabetes later go on to *develop type 2 diabetes*, often *without noticeable symptoms*. In the United States, *gestational diabetes affects between 2% and 10% of pregnancies annually*.

Other specific types of diabetes may result from various causes, including:

1. *1.Diabetes resulting from conditions that impact the pancreas*, such as *inflammation of the pancreas (pancreatitis)*, *physical injury*, *infections*, *pancreatic tumors*, or *surgical removal of the pancreas (pancreatectomy)*.
2. *2.Drug- or chemical-induced diabetes* caused by *medications or substances* that *interfere with insulin production or insulin function*.
3. *3.Diabetes linked to hormonal disorders*, such as those involving the *overproduction of insulin-opposing hormones*, like in *Cushing's syndrome*.
4. *4.Diabetes associated with genetic disorders*, including *Prader-Willi syndrome*, *Down syndrome*, and *Friedreich's ataxia*.
5. *5.Rare, specific forms of immune-mediated diabetes*, which are associated with *autoimmune conditions* other than those responsible for type 1 diabetes.
6. *6.Virus-related diabetes* caused by *infections that lead to the destruction of pancreatic beta cells*.

Nutraceuticals :

The term "nutraceutical" was coined in 1989 by Stephen DeFelice, founder and chairman of the Foundation for Innovation in Medicine, Cranford, New Jersey. He created the word by merging "nutrition" and "pharmaceutical."

According to DeFelice's definition, a nutraceutical refers to a food or food-derived component that provides medical or health benefits, including the prevention and/or management of diseases. The ancient Greek physician Hippocrates once said, *"Let food be your medicine."* This reflects the foundational idea behind nutraceuticals: emphasizing prevention over cure.

Under European pharmaceutical regulations, nutraceuticals are sometimes classified as medicinal products for the following reasons:

1. They can be used to prevent, manage, or treat specific health conditions.
2. They can be administered to restore, regulate, or modify physiological functions in the human body.

Nutraceuticals may include a wide variety of products such as:

- Isolated nutrients
- Herbal extracts
- Dietary supplements
- Specialized diets
- Genetically enhanced functional foods
- Processed food products like breakfast cereals, soups, oats, and health beverages.

These products are used in the management or prevention of various health issues, including:

- Arthritis,
- Colds and respiratory infections,
- Sleep disorders,
- Digestive problems,
- Certain types of cancer,
- Osteoporosis,
- High blood pressure,
- Cholesterol management,
- Pain relief,
- Depression,
- Diabetes,
- Heart disease,
- And other chronic and degenerative disorders, such as Parkinson's disease and Alzheimer's disease.

Health Advantages of Nutraceuticals

1. They have minimal or no side effects.
2. They may enhance overall health outcomes.
3. They often serve as natural dietary supplements without adverse reactions.
4. They can improve nutritional value, support a balanced diet, and enhance medical well-being.
5. They are readily available and cost-effective.

Table1:Nutraceuticals Available in market

S.No.	ProductBrandName	Plantconstituents/Extract	Functions
1	Fenulife	Fenugreekgalactomannan	ControlsBloodsugar
2	Teamax	Greenteaextract	PotentAntioxidant
3	Cholestaid	Saponin	ReduceCholesterol

4	Soylife	Soybean phytoestrogen	Maintains Bone health
5	Betatenene	Carotenoids	Immune Function
6	Clarinol	CLA	Weight loss ingredient
7	Glucocare	Bitter melon	Control Blood sugar

Classification of Nutraceuticals

1. *Functional Foods* – These are food products that, beyond providing basic nutrition, contain *antioxidant compounds* that help in the *prevention of diabetes*.
2. *Carotenoids* – These are *natural pigments* such as *alpha-carotene*, *beta-carotene*, and *beta-cryptoxanthin*. They possess *antioxidant* and *anti-inflammatory* effects, and are known to *support eye health*, *strengthen the immune system*, and help in the *prevention of certain cancers*.
3. *Collagen Hydrolysate* – A *crucial human protein* primarily produced by the skin. It offers multiple *therapeutic benefits*.
4. *Dietary Fibers* – These are *non-starch, low-digestibility plant carbohydrates*, commonly found in *fruits, vegetables, wheat bran, and oats*. They *enhance digestion* and help in reducing conditions such as *Crohn's disease* and *ulcerative colitis*.
5. *Fatty Acids* – This group includes *plant-based oils*, such as *olive oil*, which offer numerous *health benefits*, especially for the *heart* and *inflammatory conditions*.
6. *Phytochemicals* – These are *bioactive plant compounds* that help maintain *internal balance* and regulate *nervous system activity*, thereby *lowering cancer risk*. Two key examples are *lutein* and *lycopene*.
7. *Herbs* – Medicinal *plants with minimal or no side effects*, known for their *antioxidant properties*. Examples include *garlic extract* and *ginger*, which are used for *cholesterol management*, *wound healing*, and as *anti-ulcer agents*.
8. *Probiotics* – These are *beneficial microorganisms*, mainly found in *dairy products*, that provide various *health and medicinal benefits*. They have *antioxidant properties* and help maintain a *healthy balance of gut microbiota*.
9. *Dietary Supplements* – These are *nutritional products in tablet or capsule form*, derived from various *natural sources*, used to *complement the diet* and *improve health*.

Table 2: Nutraceutical used in various diseases

S.No.	Diseases	Nutraceuticals Used
1	Eye health	Lutein and Zeaxanthin
2	Mental health	Phosphatidylserine Docosahexaenoic acid Isoflavones
3	Sleep Enhancement	Melatonin
4	Cancer prevention	Tea lycopene flaxseed
5	Bone health	Melatonin L-carnitine
6	Skin health	Tea soy isoflavones glycol amines melatonin

People are increasingly turning to dietary aids, nutritional therapies, herbal medicine, and nutraceutical products due to growing dissatisfaction with the potential dangers of synthetic pharmaceutical drugs and rising concerns about maintaining their well-being through safer and more natural remedies. Nutraceuticals—a term blending “nutrition” and “pharmaceuticals”—are biologically active compounds used to support health, prevent medical conditions, and assist in the management of various diseases.

These products can be classified into the following groups based on their chemical nature:

- (a) Edible components (such as vitamins, minerals, amino acids, etc.).
- (b) Plant-based substances (herbs or plant-derived products in the form of concentrates and extracts).
- (c) Dietary supplements (including probiotics, prebiotics, antioxidants, and enzymes).

Functional foods and beverages are enriched with specific nutrients such as vitamins, lipids, proteins, sugars, minerals, or other key dietary elements that contribute to overall well-being. Dietary supplements deliver nutraceuticals in forms like pills or capsules, typically at concentrations higher than what is naturally found in everyday meals. When these nutraceuticals are employed to prevent or manage illnesses, they can be regarded as therapeutic agents.

Natural sources such as fruits, vegetables, whole cereals, medicinal plants, seeds, and nuts are rich in bioactive compounds like polyphenols, terpenes, sulfur-based elements, natural colorants, and other antioxidants. These naturally occurring substances are used in addressing a variety of health disorders.

Herbs with Anti-diabetic properties:

1. *Momordica charantia* (Bitter gourd)

Common name: Karela

Family: Cucurbitaceae

Plant parts used: Fruit, seeds, bark, roots, leaves, and oil

Momordica charantia, also known as bitter gourd, is native to the Asian and African regions. The vine can reach a height of up to 5 meters and has simple, alternating leaves measuring between 4 and 12 cm in diameter. The fruit is commonly incorporated into meals as a vegetable. *M. charantia* is widely valued for its blood sugar-lowering effects and is traditionally used in folk medicine across Asia, South America, India, and Eastern Africa for diabetes management.

It contains active compounds with antidiabetic potential, such as *charantin*, *vicine*, and *polypeptide-p*, along with various natural *antioxidants*.

Mode of blood glucose-lowering activity: Bitter gourd juice has been shown to promote the regeneration or increase of *pancreatic β -cells*, reduce blood glucose by inhibiting the enzymes *fructose-1,6-bisphosphatase* and *glucose-6-phosphatase*, and enhance glucose utilization through the *pentose phosphate pathway* by stimulating the enzyme *glucose-6-phosphate dehydrogenase (G6PDH)*, which plays a critical metabolic role.

2. *Syzygium cumini* (Blackberry)

Common name: Jamun

Family: Myrtaceae

Plant parts used: Seeds, leaves, fruit, bark

Syzygium cumini is a medium to large-sized tree, growing between 8 and 15 meters in height. It has smooth, glossy leaves arranged oppositely on the branches, and they emit a turpentine-like aroma. The plant is also known by its synonym, *Eugenia jambolana*. It bears edible, purplish-black, oval-shaped berries and aromatic white flowers that grow in branched clusters, with each berry containing a single seed. The fruit has a tangy, mildly sweet, and slightly bitter taste.

S. cumini is widely cultivated across the Indian subcontinent and other South Asian countries, including Indonesia, Bangladesh, Pakistan, Myanmar, Nepal, and Sri Lanka.

The *blood sugar-lowering* effects of *Syzygium cumini* may occur through increased *insulin release* or reduced *insulin degradation*. Research on the chemical composition and pharmacological properties of its *ethanolic extract* has revealed the presence of compounds such as *phenolic substances*, *steroids*, *saponins*, and *flavonoids*. The stimulation of pancreatic cells and the subsequent *insulin synthesis* appear to be influenced by the presence of *saponins*.

Reports suggest that *S. cumini* also exhibits a *lipid-lowering* effect by decreasing levels of *triglycerides*, *free fatty acids*, and *cholesterol* in the bloodstream. This effect is believed to be due to the presence of *flavonoids*, *saponins*, and *glycosides* in the extract, which contribute to the suppression of *hepatic 3-HMG CoA reductase* activity—an enzyme crucial in cholesterol biosynthesis.

Furthermore, the *seed extract* of *S. cumini* contains *ellagic acid*, a compound known for its potential to help *reduce blood pressure*.

3. *Trigonella foenum-graecum* (fenugreek)

Common name: Methi

Family: Fabaceae

Parts used: Leaves, seeds

Trigonella foenum-graecum, commonly known as fenugreek, is cultivated widely across India and in various other regions of the world as a semi-arid crop. Its green leaves and seeds are commonly used in Indian cuisine as both a vegetable and a culinary spice. *T. foenum-graecum* is well-known for its distinctive flavor and strong aromatic qualities, making it a frequent addition to many dishes.

Mechanism of blood glucose-lowering activity: Numerous experimental studies have identified *T. foenum-graecum* as an effective antidiabetic agent. Clinical research in humans has confirmed its ability to reduce blood sugar and lipid levels. Multiple investigations have demonstrated that extracts from its leaves and seeds—as well as its mucilage and powdered form—can effectively lower blood glucose and cholesterol in both human subjects and diabetic animal models.

The presence of *saponins*, dietary fiber, 4-hydroxyisoleucine, and the alkaloid trigonelline contributes to its therapeutic potential. Additionally, the hypoglycemic effect of *T. foenum-graecum* may involve extra-pancreatic mechanisms beyond just stimulating insulin activity.

4. *Cinnamomum zeylanicum* (cinnamon)

Common name: Dalchini

Family name: Lauraceae

Parts used: Leaves, bark

Cinnamomum zeylanicum is used as a spice and medicinal herb; it is obtained from the inner bark of the tree and is incorporated into several Ayurvedic formulations. The essential oil extracted from the leaves and bark of *C. zeylanicum* contains active constituents such as cinnamaldehyde, cinnamyl acetate, alcohol, eugenol, and other volatile compounds.

Mechanism of hypoglycemic effects: Therapeutic studies have demonstrated its efficacy as a blood sugar-lowering agent by inhibiting the enzyme aldose reductase, a key catalyst in the polyol pathway. Blocking this enzyme prevents the conversion of glucose to sorbitol, thereby reducing the risk of diabetic complications such as cataracts, neuropathy, and retinopathy.

5. *Nigella sativa* (Black cumin)

Common name – Kalonji

Family – Ranunculaceae

Parts used – Seeds

N. sativa is an annual flowering plant traditionally used for treating infertility, fever, cough, bronchitis, asthma, and various other ailments. Its chemical constituents include nigellicine, nigellidine, thymol, linoleic acid, oleic acid, among others. The principal bioactive compound responsible for its antidiabetic effect is thymoquinone, which constitutes 1.8% to 48% of the seed content. Its seeds have been utilized for centuries as a natural remedy with anti-hyperglycemic, antioxidant, antihypertensive, and anti-hyperlipidemic properties.

6. *Allium sativum* (Garlic)

Common name – Garlic

Family – Amaryllidaceae

Parts used – Leaves, flowers, cloves

Garlic has been traditionally used in managing heart disease, arthritis, toothache, constipation, and various infections. Its main active constituent is allicin (0.2-0.53%).

Mechanism of hypoglycemic effects: Studies indicate that garlic aids insulin secretion by restoring the activity of enzymes involved in glucose metabolism such as glucose-6-phosphatase, fructose-1,6-phosphatase, and fructose-1,6-bisphosphatase involved in gluconeogenesis. It also exhibits effects similar to SGLT-2 inhibitors and thiazolidinediones. Allicin acts as a hypoglycemic agent by activating the PI3K/AKT signaling pathway, which promotes insulin secretion and reduces the formation of advanced glycation end products.

7. *Gymnema sylvestre*

Common name: Gurmar

Family: Asclepiadaceae

Parts used: Rhizomes, leaves, volatile oils

Gymnema sylvestre is a herb indigenous to the tropical forests of India and Sri Lanka. It is a large climbing plant with roots at its nodes and has been used in Ayurvedic medicine since ancient times.

Mechanism of hypoglycemic effects: The aqueous extract of *G. sylvestre* causes a reversible increase in intracellular calcium and stimulates insulin secretion in pancreatic β -cells of both mice and humans with type 2 diabetes. It has also been reported to inhibit adrenal hormones from prompting the liver to produce glucose, thus lowering blood sugar levels. This activity is attributed to bioactive compounds such as triterpene saponins known as gymnemic acids (I–XVIII) and gymnosaponins (I–V).

8. *Ocimum sanctum*

Common name: Tulsi

Family: Lamiaceae

Parts used: Whole plant and leaf oil

O. sanctum is a widely distributed plant, native to South Asia. It is an upright, heavily branched subshrub, 30–60 cm tall, with hairy stems and simple, opposite green or purple leaves. Its chemical and nutritional profile indicates a plant with diverse therapeutic potential. Eugenol is the primary bioactive compound; in addition, the leaf oil contains euginal, ursolic acid, carvacrol, linalool, limatrol, and caryophyllene in substantial quantities.

Mechanism of hypoglycemic effects: The antidiabetic properties of tulsi have been acknowledged in Ayurveda. In streptozotocin (STZ)-induced diabetic rats, supplementation with the ethanolic extract of tulsi resulted in a significant reduction in blood glucose, glycosylated hemoglobin, and urea, along with an increase in glycogen, hemoglobin, and protein levels. The plant's leaf extracts have also been reported to stimulate physiological mechanisms that promote insulin secretion.

Table3: Various herbs used in Diabetes

S. No.	Plant Common Name	Biological source	Phytoconstituent	Health Benefits
1	Karela	Momordica charantia	Charantin, Vicine, Polypeptide-p, antioxidant	Anti-diabetic Properties
2	Jamun	Syzygium cumini	Flavonoids, saponins, glycoside	Anti-diabetic properties, Reduce BP
3	Methi	Trigonella foenum graecum	Saponin, 4-Hydroxy isoleucine and Trigonelline, Alkaloid	Hypoglycemic agent
4	Dal Chini	Cinnamomum zeylanicum	Cinnamaldehyde	Anti-diabetic
5	Kalonji	Nigella sativa	Thymoquinone	Hypoglycemic agent
6	Garlic	Allium Sativum	Allicin	Anti-diabetic
7	Gurmar	Gymnema sylvestre	Triterpene Saponins (gymnemic acid and gymnosaponins)	Hypoglycemic agent

Supplementing with macronutrients as antidiabetics: Micronutrients are vitamins, minerals, and other compounds that our bodies need in very small quantities to perform specific functions. They aid in supporting a healthy metabolism and help convert sugars and other carbohydrates from food into energy. Some of the key nutraceuticals influencing diabetes include micronutrients such as calcium (Ca), magnesium (Mg), chromium (Cr), alpha-lipoic acid (ALA), coenzyme Q10, carnitine, inositol, various vitamins (B12, C, D, E, H), vanadium, and others.

1. **Alpha-Lipoic Acid (ALA):** ALA is a disulfide molecule synthesized in small amounts within cells and acts as a coenzyme in mitochondrial enzyme complexes like alpha-ketoglutarate dehydrogenase and pyruvate dehydrogenase. ALA possesses strong antioxidant effects; intravenous administration has been shown to enhance insulin-stimulated glucose uptake. It has been applied to treat diabetic neuropathy and is also suggested to protect against diabetic heart disease. ALA boosts insulin sensitivity and fat metabolism, especially when combined with omega-3 fatty acids and vitamin E. Injectable ALA at 600 mg daily for 7 days improved body mass index (BMI), HbA1c, and cholesterol levels, showing benefits in managing erectile dysfunction and metabolic disorders in diabetes. It is effective in treating diabetic distal sensory-motor neuropathy.
2. **Magnesium:** Magnesium is vital for nerve signaling, RNA and DNA production, glucose regulation, and serves as a cofactor for numerous enzymes. Deficiency in magnesium is linked to reduced insulin-mediated glucose uptake. Diabetic patients frequently have low blood magnesium levels and increased magnesium loss through urine. Magnesium supplementation shows promise in preventing insulin resistance.
3. **Chromium:** Chromium, a trace element, is often deficient in people with diabetes. Supplementing chromium may improve glucose tolerance and increase insulin sensitivity in individuals with type 2 diabetes. However, a meta-analysis of randomized controlled trials revealed that chromium supplementation moderately improved blood sugar control but did not significantly affect glucose tolerance. The American Diabetes Association notes conflicting evidence regarding chromium's benefits for diabetes.

4. *Vanadium*: Studies suggest vanadium mimics insulin by promoting glucose uptake into cells, making it potentially useful for both type 1 and type 2 diabetes. Vanadium supplementation lowers fasting blood sugar, cholesterol, and HbA1c levels. Doses between 45 and 150 mg daily are considered safe and generally well tolerated, though some individuals experience mild gastrointestinal discomfort at higher doses (up to 400 mg/day) or during early treatment.
5. *Vitamin C*: Ascorbic acid, the active form of vitamin C, acts as an antioxidant that interrupts reactive oxygen species (ROS) and prevents protein glycation reactions. It also reduces diabetes-associated lipid peroxidation and sorbitol buildup in red blood cells of animals. A daily dose of 800 mg vitamin C is often given to type 2 diabetic patients with low vitamin C levels, but it does not appear to improve endothelial dysfunction or insulin resistance.
6. *Vitamin E*: This essential fat-soluble vitamin mainly functions as an antioxidant. Low vitamin E levels have been observed in diabetics, who may also have decreased antioxidant defenses. Elevated free radical production caused by high blood sugar may increase the demand for antioxidants. Vitamin E doses up to 400 IU are typically safe; however, doses above 800 IU may influence blood clotting, although clinical monitoring has not found significant changes.
7. *Coenzyme Q10*: Coenzyme Q10 is crucial since many medications for diabetes and its complications reduce its levels. It has potential as a supplement to improve insulin resistance, particularly in patients with hypertension. In a double-blind, randomized study involving 59 hypertensive patients, taking water-soluble CoQ10 (60 mg twice daily) for eight weeks lowered fasting insulin and glucose, indicating improved insulin sensitivity.
8. *Vitamin B complex*: Treatment of type 2 diabetes often includes B vitamins like thiamine (B1), pyridoxine (B6), biotin, folic acid (B9), and cobalamin (B12). Thiamine is commonly used to manage diabetic neuropathy, as many patients show deficiencies. Because thiamine is poorly absorbed, high doses are required. Levels are generally lower in those with type 2 diabetes, and supplementation has been shown to reduce blood sugar and lipid levels.
9. *Vitamin D*: Research by Liese et al. found seasonal changes in diabetes control and a relationship between geographic latitude and the incidence of type 1 and type 2 diabetes, indicating a negative correlation between sunlight exposure and diabetes prevalence. Vitamin D is thought to reduce insulin resistance and stimulate insulin secretion because pancreatic beta cells have vitamin D receptors. Vitamin D deficiency is linked to type 2 diabetes, possibly due to its storage in fat tissue reducing its availability. Clinical trials with calcium and vitamin D supplementation suggest it may reduce the risk of developing type 2 diabetes.

Table 4: Various vitamins and their health benefits

S. No.	Vitamins	Source	Health benefits
1	Vitamin A	Green leafy vegetables, Guava, Ripe yellow fruits, milk, Broccoli	Reduce Blood sugar and Potent Anti- Oxidant, Improve skin health.
2	VitaminB1 (Thymine)	Fresh fruits, potatoes, sweet potatoes, peas, corn, cashew, nuts, milk	Control Diabetes and essential neurologic.
3	VitaminB3 (Niacin)	Meat, fish, eggs, milk, cereals, mushroom	Reduce blood sugar.
4	VitaminB6 (Pyridoxine)	Chicken, beans, avocado, sunflower seeds, sesame seeds	Helps to produce essential proteins and maintain blood sugar level.
5	Vitamin C (Ascorbic acid)	Fresh fruits, broccoli, goat milk, chestnuts, black currant	Anti-oxidant(reduce damage cause by free radicals), Decrease hypertension.
6	Vitamin D	Fish liver oil, egg, beef, Chicken breast	Improve glucose tolerance and insulin resistance, improve bone health.
7	Vitamin E	Potatoes, pumpkin, milk, nuts, seeds, Mango	Improve renal function, the renal blood flow.

Marketed Antidiabetic Nutraceuticals:

1. Organic Gymnema (Himalaya)
2. Dia free juice (kapiva)
3. Glucocare (Himalaya)
4. V-GANO DIABETES
5. Nutrilite
6. Fenulife
7. Cinnamon Extract
8. Glucomap

Market Forecast for Nutraceuticals (2022-2032): The size of the world market for nutraceuticals, estimated at USD 454.55 billion in 2021, is anticipated to rise at a 9.0% compound annual growth rate (CAGR) from 2021 to 2030.

Key Companies List Profiled:

1. Herbalife Nutrition Limited is one (California, United States)
2. The Archer Daniels Midland Corporation (Illinois, United States)
3. General Mills (Minnesota, United States)
4. PepsiCo, Inc. (New York, United States)
5. BASF SE (Mannheim, Germany)

6. Abbott (Illinois, United States)
7. Amway (Michigan, United States)
8. Glanbia Plc. (Ireland)
9. Danone S.A. (Paris, France)
10. Nestle S.A. (Vevey, Switzerland).

Conclusion:

When taken within the recommended daily intake levels, nutraceuticals have been found to support overall well-being and contribute to maintaining good health. Although these compounds hold significant promise in enhancing human wellness and preventing diseases, it is essential for regulatory scientists, healthcare providers, and nutrition experts to work together in developing appropriate guidelines to ensure their optimal health and therapeutic benefits. To bring consistency and accountability to the nutraceutical sector, proper regulatory frameworks need to be established. Examining this topic is particularly important as the nutraceutical industry is growing at a much faster pace than both the food and pharmaceutical sectors. Herbal-based nutraceuticals serve as a powerful means of promoting wellness and managing both short-term and long-standing diseases linked to inadequate nutrition, thereby fostering improved health, increased longevity, and better quality of life.

REFERENCES :

- [1]. American diabetes association diagnosis and classification of diabetes mellitus, *Diabetes Care* 2009 Jan; 32(Suppl 1): S62-S67.
- [2]. Wild S. Sicree R. Roglic G. 2004. Global prevalence of diabetes. *Diabetes Care*, 27(5):1047-1053.
- [3]. Santaguida PL. Balion C. Hunt D. 2005. Diagnosis, prognosis, and treatment of impaired glucose tolerance and impaired fasting glucose. *Evid Rep Technol Assess*, 128:1-11.
- [4]. Evans JL. Goldfine ID. Maddux BA. 2002. Oxidative stress and stress activated signaling pathways: a unifying hypothesis of type 2 diabetes. *Endocr Rev*, 23(5): 599-622.
- [5]. Spranger J, Kroke A, Möhlig M. 2003. Inflammatory cytokines and the risk to develop type 2 diabetes: results of the prospective population-based European Prospective Investigation into Cancer and Nutrition (EPIC) Potsdam Study. *Diabetes*, 52(3):812-817.
- [6]. Centers for disease control and prevention. <https://www.cdc.gov/diabetes/basics/gestational.html>
- [7]. IDF Diabetes Atlas 2021 ,10th edition, www.diabetesatlas.org
- [8]. Das L. Bhaumik, E. Raychaudhuri, U., and Chakraborty, R. 2012. Role of nutraceuticals in human health. *Journal of Food Science and Technology*, 49:173-183.
- [9]. Pandey M. Verma, R.K. and Saraf S.A. 2010. Nutraceuticals: new era of medicine and health. *Asian Journal of Pharmaceutical and Clinical Research*, 3:11-15.
- [10]. Dureja H. Kaushik, D. and Kumar, V. 2003. Developments in nutraceuticals. *Indian Journal of Pharmacology*, 35:363-372
- [11]. Bagchi Debasis, Harry G Preuss, Swaroop Anand. Nutraceuticals and functional foods in human health and disease prevention , CRC press Taylor and Francis Group. <http://www.taylorandfrancis.com>
- [12]. Asif M. 2014, The prevention and control the type-2 diabetes by changing lifestyle and dietary pattern. *J Educ Health Promot*. 3:3977-406. doi:10.4103/2277-9531.127541.4.
- [13]. Bhatt T, Carotenoids PK. 2020. Potent to Prevent Diseases Review. *Nat Prod Bioprospect*, 10(3):109-17. doi:10.1007/s13659-020-00244-2.5.
- [14]. Wang Z. Liu H. Luo W. 2020. Regeneration of skeletal system with genipin crosslinked biomaterials. *J Tissue Eng*. 11:2041731420974861. doi:10.1177/2041731420974861.6.
- [15]. Dhingra D. Michael M. Rajput H. Patil RT. 2011. Dietary fibre in foods: a review. *J Food Sci Technol*. 49(3):255-66. doi:10.1007/s13197-011-0365-5.7.
- [16]. Castro F. and Souza HD. 2019. Dietary Composition and Effects in Inflammatory Bowel Disease. *Nutrients*. 11(6): 1398. doi:10.3390/nu11061398.8.
- [17]. Kuijpers MC. Dijkstra G. 2021. Food and Food Groups in Inflammatory Bowel Disease (IBD): The Design of the Groningen Anti-Inflammatory Diet (GrAID). *13(4): 1067*. doi:10.3390/nu13041067.9.
- [18]. Tan BL. Norhaizan ME. Liew WP. and Rahman S. 2018. Antioxidant and Oxidative Stress: A Mutual Interplay in Age-Related Diseases. *Front Pharmacol*. 9:1162. doi:10.3389/fphar.2018.01162.10. IJCRT2211545 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org e616 www.ijcrt.org © 2022 IJCRT | Volume 10, Issue 11 November 2022 | ISSN: 2320-2882
- [19]. Markowiak P. Sliżewska K. 2017. Effects of Probiotics, Prebiotics, and Synbiotics on Human Health. *Nutrients*. 2017;9(9):1021. doi:10.3390/nu9091021.11.
- [20]. Dietary Supplements Market Size & Trends Report. 2021. Available from: <https://www.grandviewresearch.com/industry-analysis/dietary-supplements-market.12.13>
- [21]. Syed W. Muhammad A. Current trends and future prospect of medicinal plants derived nutraceuticals-a Review https://www.researchgate.net/publication/358571927_Current_trends_and_future_prospect_of_medicinal_plants_derived_nutraceuticals_A_review
- [22]. Rohit S. Hetal A. Prajapati PK. 2016. Plant Kingdom nutraceuticals for diabetes, *Journal of Ayurvedic and Herbal Medicine*, 2(6): 224-228.
- [23]. Hathcock J. 2001. Dietary supplements: How they are used and regulated. *J Nutrition*. 131:1114-1117.
- [24]. Zeisel SH. 1999. Regulation of Nutraceuticals. *Science*. 285:185-6.
- [25]. Brower V. 1998. Nutraceuticals: Poised for a healthy slice of the healthcare market? *Nat Biotechnol*. 16:728-31. [26]. Dzanis DA. 1998. Nutraceuticals: Food or drug? The North American Veterinary Conference Publishing Committee, Florida, TNAVC proceedings. 430-431.

- [27]. Prabu SL, Suriyaprakash TN, Kumar CD, Kumar SS. 2012. Nutraceuticals and their medicinal importance. *Int J Health Allied Sci.* 1:47-53.
- [28]. Krawinkel MB and Keding GB. 2006. Bitter gourd (*Momordica Charantia*): A dietary approach to hyperglycemia. *Nutr Rev.* 64:331–337.
- [29]. Joseph B and Jini D. 2013. Antidiabetic effects of *Momordica charantia* (bitter melon) and its medicinal potency. *Asian Pacific journal of Tropical Medicine.* 3(2): 93–102.
- [30]. Periyathambi R. 2007. Jamun -The potential untapped. *Horticulture.* 1:30–32.
- [31]. Ayyanar M. and Subash-Babu P. 2012. *Syzygium cumini* (L.) Skeels: A review of its phytochemical constituents and traditional uses. *J Trop Biomed.* 2:240–246.
- [32]. Srivastava B. Sinha AK. Gaur S. 2012. Study of hypoglycaemic and hypolipidemic activity of *Eugenia Jambolana* pulp and seed extract in streptozotocin induced diabetic albino rats. *Asian J Pharm Life Sci.* 2:10–19.
- [33]. Sagrawat H. Mann AS. and Kharya MD. 2006. Pharmacological potential of *Eugenia jambolana*: A review. *Pharmacog Mag.* 2:96–105.
- [34]. Ravi K. Rajasekaran S. and Subramanians S. 2005. Anti-hyperlipidemic effects of *Eugenia jambolana* seed kernel on streptozotocin induced diabetic rats. *Food Chem Toxicol.* 43:1433–1439.
- [35]. Morton JF. 1987. *Fruits of Warm Climates*. Creative Resource Systems, Inc., Winterville, NC, 505.
- [36]. Kavishankar GB. Lakshmidevi N. Mahadeva MS. 2011. Diabetes and medicinal plants—A review. *Int J Pharm Biomed Sci.* 2:65–80.
- [37]. Vats V. Grover JK. and Rath SS. 2002. Evaluation of anti-hyperglycemic and hypoglycemic effect of *Trigonella foenum graecum* Linn, *Ocimum sanctum* Linn and *Pterocarpus marsupium* Linn in normal and allox-anized diabetic rats. *J Ethnopharmacol.* 79:95–100.
- [38]. Wang Z. Wang J. and Chan P. 2013. Treating type 2 diabetes mellitus with traditional Chinese and Indian medicinal herbs. *Evid Based Complem Alter Med.* 1–17.
- [39]. Zia T. Hasnain SN. and Hasan SK. 2001. Evaluation of the oral hypoglycemic effect of *Trigonella foenumgraecum* in normal mice. *J Ethnopharmacol.* 75:191–195.
- [40]. Sharma RD. Raghuram TC. and Rao NS. 1990. Effect of fenugreek seeds on blood glucose and serum lipids in type I diabetes. *Eur J Clin Nutr.* 44:301–306.
- [41]. Gupta A. Gupta R. and Lal B. 2001. Effect of *Trigonella foenum-graecum* (fenugreek) seeds on glycaemic control and insulin resistance in type 2 diabetes mellitus: A double blind placebo-controlled study. *J Assoc Phys India.* 49:1057–1061.
- [42]. Petit PR. Sauvaire YD. Hillaire-Buys DM. 1995. Steroid saponins behavior and plasma cholesterol. *Steroids.* 60:674–680.
- [43]. Raghuram TC. Sharma RD. Sivakumar B. and Sahay K. 1994. Effect of fenugreek seeds on intravenous glucose disposition in non-insulin dependent diabetic patients. *Phytotherapy Res.* 8:83–86.
- [44]. Saxena A. and Vikram NK. 2004. Role of selected Indian plants in management of type 2 diabetes: A review. *J Altern Complem Med.* 10:369–378.
- [45]. Lee SC. Xu WX. Lin LY. 2013. Chemical composition and hypoglycemic and pancreas-protective effect of leaf essential oil from indigenous cinnamon (*Cinnamomum osmophloeum* Kanehira) *J Agric Food Chem.* 61: 4905–4913. [46]. Gholamnezhad Z. Havakhah S. Boskabady MH. 2016. Preclinical and clinical effects of *Nigella Sativa* and its constituent, thymoquinone: A review. *Journal of Ethnopharmacology.* 190: 372-86
- [47]. Magkos F. Yannakoulia M. Chan J. 2009. Management of the metabolic syndrome and type 2 diabetes through lifestyle modification. *Annual Review of Nutrition.* 29:223–56.
- [48]. Bayan L. Koulivand PH. Gorji A. 2014. Garlic: a review of potential therapeutic effects. *Avicenna J Phytomed.* 4(1):1-14.
- [49]. Sugihara Y. Nojima H. Matsuda H. 2000. Antihyperglycemic effects of gymnemic acid IV, a compound derived from *Gymnema sylvestre* leaves in streptozotocin-diabetic mice. *J Asian Nat Prod Res.* 2:321–327.
- [50]. Whitman M. 2001. Understanding the perceived need for complementary and alternative nutraceuticals: Lifestyle issues. *Clin J Oncol Nurs.* 5:190-4.
- [51]. Liu B. Asare AH. Al-Romaiyan A. 2009. Characterisation of the insulinotropic activity of an aqueous extract of *Gymnema sylvestre* in mouse beta-cells and human islets of Langerhans. *Cell Physiol Biochem.* 23:125–132.
- [52]. Gholap S. and Kar A. 2003. Effects of *Inula racemosa* root and *Gymnema sylvestre* leaf extracts in the regulation of corticosteroid induced diabetes mellitus: Involvement of thyroid hormones. *Pharmazie.* 58:413–415. [53]. Pattanayak P. Behera P. Das D. 2010. *Ocimum sanctum* Linn. A reservoir plant for therapeutic applications: An overview. *Pharmacogn Rev.* 4:95–105.
- [54]. Narendhirakannan RT. Subramanian S. and Kandaswamy M. 2006. Biochemical evaluation of antidiabetogenic properties of some commonly used Indian plants on streptozotocin-induced diabetes in experimental rats. *Clin Exp Pharmacol Physiol.* 33:1150–1157.
- [55]. Hannan JM. Marenah L. Ali L. 2006. *Ocimum sanctum* leaf extracts stimulate insulin secretion from perfused pancreas, isolated islets and clonal pancreatic beta-cells. *J Endocrinol.* 189:127–136.
- [56]. Baldi A. Choudhary N. Kumar S. 2013. Nutraceuticals as therapeutic agents for holistic treatment of diabetes. *Int J Green Pharm.* 7:278-87.
- [57]. Evans JL. and Goldfine ID. 2000. Alpha-lipoic acid: A multifunctional antioxidant that improves insulin sensitivity in patients with type 2 diabetes. *Diab Technol Ther.* 2:401–413.
- [58]. Hegazy SK. Tolba OA. Mostafa TM. 2013. Alpha-lipoic acid improves subclinical left ventricular dysfunction in asymptomatic patients with type 1 diabetes. *Rev Diab Stud.* 10:58–67
- [59]. Udupa A. Nahar P. Shah S. 2013. A comparative study of effects of omega-3 Fatty acids, alpha lipoic Acid and vitamin e in type 2 diabetes mellitus. *Ann Med Health Sci Res.* 3:442–446.
- [60]. Mitkov MD. Aleksandrova IY. Orbetzova MM. 2013. Effect of transdermal testosterone or alphas lipoic acid on erectile dysfunction and quality of life in patients with type 2 diabetes mellitus. *Folia Med (Plovdiv).* 55:55–63
- [61]. Ibrahimspasic K. 2013. Alpha lipoic acid and glycaemic control in diabetic neuropathies at type 2 diabetes treatment. *Med Arh* 67:7–9.
- [62]. Swaminathan R. 2003. Magnesium metabolism and its disorders. *Clin Biochem Rev.* 13:47–66.

- [63]. Afridi HI. Kazi TG. Kazi N. 2006. Potassium, calcium, magnesium, and sodium levels in biological samples of hypertensive and nonhypertensive diabetes mellitus patients. *Biol Trace Elem Res*. 13:206–224.
- [64]. Mooren FC. Kruger K. Volker K. 2011. Oral magnesium supplementation reduces insulin resistance in non-diabetic subjects— A double-blind, placebo-controlled, randomized trial. *Diab Obes Metab*. 13:281–284
- [65]. Lau FC. Bagchi M. Sen CK. 2008. Nutrigenomic basis of beneficial effects of chromium (III) on obesity and diabetes. *Mol Cell Biochem*. 317(1-2):1–10.
- [66]. Althuis MD. Jordan NE. Ludington EA. 2002. Glucose and insulin responses to dietary chromium supplements: A meta analysis. *Am J Clin Nutr*. 76(1):148–155.
- [67]. Dureja H. Kaushik D. Kumar V. 2003. Developments in nutraceuticals. *Indian J Pharmacol*. 35:363-72.
- [68]. Halberstam M. Cohen N. Shlimovich P. 1996. Oral vanadyl sulfate improves insulin sensitivity in NIDDM but not obese nondiabetic subjects. *Diabetes*. 45(5):659–666.
- [69]. Cohen N. Halberstam M. Schilmovich P. 1995. Oral vanadyl sulfate improves hepatic and peripheral insulin sensitivity in patients with noninsulin dependent diabetes mellitus. *J Clin Invest*. 95(6):2501–2509.
- [70]. Boden G. Chen X. Ruiz J. 1996. Effects of vanadyl sulfate on carbohydrate and lipid metabolism in patients with non-insulin dependent diabetes mellitus. *Metabolism*. 45(9):1130–1135.
- [71]. Wyn S. Managing Editor. With Diabetes Surging Some Look for Alternative Treatment. 20 October 2006.
- [72]. Riccioni G. Bucciarelli T. Mancini B. 2007. Antioxidant vitamin supplementation in cardiovascular diseases. *Ann Clin Lab Sci*. 37(1):89–95.
- [73]. Chen H. Karne RJ. Hall G. 2006. High-dose oral vitamin C partially replenishes vitamin C levels in patients with type 2 diabetes and low vitamin C levels but does not improve endothelial dysfunction or insulin resistance. *Am J Physiol Heart Circ Physiol*. 290(1):H137–H145.
- [74]. Ni Z. Smogorzewski M. Massry SG. 1994. Effects of parathyroid hormone on cytosolic calcium of rat adipocytes. *Endocrinology*. 135(5):1837–1844.
- [75]. Prunell JG. Brunzell JD. 1997. The central role of dietary fat, not carbohydrate, in the insulin resistance syndrome. *Curr Opin Lipidol*. 8(1):17–22.
- [76]. <https://www.uspharmacist.com/article/the-role-of-supplements-in-diabetes-management>