Plant-derived functional components: prevent from various disorders by regulating the endocrine glands

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ABSTRACT
The current review is informed about the effectiveness of plant-derived functional components that aids in the regulation and health of endocrine glands. The endocrine glands include the thyroid, adrenal, hypothalamus, pituitary and pineal, ovaries and testes that play vital functions in our body such as growth and development, metabolism, mood and reproduction controlled by hormones. The abnormalities in the functions of endocrine glands are formed various disorders, such as diabetes, goiter, kidney problem, brain-related diseases and PCOS. Different parts of plant-based foods (fruits, vegetables, cereals, beans, legumes, herbs and spices) are composed of vitamins, minerals, antioxidants and phenolic compounds that help support different body functions. It is concluded that plant-based foods are a rich source of functional components that play a valuable role in regulating the function of the endocrine glands.

Introduction
The plant-based food pattern mainly targets plant foods that consist of fruits, vegetables, nuts, seeds, whole grains, legumes, beans, herbs, and spices. Fruit and vegetables are an essential part of a healthy diet. It helps to grow and support various body functions for better physical, mental and social well-being at all ages. It has been recognized as an excellent source of vegetable protein, vegetable fat (omega-3 polyunsaturated fatty acid), minerals, vitamins, micronutrients, dietary fiber, antioxidants and polyphenol. It is also sources of phytochemicals that act as antioxidants, phytoestrogens, and anti-inflammatory agents through other protective mechanisms against many disorders. It contain a diverse group of foods that differ significantly in energy and nutrient content. Plant-based foods like lentil beans, avocados, sweet potatoes, cereals and grains that provide vitamins B6 and B5 help to regulate the pineal gland by producing and distributing the melatonin hormone, which controls essential circadian rhythms. Furthermore, it also contain indigestible compounds, such as cellulose, resistant starch, pectin and hemicellulose, made the plant-based fiber fraction. Fruits and vegetables act as low-fat foods with unique nutrients and phytochemical profiles, particularly rich in vitamin C, vitamin B6, potassium, manganese and dietary fibers. It reduce the risk of non-communicable diseases and prevent malnutrition of all forms like undernutrition, micronutrient deficiency,
overweight and obesity. As part of a well-balanced, regular diet and active lifestyle, plant-based diet consumption can aid in the reduction of obesity, cholesterol and blood pressure and the maintenance of a healthy weight. These biologically active substances can help protect you from some diseases and lower the risk of diabetes type 2, stroke, obesity, cancer and cardiovascular disease. It is regarded as cruciferous vegetables that may lower the risk of particular kinds of cancer. As a part of a balanced plant-rich diet, legumes have many components to maintain digestive health and prevent chronic diseases.

**Characterization of plant-based foods and their functional composition**

Plant based-foods are a natural gift and packed with many functional materials. The fruits, vegetables, cereals, beans, grains, herbs and species are plant-based foods that have different ingredients in different parts, as shown in Table 1.

**Types of fruits and its nutritional and functional components**

A fleshy or dried ripe ovary of a flowering plant that is the fruit surrounded by seeds. Fruits are structures associated with the fleshy seeds of plants that are usually sweet or sour and can be eaten raw. The classification of fruits is based on tissue types, texture, shape and other morphological characteristics. There are two main type of fruits, including fleshy fruits and dry fruits. The fleshy fruit contains a lot of water in the pericarp and fully ripe it becomes a fleshy mesocarp. Consequently, fleshy fruits are more juicy than dried fruits. Fleshy fruits are avocados, apples, peaches, plums, peppers, cucumbers and tomatoes. On the other hand, dry fruits have three layers in their pericarp: endocarp, mesocarp, and exocarp but they are thinner and do not have as much water like fleshy fruits. Dry fruits are cashew, apricot, dates, hazelnut, walnut, almond, pistachio, resins, etc. Moreover, fleshy fruits are divided into three categories: simple, multiple and aggregate. A simple fruit, such as a peach and a tomato, grows from a single ovary. Multiple ovaries in a single flower combine to create an aggregate fruit, for example, blackberries, strawberries and pineapples. Aggregate fruit are good source of vitamins, carotenoids, volatiles, sugars, amino acids, organic acids, minerals, fibers, polyphenols,

| Table 1. Common plant-based foods parts and their derived components |
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| **Plant-based food** | **Name of some common plant foods** | **Parts of plant foods** | **Plant-derived functional components** | **References** |
| Vegetables | Kale, spinach, radishes, potato, beets, cauliflower, broccoli, cucumber, garlic and onion | Sprout, leaf, stem, flower and root | Antioxidants, polyphenols, vitamins, minerals and polyunsaturated fatty acids | [19–21] |
| Fruits | Grape fruits, oranges, apples, pears, mangoes, bananas, tomatoes (avocados, peaches, apricots, strawberries, kiwifruit, melons, honeydew melons, watermelons, almond and cashew) | Pulp, peel and seed | Antioxidants, fibers, vitamins, minerals and polyphenols | [22–24] |
| Cereals | Wheat, rice, oat, rye, barley, sorghum and maize | Bran, endosperm and germ | Antioxidants, fibers, vitamins, minerals, fatty acids and polyphenols | [25–27] |
| Grains/legumes and beans | Dry beans, snap beans, shell beans, green peas, broad beans, green beans, chickpeas and lentils | Grain | Antioxidants, polyphenols, vitamins, minerals, polyunsaturated fatty acids and amino acids | [28–31] |
| Spices | Clove, ginger, saffron and cumin | Leaf, seed and stem | Zinc, magnesium, calcium, phosphorus, phenolic compounds and antioxidants | [27–30] |
| Herbs | Mint, Aloe vera, parsley, dill, basil, rosemary and coriander | Leaf, stem and root | Phenolic compounds and antioxidants | [5,32–36] |
flavonoids, anthocyanins, triterpenes, and other nutrients.\textsuperscript{[11]} It has many health benefits such as preventing inflammatory bowel diseases, constipation and diverticular disease, reduce the risk of cardiovascular disease and severity of asthma, enhancing psychological well-being and contributing higher bone mineral density in and adults and children, lowering the risk of depression and improving the odds of successful aging.\textsuperscript{[40]}

**Types of vegetables and its nutritional and functional components**

The fresh edible portion of certain edible plants is usually referred to as vegetables. The parts of the vegetable plants such as leaves, fruit, stems, roots, tubers, seeds and flowers are mostly commonly consumed for multiple purposes. Vegetables are more often cooked and eaten than low-sugar fruits. Vegetables are classified into various groups: sweet, carrot, radish, sweet potato and turnip are root vegetables while asparagus and kohlrabi are stem vegetables. Underground stems and edible tubers are potatoes. Cabbage, lettuce, celery, brussels sprouts, rhubarb, and spinach are leaf and leafstalk vegetables. The bulb vegetables are onion, leeks and garlic.\textsuperscript{[41]} Cauliflower, broccoli and artichokes are included in flower vegetables. Some fruits like cucumber, eggplant, okra, sweet corn, squash, peppers and tomatoes are considered vegetables by virtue of their use. Seed vegetables are legumes and peas.

Vegetables are rich sources of carbohydrates, protein, vitamins and minerals. Carbohydrates represent more than 90% of the dry matter of fruit and are the main component of vegetables.\textsuperscript{[42]} Carbohydrates are found in the form of sugars, starch and dietary fiber. Starch mainly exists in root vegetables such as potatoes and sweet potatoes. Several minerals like K, Ca, Mg, P and Fe and traces of oligo-elements are also found present in vegetables. Vegetables have been extensively involved with improving gastrointestinal health, good vision, reduced risk of heart disease, stroke, chronic diseases, diabetes, and some forms of cancer.\textsuperscript{[43]} Cruciferous vegetables such as brussels sprouts, broccoli and cauliflower are very effective for thyroid health. Some phytochemicals from vegetables act as potent antioxidants and reduce the risk of chronic disease by modifying metabolic activation, detoxifying carcinogens, protecting against free radical damage, or possibly interfering with mechanisms that alter the path of tumor cells.\textsuperscript{[44]} All vegetables can protect humans from chronic diseases.\textsuperscript{[45]}

**Types of nuts, seeds and beans, and its nutritional and functional components**

Nuts are fruits composed of edible seeds having an inedible hard shell. Generally, a variety of dried seeds are called nuts. Nuts are nutrients and energy-rich food sources. Nuts are a good source of protein and bioactive substances and are high in fiber and rich in a variety of vitamins and minerals.\textsuperscript{[46]} Generally, nuts are a good source of protein, fiber and fat. Consumption of nuts are highly beneficial and reduces the risk of cancer and cardiovascular diseases.\textsuperscript{[47]} Nuts are high in protein and fats and low in carbohydrates and glycemic index. The pituitary gland primarily runs on vitamins D and E. Foods with high protein like nuts should be incorporated into the diet.\textsuperscript{[48]} Moreover, nuts also increase intellectual functions.\textsuperscript{[49]}

Seed is an embryonic plant confined in a protective outer covering. Seeds result from the ripened ovule after fertilization by pollen and some growth within the mother plant. The embryo flourishes from the zygote and the seed coat from the envelope of the ovule. There are different types of seeds like sunflower, pumpkin, sesame, poppy and flaxseed.\textsuperscript{[50]} Protein, minerals, vitamins and fiber are all found in seeds. Seeds may also coat bread and provide texture and taste to other meals. Seeds make a nutritious snack and that can be added to salads, casseroles, breakfast cereals and smoothies. They are a source of human protein and calories.\textsuperscript{[51]} Seeds are incredibly nutritious due to their nutritional content of fiber, protein, monounsaturated and polyunsaturated fats. Seeds are used to make a nutritious snack. salads,
casseroles, breakfast cereals and smoothies. Seeds are effective additive to our daily life. It’s used in a healthy diet, seeds can help lower blood pressure, blood sugar and cholesterol levels.\(^{[49]}\)

Beans are the seeds of many species of flowering plants that are used as vegetables. Beans are used in many traditional dishes all over the world. Beans are usually found in the form of dried and green beans. Dry beans are a source of protein, complex carbohydrates, fiber, vitamins and minerals.\(^{[52]}\) Dry beans have been used to reduce the risk of chronic diseases such as coronary heart disease, diabetes mellitus, obesity and cancer\(^{[53]}\). A considerable amount of soluble fiber is also present in beans that help to reduce blood cholesterol. Green beans have been used to reduce the risk of various chronic illnesses, including cardiovascular diseases, high blood pressure, arthritis, diabetes, Alzheimer’s disease, and cancer Biological components of beans have been used to boost fertility for female reproduction.\(^{[54]}\)

**Types of cereals (grains), legumes and pulses, and their nutritional and functional components**

Cereals are seeds or grains of grasses that belong to the Gramineae family and are produced for the maximum yield of their seed, which contains of bran, endosperm and germ, and is also known as the caryopsis. Influential cereals are wheat, sorghum, maize, oat, rice, rye, millet and barley.\(^{[55]}\) Other important crops in this family are bamboo and sugar cane. Cereals are cultivated in enormous amounts and are used as a staple food in a maximum of the developing countries because it provide more energy. Cereals are considered staple crops and are cultivated in greater quantities worldwide.\(^{[56]}\) Chia, quinoa and buckwheat are indicated as pseudocereals. Whole grains have health-improving properties (dietary fiber, inulin, beta-glucan, resistant starch, carotenoids, phenolics, tocotrienols, and tocopherols) and also play an important role in preventing diseases such as hypertension, type 2 diabetes mellitus, different forms of cancer, metabolic syndrome, cardiovascular diseases, and obesity.\(^{[57]}\)

Plant from the Fabaceae family are comprised of stem, leaves and pods. Legumes are nutritious diets and composed of vitamins, protein, complex carbohydrates and fiber.\(^{[58]}\) Consumption of legumes helps to reduce the risk of cardiovascular disease and cancers, and also helps to manage body weight.\(^{[59]}\) The pulse is a form of legume which produces a grain seed in a pod where the dried seed is harvested.\(^{[60]}\) Pulses are the edible seeds of plants in the legume family. Pulses grow in pods and come in various shapes, sizes and colors. The pulses are dry beans, broad dry beans, dry peas, chickpeas, pigeon peas, lentils, bambara beans, lupines and vetches.\(^{[61]}\) A lentil is a definite pulse with a lens-shaped seed. Pulses are healthy and nutritious because it contains protein, folate, soluble, insoluble fiber, phosphorus, monounsaturated, polyunsaturated fatty acids, and iron.\(^{[62]}\) Pulse consumption also influences serum lipid profiles and other cardiovascular disease risk factors, including inflammation, platelet activity and blood pressure. Pulses are rich in fiber and have a low glycemic index that making peoples healthy by maintaining insulin levels in the blood.\(^{[63]}\)

**Types of herbs and its nutritional and functional components**

The herbaceous plant without any woody stem are present on ground and is valued for its flavor, scent and medicinal properties.\(^{[64]}\) The plants can easily uproot from soil; few consist ofbranched or some have without branchless. According to the plant’s lifespan, herbaceous plants are classified as annual, perennial or biennial.\(^{[65]}\) Few examples of herbs are parsley, mint, dill, basil, sage and rosemary. Regarding nutritional benefits, herbs contain minerals, vitamins, flavonoids, anthocyanins and phenolic compounds for a balanced diet.\(^{[66]}\) Herbs enhance digestion and immunity to provide relief from pain and anxiety.
Types of spices and its nutritional and functional components

Oil-bearing seeds of herbaceous plants and tiny aromatic fruits rich in essential oils are referred to as spices. It may be aromatic seeds, bark, bud, berries and flowers.\[67\] Few examples of spices are clove, ginger, peppercorns, saffron and cumin. Spices from seeds are the primary source of carbohydrates, protein and fat. It is a good source of micro and macronutrients. Many spices are a rich sources of zinc, magnesium, calcium, phosphorus, phenolic compounds and antioxidants. Spices help in the natural production of insulin, reduce blood cholesterol, keep the immune system healthy, and have antimicrobial and antioxidant properties.\[68\]

Overview of glands and its location, functions and disorders

Endocrine glands

Endocrine glands make and release hormones in the bloodstream. Several vital functions in our body like growth and development, metabolism, mood and reproduction are controlled by hormones. Endocrine glands including thyroid gland, adrenal gland, hypothalamus, pituitary gland and pineal gland. Some organs that contain endocrine tissues and act as glands include the pancreas, kidneys, ovaries and testes.\[69\] The endocrine framework is an assortment of organs that produce chemicals, digestion, development and improvement of tissue work, sexual capacity, propagation, rest, and temperament. Chemicals are the synthetic couriers of the human body. They convey data starting with one gathering of cells then onto the next. These chemicals are delivered by organs and shipped to different body tissues through the blood roller.\[70\] Figure 1 shows the location of different endocrine glands in the human body.

Thyroid gland

The thyroid gland is located below the larynx in front of our neck. It has a shape similar to a butterfly and measures approximately two inches. It secretes hormones that virtually affect almost every tissue in our body. Thyroid hormones regulate heart, digestive function and other metabolism. It plays a significant role in brain, nerve development and muscle control. The pituitary (a small gland at the base of the brain) controls thyroid function.\[71\] Common thyroid disorders are hypothyroidism and
hyperthyroidism. When underactive thyroid does not produce enough hormones, it results in hypothyroidism and when the thyroid produces too much hormone, hyperthyroidism happens.\textsuperscript{[72]} Both these conditions result in an enlarged thyroid gland (goiter). Hypothyroidism results in unintentional weight gain, fatigue and slow heart rate. Hyperthyroidism signare like weight loss, nervousness and rapid heart rate. The thyroid gland secretes calcitonin (thyroine and triiodothyronine) hormones into the bloodstream that control the cells and organs' conversion of nutrients into energy and the amount of oxygen that cells use. The thyroid gland works with the pituitary gland to regulate the hormones released.\textsuperscript{[73]}

**Adrenal gland**

The adrenal gland is located at the top of each kidney and produces distinct hormones like cortisol, aldosterone, adrenaline and a small number of sex hormones called androgens. Hormones produced by adrenal gland have many important functions.\textsuperscript{[74]} It assist to control blood sugar, digest of fat and protein, regulate blood pressure, and react to stressors. Adrenal gland disorders is the result of too much or too low of certain hormones, like cortisol.\textsuperscript{[75]} High cortisol production due to adrenal disorder results in Cushing syndrome that causes weight gain, high blood pressure and a fatty hump between the shoulders. It is usually caused by extended use of corticosteroids.\textsuperscript{[76]} When the body produces too little cortisol and sometimes aldosterone, adrenal insufficiency can cause weight loss, decreased appetite and muscle weakness. Tumors or mass present on the adrenal gland resulting in adrenal incidentaloma which causes more production of hormones. The excess of these hormones could motivate heart attack due to high blood pressure.\textsuperscript{[75]}

**Hypothalamus**

The function of the hypothalamus is to act as a communication center for pituitary glands sending signals and messages to the pituitary to generate and release hormones that trigger the production and discharge of other hormones. Hypothalamus influences several body functions such as temperature regulation, memory, sleep and wakefulness, food intake, thirst and emotional behavior.\textsuperscript{[77]} To maintain homeostasis, the hypothalamus plays a role in creating or controlling many hormones in the body. Homeostasis is maintained by integrating sensory inputs, affecting responses through behavioral, endocrine, autonomic outputs throughout various time scales and throughout an individual’s lifetime.\textsuperscript{[78]} The hypothalamus collaborates with the pituitary gland to produce and transmit hormones throughout the body. The endocrine system is the name given to the whole system which comprises the gonads, thyroid, and adrenal cortex. Hormones produced by the hypothalamus are prolactin-controlling hormones, antidiuretic hormone, gonadotropin-releasing hormone, corticotropin-releasing hormone, thyrotropin-releasing hormone and oxytocin.\textsuperscript{[79]} The antidiuretic hormone increases the absorption of water in the blood by the kidney. The purpose of corticotropin hormone is to regulate immune response and metabolism. Oxytocin hormone induces several processes such as moderating body temperature and regulating sleep cycles and a mother’s breast milk flow. The thyroid is activated by thyrotropin hormones that control developmental growth, metabolism and energy levels.\textsuperscript{[80]}

**Pituitary gland**

The pituitary gland is located at the base of the brain. It is a pea-sized gland just behind the bridge of our nose. It is organized by the hypothalamus which is located above on it. It regulates many hormones in glands including the thyroid, adrenal glands, testes and ovaries; it
is also known as the master gland. Endocrine cells of the pituitary gland are arranged into structural and functional networks that is responsible for the coordinated response of endocrine cells to stimuli. These cellular networks are formed during embryonic development and are maintained in adulthood, granting the plasticity of the gland.\textsuperscript{81} The anterior pituitary produces seven hormones and the posterior pituitary secretes two hormones. The adrenal gland secretes cortisol that plays a role in controlling blood pressure, the body’s metabolism and blood sugar.\textsuperscript{82} Ovaries are stimulated by follicle-stimulating hormone to causes an increase in the hormone estrogen and produce ovum for fertilization. Growth hormone controls the amount of fat and muscles in the body. Luteinizing hormone triggers the release of ovum fertilization and in testes, it stimulates testosterone production. Melanocyte-stimulating hormone may control brain activity. Prolactin triggers the breasts to produce milk. Thyroid-stimulating hormone encourages the production of hormones, thyroxine and triiodothyronine. These hormones control functions such as metabolism, temperature and heart rate.\textsuperscript{83}

\textbf{Pineal gland}

The pineal gland is placed in the center of our brain. It produces and regulates specific hormones including melatonin that helps to regulate sleep patterns and also termed circadian rhythms. The functions pineal gland and the functions of melatonin overlap each other that having extremely general effects on précised functions like sleep and immunity.\textsuperscript{84} This gland plays a role in regulating female hormones that affect the menstrual cycle and fertility. Melatonin secretes concerning the light exposed to a person. It controls the natural sleep cycle and has a role in circadian rhythm. In ovaries, melatonin level affects frequency, duration and onset of the menstrual cycle. It acts as an anti-aging substance and regulates raw bone deposition. Pineal gland tumors account for one percent of total brain tumors and cause severe complications. Sometimes, pineal tumors block the route of cerebrospinal fluid, which causes the patinaed syndrome, visual changes, headache, nausea and seizures.\textsuperscript{47}

\textbf{Plant-derived foods components aid in regulating the endocrine glands that reduce the risk of different disorders}

Plant derived functional components including phenolic compounds, antioxidants, vitamins, minerals, omega-3 fatty acids and fiber are present in fruits, vegetables, cereals, nuts, spices and herbs. These components are played valuable role in different body functions and helpful in various disorders such as cancer, cardiovascular, infectious, diabetes, and others endocrine disorders.\textsuperscript{85,86} Different nutrients derived from plants plays an important role of great magnitude in the prevention of endocrine diseases. A review was conducted to highlighting the important nutritional risk factors that have impacts on various endocrine disorders. The finding show that the role of endocrine disrupter chemicals that are consistently being ingested in routine diet is being evaluated.\textsuperscript{87} The different endocrine and metabolic abnormalities found in patients with chronic kidney disorder include deficiencies in estrogen, testosterone, triiodothyronine, calcitriol and erythropoietin. In addition, accumulation of hormones (adiponectin, leptin, triglycerides and prolactin) also is seen. After that this can lead to the development of a wide range of clinical consequences including but not limited to anemia, hyperparathyroidism, insulin resistance, anorexia-cachexia, infertility, bone disorders and cardiovascular diseases.\textsuperscript{88} Various disorders occur due to abnormalities of different endocrine glands shown in Flow diagram 1. Plant-derived components aid in the endocrine gland’s health and regulation are represented in Table 2
**Plant-derived foods components regulate the pancreas that linked with diabetes**

Diabetes is a perplexing, quickly developing, persistent, nontransferable endocrine issue of worldwide concern related to the serious danger of creating digestion-related difficulties in patients. Diabetes is caused by the failure of pancreatic β-cells to discharge satisfactory insulin degrees. People with type 2 diabetes make insulin, but their β-cells don’t use it as well as they should.\textsuperscript{[107]} Pancreatic beta-cell brokenness is vital to the turn of events and deteriorating type 2 diabetes. Diminishes in both β-cell capacity and number can add to insulin inadequacy in type 2 diabetes. The β-cells have advanced significant metabolic components to avoid excessive insulin discharge and hypoglycemia.\textsuperscript{[108]}

Etiopathology of type 2 diabetes is irritation of the pancreas. Supporting this hypothesis, a raised number of macrophages have been recognized in islets of type 2 diabetes patients related to expanded degrees of cytokines and chemokines CD8+ cells and macrophages have likewise been observed to be raised in the exocrine compartment in type 2 just as type 1 diabetes recommending an immediate job of aggravation in type 2 diabetes islet brokenness. By and large, these perceptions propose that irritation of the pancreas assumes a certain pathogenic part in type 2 diabetes.\textsuperscript{[109]}

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**Table 2. Plant-derived components aid in endocrine glands health and regulation**

| Exocrine Gland | Plant-derived components | Functional Mechanism | Authors |
|----------------|--------------------------|----------------------|---------|
| Pineal gland   | PUFA, antioxidants and polyphenols | Some plant-derived ingredients including fatty contents, antioxidants and polyphenols regulate the functions of the pineal gland | \[89,90\] |
| Pituitary gland | Fiber, PUFA and polyphenols | Plant foods are composed of fiber, PUFA and polyphenols that aid in the regulation of the pituitary gland | \[91,92\] |
| Hypothalamus   | Omega-3 fatty acids, antioxidants, vitamin C, vitamins B1 and B12 | Omega-3 fatty acids, antioxidants, vitamin C, vitamins B1 and B12 are helpful in the normal performance of the hypothalamus | \[93,94\] |
| Adrenal gland  | Chlorophyll, vitamin C, iron and magnesium | Chlorophyll, vitamin C, iron and magnesium are derived from different plant sources that improve the performance of the adrenal gland | \[95–97\] |
| Thyroid gland  | Vitamin A, D, E, B2, B3, B12, iodine, iron, selenium and zinc | Some vitamins and minerals regulate the function of the thyroid gland | \[98–100\] |
| Ovaries        | Vitamins (C, D, B1, B2, B3, B6 and B12), calcium, zinc, iron and selenium | Both water and fat-soluble vitamins and specific minerals are used in regulating the function of ovaries that are prevented from various diseases | \[101–103\] |
| Testes         | Vitamins (C, E and D), zinc and D-Aspartic acid | D-Aspartic acid, specific vitamins and minerals are useful for the proper growth of testes | \[104–106\] |

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**Flow diagram 1. Various types of disorders occur due to abnormalities of different endocrine glands**
Plant-based foods can work on the metabolic status of patients, being utilized as adjuvants of exemplary antidiabetic treatment. The motivation behind our review to assess the effect of a unique plant-based antidiabetic detailing (PBAF). Diet and way of life, especially plant-based eating regimens, are powerful devices for type 2 diabetes counteraction and the executives. Plant-based eating regimens are eating designs that derscore vegetables, entire grains, vegetables, organic products, nuts and seeds.\cite{110} Plant-based food and supplement parts of plant-based are played important role in diminishing the danger of type 2 diabetes by weight control plans. Regardless, evidence suggests that the type and source of carbs, lipids, and protein (plant versus animal) have a key role in the prevention and management of type 2 diabetes.\cite{111} Various potential components underlie the advantages of a plant-based eating routine in enhancing insulin opposition including the expansions in fiber and phytonutrients, food-microbiome communications, diminishes in soaked fat, progressed glycation products, nitrosamines and heme iron.\cite{112} Explicit soil products, including root vegetables, green verdant vegetables, blueberries, grapes, and apples, have been connected to bringing down diabetes rates. Vegetables are played vital role to improve insulin opposition and ensure against metabolic disorder, and more noteworthy nuts utilization make lower diabetes hazards. All type of grain fiber seems to be particularly defensive against type 2 diabetes. Meta-examinations showed that sugars from entire grains and cereal strands decrease the danger of diabetes, while low-fiber carbs can expand the danger of diabetes.\cite{113} Another study suggests that plumbagin may be used as a novel therapeutic agent against human pancreatic cancer. Plumbagin is basically a quinoid constituent extracted from the roots Plumbago zeylanica L plant. Results showed that plumbagin treatment can prevent phosphorylation and DNA-binding activity of NF-κB in both cultured PC cells (PANC1 and ASPC1) and in PANC1 cells xenograft tumors.\cite{114}

The previous review shows the most relevant effects of various plant-derived natural compounds on the functionality of pancreatic beta cells. Drugs prepared from natural sources are more valuable than synthetic drugs because of their diversity and minimal side effects. It also suggests that natural compounds directly enhance insulin secretion, prevent pancreatic beta cell apoptosis, and modulate pancreatic beta cell differentiation and proliferation.\cite{115} Phytochemicals are essential in diabetes mellitus, particularly in agricultural nations with pitiful assets. Phytochemicals derived from plants that considered chance to new kinds of therapeutics for diabetes mellitus. Generally pervasive among phytochemical bunches are the alkaloids, glycosides, polysaccharides, and phenolics (flavonoids, terpenoids, and steroids). Despite impressive advancements in improving engineered drugs, the revelation of phytomedicine as an elective treatment is advancing.\cite{116}

Plant-based antidiabetic definition (PBAF) are Vaccinium myrtillus, Ribes nigrum, Rosa canina and Capsicum annuum that reduced oxidative weight found in diabetes mellitus. Vaccinium myrtillus berries are known as a “utilitarian food” or “superfood” because of their vast substance of bioactive mixtures as rich in polyphenols, flavonoids, nutrients, α-linolenic corrosive, chlorogenic corrosive and pentacyclic triterpenic acids (oleanolic and ursolic acids). Because it contained valuable phytochemical components that prevent cancer prevention agent and calming impacts were accounted for and a positive impact regarding the advancement of T2DM cardiovascular inconveniences.\cite{117} Ribes nigrum berries display a significant cancer prevention agent movement generally because of undeniable degrees of polyphenols (anthocyanins) and ascorbic corrosive, associating with responsive oxygen and nitrogen species, diminishing lipid and protein peroxidation. Additionally, it acts as antibacterial, antiviral and antiproliferative and antidiabetics.\cite{118} Rosa canina natural products are rich in ascorbic corrosive, polyunsaturated unsaturated fats, phenolic acids, proanthocyanins, flavonoids, carotenoids and tannins, intensifies yielding subterranean insect provocative and cell reinforcement impacts. In that capacity, it can be utilized as an medicinal purpose in treating endocrine diseases like diabetes.\cite{119} Capsicum annuum powder contained phytochemicals including capsaicin, phenols, carotenoids, tocopherols and ascorbic corrosive that has a positive effect on diabetic patients.\cite{120}
Plant-derived foods components regulate thyroid, hypothyroid that linked with goiter

The thyroid organ is the biggest in the body that emitting thyroxine and triiodothyronine and can direct energy digestion. Notably, thyroid chemical status is identified with body weight and energy use.\[121\] Hyperthyroidism, an excessive amount of thyroid chemical, advances a hypermetabolic state, which is described by expanded resting energy consumption, weight reduction, diminished cholesterol levels, expanded lipolysis, and gluconeogenesis.\[122\] On the other hand, hypothyroidism (diminished thyroid chemical levels) is related to hypometabolism which is portrayed by diminished resting energy use, weight acquires, expanded cholesterol levels, diminished lipolysis, and diminished gluconeogenesis.\[123\] The thyroid organ is fundamental for the guideline of digestion, improvement, and development. It acts through triiodothyronine (T3) and thyroxine (T4).\[124\] The thyroid and its chemicals play a diverse job in organ advancement and the homeostasis control of fundamental physiological instruments (for example, body development and energy consumption in all vertebrates).\[125\]

The expression “goiter” alludes to the abnormal growth of the thyroid organ. In people, lacking thyroglobulin Tg is a significant reason for inborn hypothyroidism. Realize that the presence of a goiter doesn’t imply that the thyroid organ is failing. Goiter might happen in organs that produce a lot of chemical (hyperthyroidism), too couple of chemicals (hypothyroidism), or the right measure of chemicals (typical thyroid capacity). Goiter shows the presence of a sickness that causes unusual development of the thyroid organ. Basic (nonpoisonous) goiter is amazingly normal worldwide and is thought to influence more than 200 million individuals.\[126\]

Iodine is a significant micronutrient that is especially significant for human wellbeing. Adequate dietary iodine is fundamental for the creation of thyroid chemicals. Deficient dietary iodine admission is related to numerous useful and formative irregularities called iodine lack issues (IDD), the most widely recognized is goiter.\[127\] Iodine nourishment is a vital determinant of thyroid sickness hazard; notwithstanding, different factors like maturing, smoking status, liquor utilization, conditions, hereditary helplessness, sex, race, the presence of other immune system infections, endocrine disruptors, and the rise of new treatments, also influences transmission of thyroid illness.\[128\]

Because of the broad utilization of salt for iodization, extreme iodine lack is uncommon. But even in many nations, gentle to direct insufficiency is boundless. Dietary iodine is available in different items including food, drinks, water and salt. The enhancements is significant for understanding iodine admission examples and arranging intercessions.\[129\] Notwithstanding, many mixtures can forestall the blend of these thyroid chemicals. These mixtures incorporate fluoride, nitrate, bromide, chloride, phosphate, and cyanide. These mixtures ordinarily come from food and water. Cassava, cabbage and pearl millet are a couple of normal food sources wealthy in thyroid chemicals. In spite of the fact that there are a ton of reports about the substance of thyroid chemical in food. In spite of the fact that vegetables are wealthy in supplements, if their goiter content is higher than as far as possible, their utilization might be limited and imperil wellbeing. Nonetheless, the aftereffects of this review show that the goiter-causing substances in vegetables are protected. Accordingly, eating these vegetables is helpful for wellbeing.\[130\]

Some plant can helpful in treatment of thyroid and prevent the danger of goiter or brokenness (like hypothyroidism). Plant parts (like cyanogens, glycosides, polyphenols, phenolic acids and alkaloids) that meddle with typical thyroid capacity.\[131\] The phenolic optional plant metabolites present in vascular plants and natural products have an assortment of beneficial impacts on wellbeing like the anticipation of malignancy and cardiovascular illnesses and even chemical substitution treatment. However, genistein, the principle part of soybeans and flavonoids, is known to meddle with the thyroid chemical framework incompletely because they are fundamentally like thyroid chemicals.\[132\] Previous studies suggest that plant derived compounds including curcumin, quercetin, catechins, resveratrol, myricetin and apigenin could be suitable for the treatment of thyroid cancer by slowing or blocking dedifferentiation and cancer progression.\[133\] Another review suggests beneficial effects of
some plant-derived phytochemicals including myricetin, quercetin, apigenin, rutin, genistein, and curcumin, and their possible role as adjuvants for the treatment of thyroid cancers have been described.\textsuperscript{[134]}

Vitamins and minerals are necessary for the proper functioning of the thyroid. Essential micro-nutrients for thyroid health are iodine, iron, selenium and zinc while, vitamins include vitamin A, D, E, B2, B3 and B12.\textsuperscript{[135]} Iodine is one of the most necessary nutrients for thyroid functioning. It is essential for the proper production of thyroid hormones.\textsuperscript{[136]} An iron-rich diet such as wholegrain cereals, parsley leaves must be consumed. Patients suffering from hypothyroidism must consume healthy and nutritious that contained polyunsaturated fatty acids and protein. For intake of unsaturated fatty acids vegetable oils, nuts, avocados are recommended.\textsuperscript{[137]} Selenium supplementation has a good impact on the treatment of Hashimoto’s thyroiditis. Selenium can neutralize free radicals and reduce inflammation and is also vital for the production of hormones. The deficiency of selenium can cause oxidative damage to the thyroid structure.\textsuperscript{[138]} Rich sources of selenium are mushrooms and nuts. Thyroid antibodies are positively associated with zinc concentration that shows the role of zinc in the immune defense of the organism. The deficiency of zinc causes a reduction of the metabolic rate of hormones.\textsuperscript{[139]}

**Plant-derived foods components regulate pineal and pituitary glands that play a role in brain**

The pineal and pituitary glands are vital neuroendocrine organs. The fundamental chemical discharged by the pineal organ is melatonin, however the pineal organ additionally delivers numerous different chemicals, including arginine angiotensin. The pineal organ controls gonadal activity, intervenes in light reactions, and affects the shade color. The pituitary organ dangles from the lower part of the nerve center at the lower part of the mind, in a little hard hole over the highest point of the mouth.\textsuperscript{[140]}

Nutrition that is essential for supporting the role of the hypothalamus includes omega-3 fatty acids, antioxidants, vitamin C, vitamins B-1 and B-12.\textsuperscript{[141]} Thiamine plays an important role to boost hypothalamus health.\textsuperscript{[142]} It helps to control the “satiety center” located in the hypothalamus of the brain, has a beneficial impact on the maintenance of appetite and helps to improve the function of the nervous system. The main sources of thiamine are sunflower seeds, lima beans, split peas, whole grains and bran. Vitamin B12 plays a primary function in the hypothalamus.\textsuperscript{[143]} It controls moods, energy levels, regulates fatigue and lowers depression symptoms. Vitamin B12 sources include fortified plant milk (soy, almond, coconut and rice), tempeh, cereals, algae, seaweed and mushrooms. Vitamin C is essential for brain and hypothalamus functioning.\textsuperscript{[144]} It plays a role in immunity promotion, sleep regulation, anxiety reduction and defend the hypothalamus against toxins. Food rich in vitamin C are red bell peppers, grapefruits, cantaloupe plus potatoes, strawberries and lemons. N-3 PUFA’s have anti-inflammatory properties and are aid in control brain functioning positively.\textsuperscript{[145]} Omega-3 polyunsaturated fatty acids, such as docosahexaenoic acid, eicosatetraenoic acid, and alpha-linolenic acid, are found mostly in fatty fish and some other seeds, nuts, and seafood. Essential fatty acids and prebiotics are found in many plant sources.\textsuperscript{[146]} The good sources are walnuts, hemp seeds, chia seeds, artichoke, garlic, banana, flaxseeds, algae, seaweed, and edamame. Small quantities can also be found in other green leafy vegetables including legumes. Prebiotics are beneficial for long-term blood glucose and insulin sensitivity due to the higher contents of plasma-free fatty acids using low tissue glucose. Omega-3 fatty acids are good for the brain by regulating pineal and pituitary glands and reducing the risk of heart diseases and metabolic disorders.\textsuperscript{[147,148]} Previous report shows a novel relation between a neuroendocrine system- and stress response-dependent mechanism and the regulation of cancer growth in vivo. Polyphenols derived from natural source can interfere with the growth and defense of cancer cells by down-regulating the pituitary gland-dependent ACTH synthesis.\textsuperscript{[149]} Another study was conducted psychologically stressed female rats that treat with flavonoids (semen cuscutae) on the hippocampal-hypothalamic-pituitary-ovarian sex hormone receptors in female rats exposed to psychological stress and to explore the related mechanism. Flavonoids from semen cuscutae is ability to
enhance estrogen receptor (ER) expression in the hippocampus, hypothalamus, and pituitaries, as well as luteinizing hormone receptor (LHR) expression in the ovaries. Conclusively, Flavonoids from semen cuscutae is effective medicine that can treat the ovarian endocrine dysfunction in psychologically stressed rats.\textsuperscript{[150]}

\textit{Plant-derived foods components regulate ADRENAL that improves renal health and others diseases}

The endocrine gland incorporates organs and tissues which produce chemicals to direct and organize significant body capacities. The adrenal organs are pyramid-formed organs on top of every kidney. Every adrenal organ comprises two constructions: the external adrenal cortex and the internal adrenal medulla.\textsuperscript{[151]} The adrenal cortex is the fine connective tissue network that makes up the greater part of the organs. It secretes a progression of steroid chemicals. The adrenal medulla (in the organs) produces adrenaline and norepinephrine (NE). These synthetics advance “acute stress,” the body’s underlying reaction to stretch.\textsuperscript{[152]} Adrenal deficiency is a reduction in the chemicals delivered by the adrenal organs (situated at the highest point of the kidneys). Inordinate adrenal capacity brought about by pituitary or adrenal cancers can likewise prompt genuine sicknesses like corpulence, muscle shortcoming, glucose bigotry, and disposition issues.\textsuperscript{[153]} The connection between the adrenal organ’s reaction to push stress mirrors a deviation from the typical body’s physiological or mental set point demonstrates that the hypothalamic-pituitary-adrenal (HPA) hub is a more normal and similarly significant capacity in everyday transformation conditions.\textsuperscript{[154]}

Plant medicines can play an important role in discovering novel targets for any illness. The leaves of Polygonum multiflorum include a variety of beneficial properties. The capacity of its basic fixes to act as energizers has been examined. The leaf portion of Polygonum multiflorum less can turn into a stimulant decision later on due to the existence of flavonoids expressly related with increasing memory activities and expanding synapse levels. As per them the detailed impact is in the cerebrum. In light of the perceptions of momentum audits, it is unequivocally prescribed to direct exploratory screening of the stimulant movement of Polygonum multiflorum less leaves.\textsuperscript{[155]} The job of normal mixtures in the therapy of kidney infections (counting intense renal disappointment and persistent kidney sickness) shows that regular mixtures from restorative plants have solid kidney and cardio-protective potential. The flavonoids in natural citrus products, red wine, tea and cocoa have mitigating action, managing pulse, and diminishing oxidative pressure. Olive oil wealthy in phenols; omega-3 unsaturated fats in flaxseed, soybean, rapeseed oil, and verdant vegetables; lycopene found in tomatoes, watermelons, and papaya; resveratrol in grape skins and seeds; the organically dynamic elements of tea and espresso; and different normal mixtures, for example, plant sterols, saponins, phenolic corrosive, phytic corrosive and isoflavones give more secure applications in the avoidance and therapy of different ongoing sicknesses. Regular mixtures separated from medicinal plants can be helpful guides due to their wide accessibility, better decency, less incidental effects, and essentialness in conventional medication.\textsuperscript{[156]}

Plant based diet including leafy greens and whole grains (hemp, chia, flax, almonds, chickpeas, lentils & quinoa) having vital amino acids are important for adrenal health. Some herbs like valerian help to reduce cortisol levels.\textsuperscript{[66]} Leafy green vegetables provide magnesium, vitamin C, iron and chlorophyll that provide energy and promote balance in the body. Leafy green vegetables are necessary fibers for the endocrine system to work well.\textsuperscript{[157]} Some herbs like ashwagandha and rhodiola are excellent for stabilizing adrenals and reducing stress. Likewise, an herb, valerian helps to reduce cortisol levels.\textsuperscript{[158]} Vitamin C is used by the adrenal glands to produce adrenal hormones. Principally, cortisol is a fat-storing and stress-related hormone. Fresh fruits and vegetables high in vitamin C include berries, citrus fruits, pineapple, broccoli, capsicum, papaya and leafy green vegetables. Pantothenic acid is most important to the adrenal gland working. It enhances the supplementation of progesterone and cortisol. It prevents the adrenal gland from being hyper-responsive and regulates its metabolism. Its deficiency causes adrenal exhaustion and metabolic disorders.\textsuperscript{[159]}
Plant-derived foods components regulate ovaries or testes that helpful in different diseases

In ladies, ovaries organ produces estrogen and progesterone. These chemicals assist with creating bosoms during adolescence, direct cycles, and backing pregnancy. Male gonads, the balls produce testosterone. It can assist them with developing facial and body hair during adolescence. It likewise advises the penis to grow and assume sperm creation.[160] Sex separation is the aftereffect of intricate hereditary and endocrine instruments which are firmly identified with improving the urogenital framework and adrenal organs. The arrangement of bipotent balls and one development testicles’ ensuing development. The testicles emit steroids and peptide chemicals which are essential for improving the male interior and outside genitalia.[161] The association of sex chemicals in the pathogenesis of immune system illnesses is by all accounts dependable because ladies experience the ill effects of immune system sicknesses more habitually than men. 5% of everyone experiences immune system infections, of which 78% are ladies. Ladies' immune system sicknesses have a prior beginning and are generally connected with raised sex chemicals.[162]

Youthfulness problems can significantly affect physical and social-emotional wellness. Intelligent adolescence implies that young ladies and young men start to enter pubescence before eight. Patients with early disconnected pubertal changes, straight development before pubescence and no stressing neurological indications normally have a harmless advancement design and should be observed in a fitting clinical setting.[163] Among patients with genuine bright adolescence or complete actuation of the hypothalamic-pituitary-testicle pivot, youngest ladies have idiopathic causes, while young men are typical because of specific imaging pathology. After the clinical history and actual assessment, serum follicle-animating chemical, luteinizing chemical, testosterone (young men), or estradiol (young ladies) should be estimated; thyroid capacity testing; and bone age radiography. Mind-attractive reverberation imaging should be performed in young ladies under 6, all young men with gifted pubescence, and youngsters with neurological indications.[164]

Polycystic ovarian condition (PCOS) is the most widely recognized female endocrine illness in ladies of childbearing age. Ladies with PCOS have relative estrogen levels, higher testosterone, and lower progesterone levels. Ovarian brokenness can prompt uncommon or no period hyperandrogenemia and additionally hyperandrogenemia, polycystic ovaries/ovaries in gynecological insulin resistance, hyperinsulinemia, stoutness (particularly the focal sort of corpulence), hypertension and nonalcoholic steatohepatitis (NASH) lastly entirely created metabolic disorder.[165] PCOS is related to insulin obstruction and expanded degrees of male chemicals (androgens). In addition to other things, a dormant way of life, absence of activity, dietary changes, and stress are mainly contributing elements. Turmeric, aloe vera, peppermint, chives, cinnamon and different plants have been demonstrated to be powerful in treating polycystic ovary disorder.[166]

Phytoestrogens are non-endocrine, non-steroidal auxiliary subordinates of plants that are burned through a plant-based eating regimen, otherwise called “dietary estrogen.” The primary wellsprings of phytoestrogens are soybeans and soy food sources, flaxseed, chickpeas, green beans, dairy items, etc. The use of phytoestrogens has an important role in the management of metabolic disorders such as obesity, diabetes, cancer, aggravation, cardiovascular infection, postmenopausal diseases and associated complexities.[167] Some Ayurvedic plants like Ashwagandha, Shatavari, green tea, garlic, fenugreek, pumpkin, angelica, cohosh racemosa and heavenly berry have sexual enhancer impacts and work on the quality and amount of semen. These spices give better nourishment to conceputive tissues. A natural medication that positively affects the conceputive framework. These common spices animate spermatogenesis, sperm motility and seminiferous tubule width, increment leydig cell count, dispose of strange sperm, improve histopathological recuperation, and sexual incitement.[168–170]
Conclusion

It is concluded that endocrine glands regulate their functions directly related to the perfect diet. Plant-based foods are composed of fruits, vegetables, cereals, beans, legumes, grains, herbs and spices. The different parts of plants contain functional components, including vitamins, minerals, antioxidants and phenolic compounds suitable for the health and regulation of all endocrine glands. The irregularity in their functions is the reason for various types of disorders. Furthermore, more study is required that specified the food for each gland in the future.

Disclosure statement

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