

Phytochemical Frontiers: Advancing the Management of Metabolic Syndrome

Shiva Shankar Reddy Nimmala ¹, Sreenu Thupakula ¹, Raju Padiya ^{1,*}

¹ Department of Biochemistry, University College of Science, Osmania University, Amberpet, Hyderabad, Telangana State 500007, India

* Correspondence: rajupadiya@gmail.com;

Scopus Author ID 44061643500

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Abstract: Metabolic syndromes, which include obesity, cancer, diabetes, and cardiovascular illnesses, are responsible for more than 50% of worldwide deaths, and there is a growing number of people affected by cardiovascular problems. The rise in these diseases is associated with changes in diet that involve a higher consumption of fats, cholesterol, sweets, and processed carbohydrates, along with a decreased intake of polyunsaturated fatty acids and fibers. Although traditional dietary approaches may initially be effective in controlling obesity and cardiometabolic illnesses, their long-term effectiveness tends to decline due to low rates of adherence. Research emphasizes the importance of bioactive chemicals, particularly polyphenols, due to their antioxidant properties and metabolic advantages. These actions encompass the promotion of widening blood vessels, the prevention of the formation of fatty deposits in arteries, and the provision of effects that counteract blood clotting and inflammation. Nevertheless, the diversity in individual reactions to polyphenols makes it challenging to create universally applicable dietary guidelines for obesity and associated cardiometabolic problems. Prior research has emphasized medicinal plants' potential in treating metabolic syndrome, supporting their use as a therapeutic intervention.

Keywords: bioactive compounds; diabetes; cardiovascular diseases; hypertension; metabolic syndrome; natural products; plant extracts.

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1. Introduction

Metabolic syndrome (MetS) is a notable health issue marked by a combination of metabolic dysfunctions, such as insulin resistance, dyslipidemia, hypertension, and central obesity, as listed in Figure 1 [1,2]. This condition greatly enhances the likelihood of developing atherosclerotic cardiovascular diseases (CVD), mostly driven by genetic predispositions and lifestyle choices, such as diet and physical exercise [3-5]. The increasing prevalence of obesity worldwide has increased emphasis on MetS, highlighting the significance of early identification and interventions encompassing lifestyle changes and using medications such as antihypertensives, statins, and metformin [6,7]. Moreover, current research investigations and discussions on the effectiveness of many natural bioactive compounds and nutraceuticals mentioned that are promised to efficiently control the MetS, as illustrated in Figure 1 [2,8-10].

The growth in MetS, especially type II diabetes mellitus (T2DM) and CVD can be attributed majorly to urbanization, sedentary lifestyles, and diets that are rich in calories and processed foods [11-13]. This escalation increases the likelihood of death from heart attacks and strokes. MetS is an important indicator for predicting future atherothrombotic events, and its

occurrence varies among different groups and locales [14]. MetS affects around 25% of adults globally and is linked to a high body mass index (BMI), insufficient physical exercise, and socioeconomic level [15]. Moreover, the occurrence of MetS is notably affected by hereditary variables, food, levels of physical activity, and the health history of one's family. This prevalence increases as individuals age and gain weight [16,17].

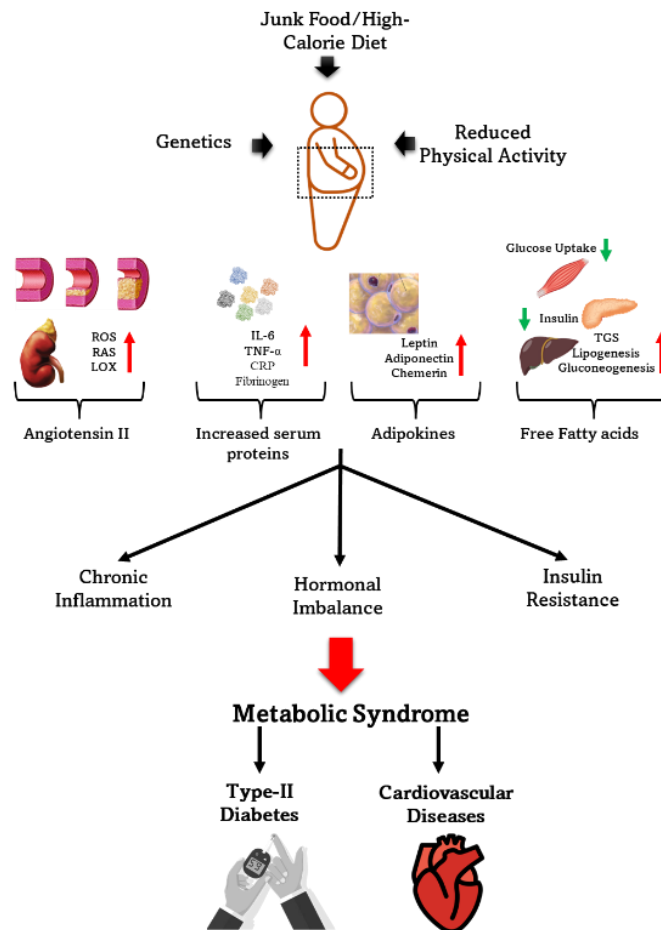


Figure 1. A detailed illustration of the sequence of events for the occurrence of metabolic disorders such as Type-II diabetes (T2D) and cardiovascular diseases (CVD), which are the repercussions of the intake of junk food, reduced physical activity, and hereditary diseases. (ROS- Reactive oxygenic species; RAS- Renin angiotensinogen system; LOX- Lipoprotein receptor-1; IL6- Interleukins; TNF α - Tumour necrotic factor alpha; TGS-Triglycerides; CRP- C-reactive protein) (Note: Images acquired under Creative Common license 4.0 CC).

Recent discussions from Chaturvedi *et al.* and Mohamed *et al.* emphasized the significance of bioactive substances, including alkaloids, flavonoids, tannins, and phenolic compounds, in managing MetS [2,18]. These plant-derived compounds have significant pharmacological benefits, including anti-inflammatory and immune-boosting characteristics, promoting metabolic health and overall well-being. This review intends to examine the importance of MetS, investigate current progress in research, and assess different approaches to managing it, with a specific emphasis on the potential of bioactive compounds [19].

2. Biological Effects of Plant-Based Compounds on Metabolic Syndrome

The scientific investigation of plant-derived compounds is crucial in identifying novel medications, with a specific emphasis on bioactive compounds found in food that benefit health. *Quercus robur*, which is abundant in antioxidants, promotes cardiovascular well-being and prevents the progression of atherosclerosis [20,21]. *Quercus infectoria*, due to its elevated tannin concentration, yields Mann, which is advantageous for treating bladder infections [22].

The intricate chemical composition of *Medicago sativa*, which includes flavonoids and amino acids, is associated with lowering cholesterol levels [23,24].

The study conducted by Abu Lafi *et al.* demonstrates the antioxidant properties of *Gundelia tournefortii* and its ability to reduce the development of atherosclerosis by regulating cholesterol and LDL levels [25]. *Valeriana officinalis* and *Eremurus persicus* are potential therapies for atherosclerosis and diabetes due to their antioxidative capabilities, as demonstrated by Nandhini *et al.* and Beiranvand *et al.* [26,27]. *Sesamum indicum* and *Origanum majorana*, due to their antioxidant properties, inhibit the oxidation of LDL and promote overall well-being [28,29].

Morus nigra and *Linum usitatissimum* are renowned for their anti-inflammatory and hypocholesterolemic properties [30,31]. *Silybum marianum* and *Jujuba ziziphus* have demonstrated efficacy in mitigating oxidative stress and diabetes, as documented by Bahmani *et al.* and Tahergorabi *et al.* [32,33]. The leaves of *Olea europaea* L. and the seeds of *Vitis vinifera* have the ability to dilate blood vessels and lower cholesterol levels, which helps in preventing cardiovascular diseases [34-36]. Many other plant sources that are potentially more abundant in bioactive compounds are illustrated in Figure 2, and their related functionalities are listed in Table 1.

Table 1. Plant-based bioactive compounds and their application in Metabolic syndromes.

Plant bioactive compound	Plant extracted from	Used for disease	References
Antioxidants	<i>Quercus robur</i>	Heart health, atherosclerosis prevention	[20,21]
Tannins, gallic, and ellagic acids	<i>Quercus infectoria</i>	Bladder infections (via D-mannose)	[22]
Flavonoids, amino acids	<i>Medicago sativa</i>	Cholesterol reduction, cholesterol-related diseases	[23,24]
Antioxidants	<i>Gundelia tournefortii</i>	Atherosclerosis prevention	[25]
Alpha-tocopherol, Vitamin E	General mention (no specific plant)	Cholesterol reduction, atherosclerosis prevention	[38]
Flavonoids, tannins, anthocyanins	<i>Pulicaria gnaphalodes</i>	Atherosclerosis prevention	[39]
Valerian hydroalcoholic extract	<i>Valeriana officinalis</i>	Anxiety, atherosclerosis	[26,40,41]
Berberine	<i>Eremurus persicus</i>	Atherosclerosis, diabetes, liver diseases	[27]
Sesamol, Sesamolol	<i>Sesamum indicum</i>	LDL oxidation prevention	[28]
Isoliquiritigenin	<i>Allium ampeloprasum</i>	Cardiovascular issues in diabetes	[42]
Phenolic Antioxidants	<i>Origanum majorana</i>	Dietary antioxidant source	[29,43,44]
Flavonoids	<i>Silybum marianum</i>	Atherosclerosis, vascular disorders	[32,45]
Antioxidants	<i>Jujuba ziziphus</i>	Anti-diabetic effects	[33]
Flavonoids, phenolic compounds	<i>Hypericum perforatum</i>	Atherosclerosis, cardiovascular disorders	[46]
Beta-sterol, Vitamins	<i>Amaranthus caudatus</i>	Cholesterol synthesis	[47]
Polyphenols	<i>Kelussia odoratissima</i>	Oxidative stress, cholesterol reduction	[48]
Caffeic acid	<i>Albizia odoratissima</i>	Oxidative stress, diabetic complications	[49]
Polyphenolics, oleuropein	<i>Olea europaea</i> L.	Atherosclerosis prevention	[34]
Polyphenolic substances	<i>Vitis vinifera</i>	Skin conditions, nausea, cardiovascular protection	[35]
Avena sativa, hordeum vulgare extracts	<i>Avena sativa</i> , <i>Hordeum vulgare</i>	Hyperlipidemia, coagulation factor reduction	[50]

3. Anti-Diabetic Activity of Bioactive Compounds

Diabetes continues to be a global health concern, but there have been notable improvements in the areas of prevention, detection, and treatment. Controlling type 1 diabetes Mellitus (T1DM) requires administering insulin injections daily and regularly checking glucose levels to prevent complications such as retinopathy and cardiovascular problems [37].

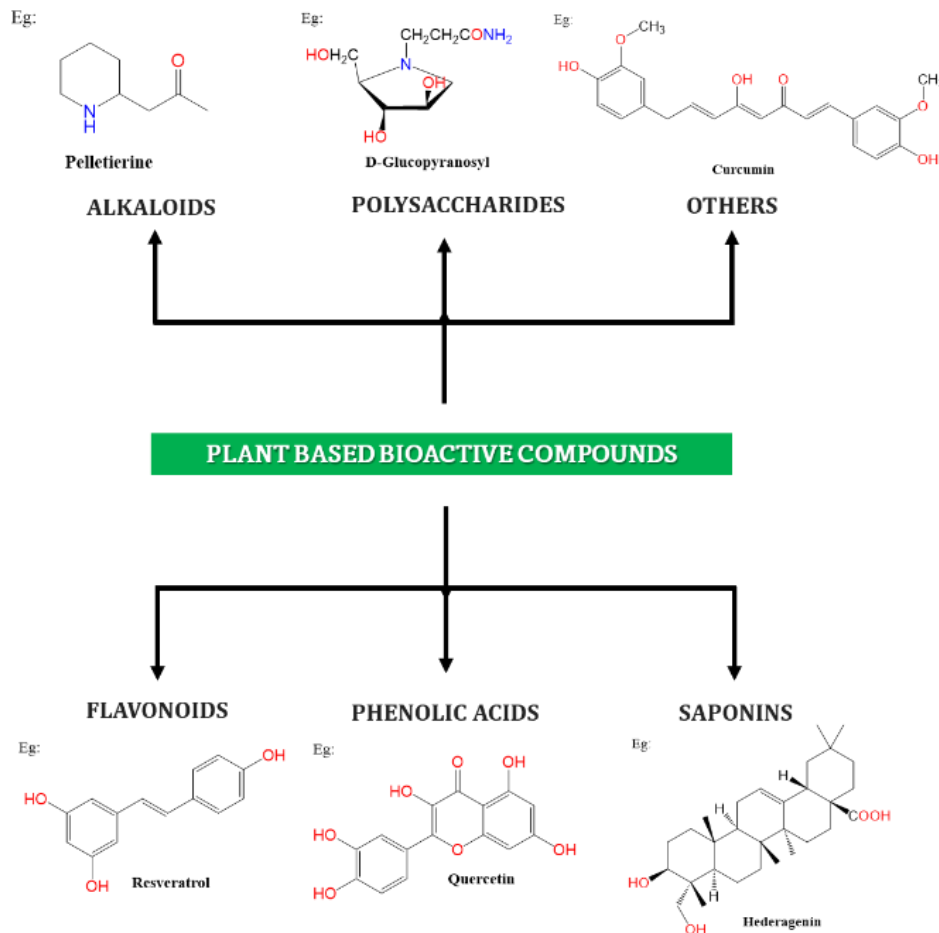


Figure 2. Bioactive compounds from plants are currently available that are effective against type-II diabetes, cardiovascular disorders, and other metabolic disorders.

Despite the possible curative benefits of organ transplants in specific circumstances, the restricted accessibility and the requirement for immunosuppressive medications, which have significant adverse effects, restrict the practicality of this alternative, as shown in Figure 3 [51,52]. The therapy of T2DM focuses on achieving optimal control of blood sugar levels to prevent cellular function degradation, which is essential for regulating glucose [53]. To address the progression of type 2 diabetes mellitus (T2DM), it is necessary to investigate peptide analogs and incretin-based therapeutics [54,55]. This is because traditional medicines and insulin do not help address the underlying metabolic and glucoregulatory difficulties.

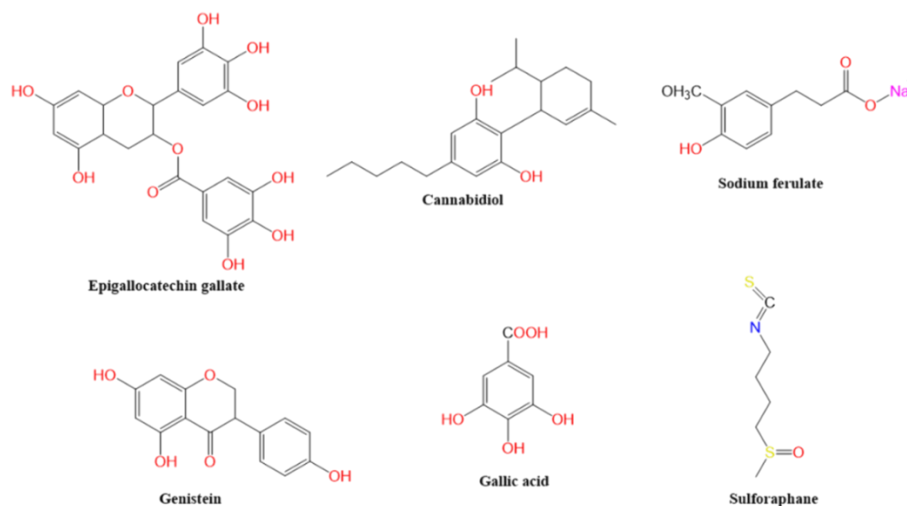


Figure 3. Selected bioactive compounds from plants that are effective against type-II diabetes.

Recent research reports highlight the healing advantages of conventional medicinal herbs and bioactive compounds produced from plants in treating diabetes, listed in Table 2 [56]. These natural therapies, renowned for their safety and minimal side effects compared to synthetic medications, specifically address several areas of diabetes pathophysiology, such as insulin production, glucose absorption, and metabolic abnormalities. *Artemisia annua* and *Brassica juncea* have demonstrated notable anti-diabetic properties by increasing insulin secretion and regulating glucose and lipids' metabolism [57]. In addition, *Nigella sativa* and *Salvia hispanica* L. (chia seeds) have shown beneficial effects on antioxidants, insulin synthesis, and glucose absorption [58]. Studies on the antidiabetic and antioxidant properties of *Lepidium sativum* L., *Moringa oleifera*, and other medicinal plants have provided valuable information on how these plants can enhance pancreas function and decrease oxidative stress [59].

Many studies emphasize the significance of utilizing medicinal chemistry to comprehend the mechanisms of action of anti-diabetic medications and to create novel treatments.

Table 2. Plant-based bioactive compounds in the management of diabetes and related disorders.

Plant	Bioactive compounds	Mechanism of action	Reference
<i>Artemisia annua</i>	Caffeoylquinic acid derivatives	Inhibits DPPIVI, α -amylase, and α -glucosidase enzymes; increases insulin release; protects pancreatic cells; delays glucose absorption; reduces postprandial glucose excursions	[61]
<i>Brassica juncea</i>	Glucosinolates, isothiocyanates, phenolic compounds, kaempferol, glycosides, flavonoids	Elevates serum insulin levels in STZ-induced diabetic mice	[62]
<i>Nigella sativa</i>	Thymoquinone, flavonoids, unsaturated fats, nigellone, p-cymene, carvone	Antioxidant effects enhance insulin secretion, improves glucose absorption, beta-cell function, and gene expression	[63]
<i>Salvia hispanica</i> L. (Chia seeds)	Vitamin B, α -linolenic acid (ALA), tocopherols, polyphenols	Reduces insulin resistance in T2DM; anti-diabetic properties	[64,65]
<i>Lepidium sativum</i> L.	Alcoholic extracts, seed powder	Protects pancreatic islets, maintains insulin secretion, stabilizes blood glucose levels	[66]
<i>Fenugreek</i>	Alkaloids, essential oils, mucilaginous soluble fibers, saponins, proteins	Lowers inflammatory mediators and glucose levels, contributing to reduced obesity and insulin resistance	[67]
<i>Moringa oleifera</i>	Methanol extracts	Antidiabetic and antioxidant effects increase protein and insulin levels and decrease serum glucose and nitric oxide levels	[68]
<i>Amaranthus sp.</i>	Whole-plant methanolic extracts	Hypoglycemic impact, an antihyperglycemic effect comparable to glibenclamide	[69]
<i>Anacardium occidentale</i>	Methanol extract	Reduces blood glucose levels in rats with streptozotocin-induced diabetes	[70]
<i>Bauhinia thonningii</i> Schum	Plant leaves extract	Anti-diabetic effects, improves blood sugar levels, LDL cholesterol, and heart disease symptoms	
<i>Origanum vulgare</i>	Methanol extracts	Significant antioxidant activity and phenol content, anti-inflammatory and cytoprotective properties	[71]

Researchers concentrate on investigating the pharmacological characteristics of natural substances in order to develop efficient treatments for diabetes. Their goal is to develop drugs that can accurately control blood sugar levels and reduce symptoms associated with diabetes.

Integrating herbal extracts with conventional pharmaceuticals offers a comprehensive strategy for managing diabetes, holding the potential for plant-based therapies to play a crucial role in addressing this widespread ailment [60].

4. Anti-Obesity Activity of Bioactive Compounds

Obesity, a condition of being clinically obese, occurs when there is an imbalance between the amount of energy consumed and expended, resulting in fat buildup in larger adipose cells [72,73]. Enzymes such as adipocyte fatty acid-binding protein, fatty acid synthase, and lipoprotein lipase, as well as the processes of lipogenesis and lipolysis, play a role in this metabolic change, leading to increased levels of blood lipids that are associated with obesity and hyperlipidemia [74]. Adipose tissue plays a critical role in metabolism and maintaining balance in the body by producing active adipokines and being controlled by peroxisome proliferator-activated receptors (PPAR), CCAAT/enhancer-binding proteins (C/EBP), and sterol regulatory element-binding proteins (SREBP) [75,76]. In addition, the activation of 5' AMP-activated protein kinase (AMPK) deactivates acetyl-CoA carboxylase (ACC), which increases the process of fatty acid oxidation and highlights the complex metabolic pathways associated with obesity [77].

The inquiry into herbal plants for weight loss has attracted attention, offering advantages over pharmaceutical therapies as a result of reduced side effects, which are listed in Table 3 and illustrated the important compounds in Figure 4. Notable herbal treatments for obesity include *Nigella sativa*, *Hibiscus sabdariffa*, *Ilex paraguariensis*, *Rosmarinus officinalis*, and *Coffea arabica* [78]. These herbs are renowned for combatting obesity due to their antioxidant, antihyperlipidemic, and anti-inflammatory properties [79]. For example, the compound thymoquinone found in *Nigella sativa* reduces triglyceride levels and suppresses hunger [13]. Similarly, the flavonoids and phenolic acids in *Ilex paraguariensis* function as appetite suppressants and improve lipid profiles [13].

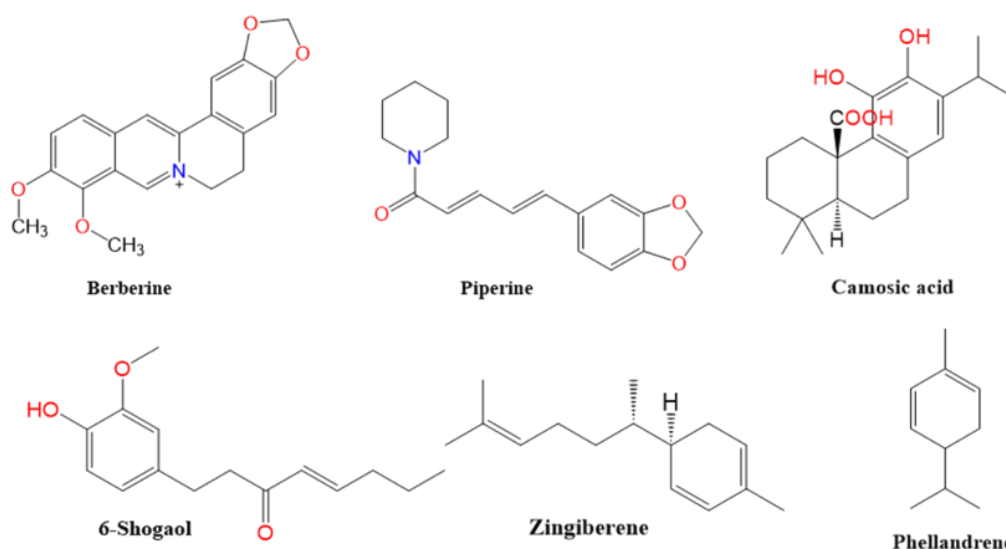


Figure 4. Selected Bioactive compounds from plants that are effective against obesity.

In addition, *Aframomum melegueta* and *Panax ginseng* show potential in preventing and treating obesity, as their bioactive substances help regulate the expression of genes involved in fat biosynthesis and consumption [78]. *Caralluma fimbriata* and *Capsicum* sp. employ distinct phytochemicals to decrease hunger and promote fat oxidation [80]. *Zingiber*

officinale, a herb used in cooking and medicine, contains chemicals such as gingerone, gingerols, shogaols, and paradols. These compounds prevent the creation of fat cells and the accumulation of triglycerides, showing anti-obesity actions [81]. This analysis emphasizes the promise of herbal medicine in managing obesity. It highlights the need for additional clinical trials and standardized manufacturing methods to verify the safety and effectiveness of herbal medicines. The diverse array of pharmacological advantages exhibited by these plants, encompassing the prevention of diabetes and cancer, facilitation of weight reduction, and provision of antibacterial qualities, underscores the pivotal significance of herbal treatments in comprehensive therapeutic approaches to obesity.

Table 3. Plant-based bioactive compounds in the management of Obesity and related disorders.

Plant	Bioactive compounds	Mechanism of action	Reference
<i>Nigella sativa</i>	Thymoquinone (TQ)	Reduces triglyceride levels, suppresses appetite, affects adiponectin levels	[82]
<i>Hibiscus sabdariffa</i>	Anthocyanins, flavonoids, organic acids	Reduces fat accumulation and oxidative stress, improves insulin sensitivity	[83]
<i>Ilex paraguariensis</i>	Quercetin, rutin, chlorogenic acids, caffeine, saponins	Suppresses appetite, reduces expression of genes regulating adipogenesis, improves lipid profiles	[84]
<i>Rosmarinus officinalis</i>	Carnosic acids	Alters activity of 3T3-L1 preadipocytes inhibits gastric and pancreatic lipase activity	[85]
<i>Coffea arabica</i>	Chlorogenic acids, caffeic acid, vanillic acid, trigonelline	Increases leptin and adiponectin levels, reduces WAT weight and weight gain, lowers mRNA expression of adipogenesis genes	[86]
<i>Aframomum melegueta</i>	6-Paradol, 6-Gingerol	Controls gene expression in liver and adipose tissue to prevent lipid accumulation and enhance fatty acid consumption	[87]
<i>Panax ginseng</i>	Ginsenosides	Influences leptin, ghrelin, adiponectin; reduces digestion and absorption of fat and carbohydrates	[88]
<i>Caralluma fimbriata</i>	Pregnane glycosides	Decreases hunger, inhibits citrate lyase, suppresses fat synthesis	[25]
<i>Capsicum sp.</i>	Capsaicin	Triggers TRPV1 pathway, affects appetite and satiety, reduces activities of GPDH and intracellular triglycerides	[89]
<i>Zingiber officinale</i>	Gingerone, gingerols, shogaols, paradols	Inhibits differentiation of preadipocytes, reduces GPDH activity, lowers levels of PPAR, C/EBP	[90]

5. Anti-Hypertension and Anti-inflammatory Activity of Bioactive Compounds

Unhealthy behaviors such as eating meals that are high in saturated fats and cholesterol, experiencing stress, smoking, not being physically active, and having underlying illnesses like diabetes, atherosclerosis, and hypertension are closely associated with the increase in instances of CVD [91,92]. These factors disturb the equilibrium between the formation of reactive oxygen species (ROS) and the capacity of the antioxidant system, resulting in endothelial dysfunction and inflammation, which are crucial in developing CVDs [93-95]. The exorbitant expense of conventional CVD drugs has generated increasing fascination with herbal medicine as a cost-efficient, safer, and more effective alternative therapy. Medical plants, which contain abundant functional and distinctive secondary metabolites such as phytochemicals, provide substantial medical advantages, are listed in Table 4, and major compounds are represented in Figure 5 and Figure 6 [96,97]. Scientists have discovered more than 2000 plants that have the potential to treat cardiovascular diseases, particularly hyperlipidemia and ischemic heart disease [98]. Pharmaceutical research is now making use of these bioactive compounds.

Table 4. Plant-based bioactive compounds in the management of hypertension and related disorders.

Plant	Bioactive compounds	Mechanism of action	Reference
<i>Allium sativum L.</i>	Selenium, amino acids, alliin, sulfide compounds	Reduces blood pressure, cholesterol levels, and atherosclerosis; enhances vasodilation	[104,105]
<i>Camellia sinensis</i>	Polyphenols, EGCG	Lowers cholesterol, anti-inflammatory, antioxidant, anti-thrombogenic	[106,107]
<i>Glycine Max L.</i>	Isoflavones	Reduces blood pressure and cholesterol, anti-thrombus formation	[97,108]
<i>Silybum marianum L.</i>	Flavonoids, Silymarin	Antioxidant and anti-inflammatory modulates preconditioning processes for heart protection	[109,110]
<i>Crataegus pinnatifida</i>	Oligomeric procyanidins, vitexin, quercetin	Improves hyperlipidemia, hypertension, CHF, and arrhythmia; enhances sodium-potassium ATPase activity	[111-113]
<i>Ginkgo biloba L.</i>	Bilobalides, flavonoids, ginkgolides	Antioxidant, anti-inflammatory, inhibits platelet aggregation	[114,115]
<i>Panax ginseng</i>	Ginsenosides	Enhances NO release, reduces platelet adhesion, stabilizes glucose homeostasis	[116]
<i>Convallaria majalis L.</i>	Cardenolides, saponins	Reduces heart rate, increases muscular contraction, lowers blood lipid levels	[117,118]
<i>Salvia miltiorrhiza Bunge</i>	Salvianolic acid, Tan IIA	It repairs cardiomyocyte survival pathways and antiplatelet, as well as reduces inflammation and coagulation.	[119-121]
<i>Borago officinalis L.</i>	Tannins, mucilage, saponins	Treats cardiovascular illnesses such as cardiotoxicism and hypertension	[122,123]
<i>Paeonia lactiflora</i>	Monoterpenes, phenolic acids	Stimulates circulatory system regulates NF-kB pathway to prevent myocardial remodeling	[124,125]

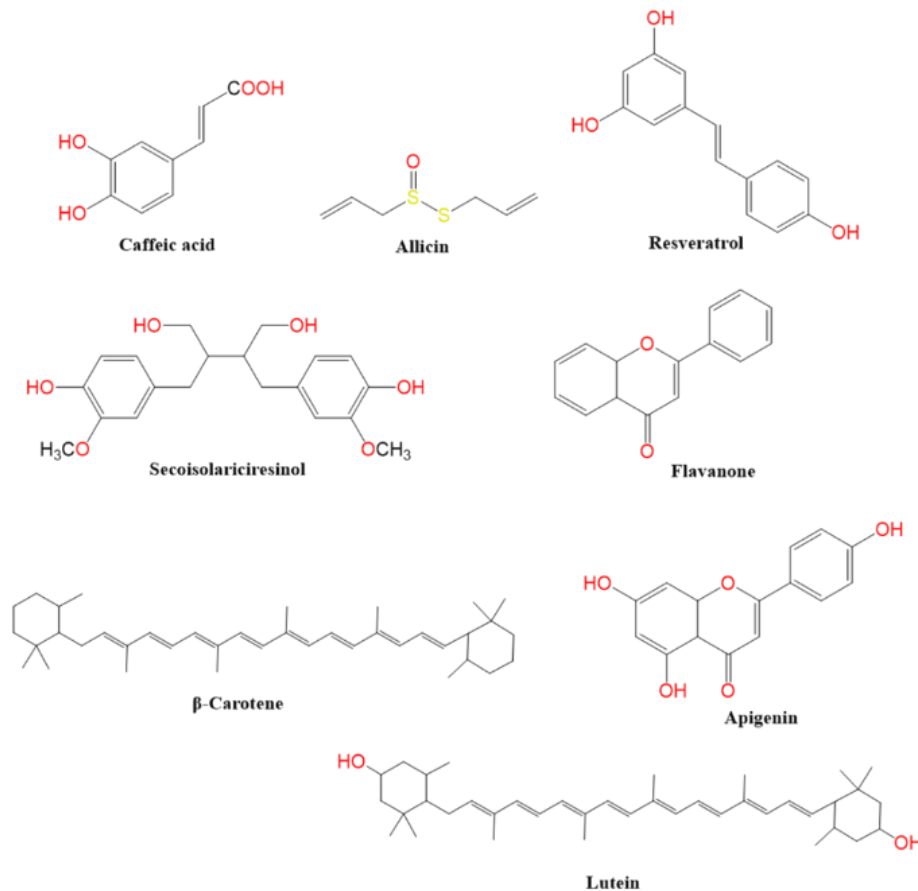


Figure 5. Selected bioactive compounds from plants that are effective against Inflammatory activity.

Different demographic groups have varying levels of ingestion of polyphenolic chemicals found in grains, legumes, wine, fruits, and nuts, which favor CVD [99]. Studies have

mostly investigated phytoestrogens, specifically lignans and isoflavonoids found in flaxseed and soy, to understand their impact on risk factors associated with CVD [100]. Compounds such as resveratrol, lycopene, and monoterpenes possess antioxidant and anti-inflammatory activities that provide preventative advantages against cardiovascular disease and CVD [101]. Research on herbal remedies like *Allium sativum* L. (garlic) and *Camellia sinensis* (tea) shows promise in preventing and treating CVD by enhancing lipid profiles and offering antioxidant advantages [102]. In addition, *Glycine Max* L. (soy) and *Silybum marianum* L. (milk thistle), together with other herbs, have therapeutic benefits due to their various bioactive components [103].

Investigating traditional and herbal remedies for cardiovascular disease (CVD) treatment highlights the need for more clinical trials and standardized manufacturing procedures to guarantee safety and effectiveness. Although natural remedies show promise, their application in clinical environments necessitates a thorough evaluation of the advantages and disadvantages, highlighting the significance of incorporating knowledge about complementary and alternative therapies into clinical practice.

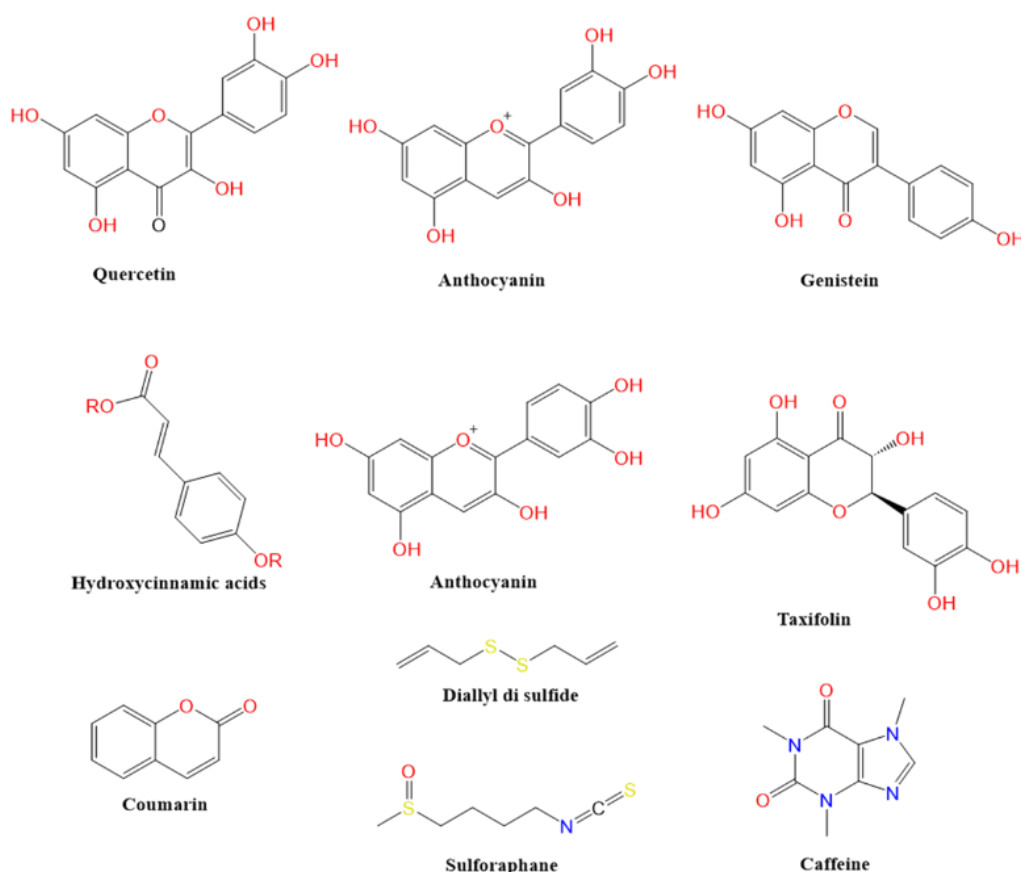


Figure 6. Selected Bioactive compounds from plants that are effective against hypertension.

6. Prospectus Research on Plant-Based Bioactive Compounds

The prevention, identification, and treatment of metabolic syndrome, which is a major public health issue, have shown advancements. Regular blood sugar monitoring and several daily insulin injections are crucial for people with type 1 diabetes Mellitus (T1DM) to prevent complications such as retinopathy and cardiovascular disease. Despite the potential curative benefits of pancreatic transplants for certain patients with T1DM, there is an insufficient supply of organs to meet the demand [37]. Additionally, the utilization of immunosuppressive

medications carries the potential for significant adverse reactions and the possibility of organ rejection. Glycemic management is of utmost importance in type 2 diabetes Mellitus (T2DM), yet traditional medications frequently fail to address the underlying metabolic dysfunctions [55] adequately. In order to effectively manage the increase in diabetes cases, it is necessary to use incretin-based therapies and peptide analogs. These treatments attempt to retain cell function and limit the progression of the disease by improving the uptake and utilization of glucose, especially by skeletal muscle.

Although synthetic anti-diabetic medications have progressed, there is an increasing inclination towards plant-derived bioactive molecules because of their safety and few adverse effects. Using medicinal chemistry to investigate these natural chemicals holds great potential for advancing the development of novel anti-diabetic drugs [55]. These studies highlight the therapeutic efficacy of combining herbal extracts with conventional medications, providing a comprehensive approach to alleviating diabetic symptoms by decreasing blood glucose levels [103]. The plant-based diet, which includes whole grains, vegetables, fruits, legumes, nuts, fish, and olive oil, promotes metabolic pathways advantageous for controlling MetS, T2DM, CVDs, and other chronic illnesses. The inclusion of olive oil and tree nuts, which are abundant in phytochemicals, minerals, and vegetable fats, plays a significant role in the preventive effects of this diet against cardiometabolic disorders, even when consumed as part of high-fat dietary patterns [1,2,8,126].

Investigating bioactive plant chemicals for treating metabolic diseases entails extracting and creating primary compounds from natural sources, offering a hopeful path for developing new drugs. A comprehensive strategy that combines conventional wisdom with contemporary drug discovery methods is crucial for addressing the obstacles encountered in natural product research. By integrating innovative plant compounds into drug development, there is a possibility of substantial effects on healthcare solutions and the production of novel drugs, emphasizing the significance of plants as a future reservoir for advanced pharmaceuticals.

7. Conclusions

Plant-based diets abundant in bioactive elements can help alleviate degenerative disorders characterized by oxidative stress and inflammation. Legumes, such as beans and lentils, provide preventive advantages against several health issues associated with MetS. These conditions include osteoporosis, neurological diseases, some types of cancer, insulin resistance, abnormal cholesterol levels, high blood pressure, and impaired glucose metabolism. A recent study highlights the capacity of plant-based diets and certain nutrients to prevent and reverse MetS and neurodegenerative disorders. This technique also targets molecular pathways such as hyperhomocysteinemia and insulin resistance, frequently observed in metabolic and neurodegenerative illnesses. Herbal therapy has a lengthy history in treating several cardiovascular ailments, and there is currently an increasing interest in traditional medicines as alternative medicine becomes more prominent. Several medicinal herbs possess properties that can alleviate cardiovascular disorders characterized by their cardiovascular, hypotensive, hemostatic, fibrinolytic, and anticoagulant activities. Although herbal medicines are often praised for their potential health advantages, the available information is largely based on personal stories rather than scientific studies. Moreover, the effects of plant chemicals such as lignans, flavonoids, and glucosinolates differ from person to person, highlighting the need for additional scientific research.

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Conflicts of Interest

The authors declare no conflict of interest.

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