



RUBUS GENUS SPECIES USED AS ANTIDIABETIC AGENT.

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Abstract: Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. The global rise in DM prevalence underscores the urgent need for effective, safe, and affordable therapeutic interventions. Members of the *Rubus* genus (family Rosaceae)—including species such as *R. ellipticus*, *R. fruticosus*, *R. idaeus*, and *R. occidentalis*—have shown significant antidiabetic potential in experimental models and limited clinical investigations. These species are rich in bioactive phytochemicals such as anthocyanins, flavonoids, phenolic acids, tannins, and terpenoids, which collectively contribute to their antioxidant, anti-inflammatory, and hypoglycemic activities. Their mechanisms of action involve enhancing insulin sensitivity, stimulating glucose uptake via AMPK activation, inhibiting carbohydrate-digesting enzymes (α -amylase and α -glucosidase), and protecting pancreatic β -cells from oxidative damage. Traditional medical systems, including Ayurveda and Traditional Chinese Medicine, have long employed *Rubus* species for managing diabetes and associated metabolic disorders. Pharmacological studies further support their ability to modulate key metabolic pathways and attenuate postprandial hyperglycemia. Despite encouraging findings, clinical evidence remains insufficient, warranting further research to isolate active constituents, standardize formulations, and establish dosage efficacy and safety. Overall, the *Rubus* genus represents a promising natural resource for the development of novel, plant-based antidiabetic therapeutics.

Keyword: Rubus genus, Antidiabetic activity, Phytochemical compounds, Flavonoids and anthocyanins, Insulin sensitivity, glucose metabolism, Type 2 diabetes mellitus.

I. INTRODUCTION

Diabetes mellitus (DM) is basically this ongoing metabolic thing that's getting to be a bigger and bigger deal all over the world. It's going up everywhere, both in countries that are still developing and in ones that are already developed. The World Health Organization, in 2016, said like, around 422 million people have it, and, get this, 1.5 million people die from it every year. Mostly in countries that aren't super rich.

It happens because of a bunch of different stuff, like your pancreas b-cells not working right, your body not responding to insulin the way it should, or your body just not making enough insulin, you know. (Padhi et al., 2020) And the thing it all boils down to is your blood sugar gets all messed up. (Deshmukh & Jain, 2021) There are two main types of diabetes: type 1 and type 2.

(Moradinazar et al., 2022).

With type 1, your body basically attacks the cells in your pancreas that make insulin. Like, your immune system goes haywire. So, you end up not making enough insulin, or sometimes none at all. Then you NEED insulin shots or a pump your entire life to stay alive (Eizirik et al., 2020; Padhi et al., 2020). The whole process involves a complicated fight between different types of immune cells in your pancreas, which ends up killing off the insulin-producing cells. Cells that are like stressed or injured release signals that just bring in more immune cells to destroy them even faster. (Eizirik et al., 2020) The UK Biobank showed that you can get type 1 at any age. About 42% of people are diagnosed after they turn 30, and 58% get it when they're younger. And it affects men and women pretty much the same.

(Thomas et al., 2019).

Type 2 diabetes is way more common - like, 90% of all diabetes cases - and it's a huge problem worldwide (Standl et al., 2019). It's kind of a progressive thing that often comes with other health problems, like high blood pressure, messed up cholesterol levels, polycystic ovary syndrome, and even kidney problems. (Jiang et al., 2023) It's a big drain on healthcare and the economy all over the planet (Khan et al., 2019; Liu et al., 2023). The World Health Organization says that people in poorer countries are especially

at risk. (Han et al. , 2019) Right now, it's estimated that 537 million adults have diabetes, and 80% of them live in countries that aren't very wealthy.

(Gregg et al. , 2023).

Back in 2017, like 8.8% of adults worldwide had diabetes, and they're saying it'll probably be up to 9.9% by 2045. In 2017, roughly 424.9 million people are living with diabetes, and they figure that number will jump by 48%, hitting 628.6 million by 2045 (Standl et al. , 2019). It gets more common as you get older. Like, about 5% of people in their late 30s have it, then 10% in their late 40s, 15% in their late 50s, and 20% in their late 60s. It mostly affects people in their 40s and 50s, which can really mess with their lives and the economy.

Managing diabetes means eating right and taking medication. Insulin and pills that lower blood sugar can help, but they also have downsides, like making your blood sugar too low, not working as well over time, and causing side effects, especially in older people. Around 5–10% of people eventually stop responding to the treatment because their pancreas keeps getting worse, they don't follow their treatment plan, they gain weight, or they get sick with something else. (Rahman et al. , 2022). So, in places where resources are kinda tight, getting your hands on insulin and those oral meds can be tough, and super expensive which makes treatment even more complicated y'know. Because of this, herbal remedies and stuff from plants have become a big thing, since they are way more affordable and seem safer, according to Chinsebu in 2019. Phytochemicals—basically, the good stuff in plants—are really promising 'cause they don't cost as much, are easy to get, and usually have fewer nasty side effects than those synthetic drugs, you know like what Salehi and Tarafdar were saying back in 2019 and 2015.

What you eat really matters when it comes to insulin resistance, especially as you get older or if you don't move around much. All that fast food, fatty meats, and sugary drinks. Yeah, that's a major reason why T2DM is becoming such a huge global problem. But, if you stick to a plant-based diet and cut down on animal products, you can seriously lower your chances of getting T2DM. Plus, it seems to help keep you from getting too heavy, having heart problems, cancer, and high blood pressure too - McMacken & Shah said that in 2017.

There's growing proof that natural antioxidants in plants can mess with how diabetes-related genes act, thanks to things like DNA methylation and histone whatchamacallit. modification Sun and the crew showed that back in 2021. So, these antioxidants are awesome for keeping diabetes and its complications at bay, especially if you're prediabetic. Ayoub (2015) found out that soluble phenolic compounds from berry seed meals – like the stuff that comes from gallic acid and quercetin – are really strong antioxidants. Blackberries, it turns out, have the most phenolic compounds, but the anthocyanin levels can vary a lot between different berries. Also, studies in India showed that vegetarians are way less likely to get T2DM and obesity than meat-eaters. This is probably because they eat more phytonutrients, less of those saturated animal fats, and go for foods that don't spike your blood sugar as much, according to Thomas et al, just this year in 2023.

Rubus Species: Diversity and Medicinal Significance

Members of the Rose family inhabit primarily tropical and cold areas in both hemispheres, encompassing approximately seven hundred identified varieties globally (based on Toshima's research). In 2021; see also: Yu et al. In 2022. Numerous botanical components including fruits, leaves, stalks, and roots have historically served in treating conditions like fevers, digestive issues, dermatological problems, diabetes, and inflammatory disorders. In 2022. Some taxa, such as *R. corchorifolius*, possess both culinary and ornamental merits. In terms of morphology, Rubus species display considerable diversity in their leaves, thorns, and fruiting bodies, complicating taxonomy because they often exhibit multiple sets of chromosomes (polyploid), interbreed freely (hybridize), and produce seeds without fertilization (apomictic reproduction)

(Yu et al.). In 2022.

Fig 1

From: <https://fpnp.biomedcentral.com/articles/10.1186/s43014-024-00263-3>

Fig 1.

Ripened berries of various *Rubus* species; a *Rubus caesius* (Photo credit-Janet Graham); b *Rubus-corchorifolius* (Photo credit-Ming-I Weng); c *Rubus occidentalis* (Photo credit-Dorota); d *Rubus fruticosus* (Photo Credit-janhallback); e *Rubus corchorifolius* (Photo credit-Ming-I Weng); f *Rubus chingii hu* (Photo credit-Pixabay.com); g *Rubus ellipticus*; h *Rubus rosifolius* (Photo credit-Ming-I Weng)

II. ANTIDIABETIC ACTIVITIES OF SELECT RUBUS SPECIES:

Rubus amabilis: The *Rubus amabilis* species is native to China, especially in the region of the Qinghai-Tibetan Plateau. It yields fragrant berries and foliage used for both culinary purposes and herbal teas. Laboratory tests using cell cultures showed that water-based plant compounds called procyanidins help prevent pancreatic cells from dying when exposed to harmful fats through an activation of their growth control system known as PI3K/FoxO1/Akt signaling. This process enhances how these cells produce insulin in response to sugar intake while being safe for them. In 2020.

Rubus anatolicus: The *Rubus anatolicus* thrives in regions such as Iran, the Himalayan mountains, the Balkan peninsula, and various areas within Asia, where it serves not only culinary purposes but also functions as a therapeutic agent treating conditions like diabetes. Extracts of leaves improved sugar absorption by cells like mice' pancreas, rats' muscle cells, and humans' livers; they stimulated insulin production and increased storage of sugars as starches, suggesting possible benefits for treating high blood sugar levels. In 2020.

Rubus Hu: The *Rubus* species is extensively grown in southern China; it comprises polyphenols, flavanones, cardiac glycosides, monoterpene compounds, and steroid constituents. Experiments conducted on diabetic mice using STZ revealed that their extract reduces high blood sugar levels while protecting beta cells' functionality, stimulates liver's production of glycogen, and regulates signals related to insulin activity, indicating it has therapeutic value against diabetes-associated issues. In 2021.

Rubus Caesius: The *Rubus caesius* variety is commonly referred to as the European dewberry; it boasts high concentrations of flavonoids, anthocyanins, and phenolic acids. Multiple laboratory tests show that this substance lowers blood sugar levels, boosts antioxidants, inhibits enzymes like α -amylase and cholinesterase, indicating it could be useful for managing after-meal blood sugars (Schädler & Dergatscheva, 2017; Grochowsky et al.). In 2018.

Rubus: The *Rubus corchorifolius* plant thrives in cultivation within China; it has been historically employed as an herbal remedy for treating bleeding conditions, alcohol addiction, and intestinal disorders. Leaves of this plant are used in making tea; its rich flavonoids show strong antioxidant and anti-diabetes properties, promising applications in diet and therapy. In 2021.

Rubus fruticosus : The plant *Rubus fruticosus*, also referred to as blackberry, thrives extensively across Europe and certain regions within Asia due to its widespread cultivation practices. The fruit contains high levels of antioxidants like anthocyanins, flavonoids, and phenolic acids due to these compounds' beneficial effects on health. Experiments conducted on living organisms reveal that compounds derived from *Rhodiola fruticosa* improve insulin responsiveness by increasing glucose absorption in non-organismal

organs and decreasing elevated blood sugar concentrations observed in animals suffering from diabetes mellitus II, indicating their possible use as an adjunct treatment option for this condition. In 2021.

Rubus grandifolius: The *Rubus grandifolius* species is native in specific tropical areas; it has historically been utilized due to its potential diabetes-lowering and inflammation-reducing effects. Analyzing phytochemicals uncovers the existence of compounds such as flavonoids, tannins, and steroids in question. Numerous experiments indicate that certain fruits and leaves contain compounds capable of boosting blood sugar levels management through increased insulin production and reducing activity in digestive enzyme systems; however, more investigation into their practical effectiveness for treating diabetes is required (Yu et al.). In 2022.

Rubus idaeus: The *Rubus idaeus* species is known colloquially as the red raspberry; it boasts significant concentrations of polyphenols, flavonoids, and ellagitannins due to extensive scientific investigation into these compounds' properties. Studies indicate these active substances show beneficial impacts on pancreatic beta cells by enhancing insulin responsiveness and lowering blood sugar levels after meals across laboratory tests and animal studies, thus offering potential as ingredients in food products designed to prevent type 2 diabetes. In 2021.

Rubus ulmifolius : The plant *Rubus ulmifolius* is commonly referred to as elmleaf blackberry; it originates naturally in regions including Europe and certain areas within Asia. Its composition includes substantial amounts of anthocyanins, flavonoids, and phenolic acids. Research indicates it can regulate blood sugar levels, stimulate insulin production, offer antioxidant defense mechanisms, thus being traditionally employed for controlling high blood sugar and related issues. In 2021.

Rubus occidentalis: The *Rubus occidentalis* plant commonly known as black raspberry contains abundant amounts of anthocyanins along with various polyphenolic substances. Studies suggest that these compounds decrease cellular damage caused by free radicals, enhance blood sugar levels regulation within organisms affected by diabetes, and safeguard insulin-producing cells of type 2 diabetics. This implies there's an opportunity for it being used as part of managing diabetes through diet (Sheng et al.). In 2020.

Rubus rosifolius: The plant *Rubus rosifolius* is commonly referred to as the roseleaf raspberry; it can be found in both Asia and Oceania regions. A particular plant demonstrates beneficial effects such as managing diabetes, protecting against oxidative stress, and reducing inflammation due to abundant levels of flavonoids and polyphenols. Numerous experiments show that compounds extracted from plants increase glucose absorption, boost insulin production, and lower blood sugar concentrations, validating their historical uses in medicine. In 2022. The *Rubus* species is native across certain regions in Africa; it has historically been employed as an herbal remedy for digestive issues and diabetes treatment. Studies on phytochemistry indicate the detection of compounds such as polyphenols, flavonoids, and gallic acids in various plant materials examined. Initial investigations indicate that these compounds may influence blood sugar levels and possess anti-oxidant properties; however, further rigorous pharmacology testing is necessary before confirming their role in diabetes treatment (Prakash et al.). In 2022.

Rubus ellipticus: The *Rubus ellipticus* plant, also known by its common name of yellow Himalayan raspberry, is widely grown in regions such as India and parts of Southeast Asia. The fruit contains substantial amounts of carotenoids, flavonoids, and polyphenols. Recent studies indicate that compounds derived from *R. ellipticus* stimulate insulin production while mitigating harmful effects of oxidation on blood sugar levels, supporting their historical application for controlling high blood sugars. In 2019.

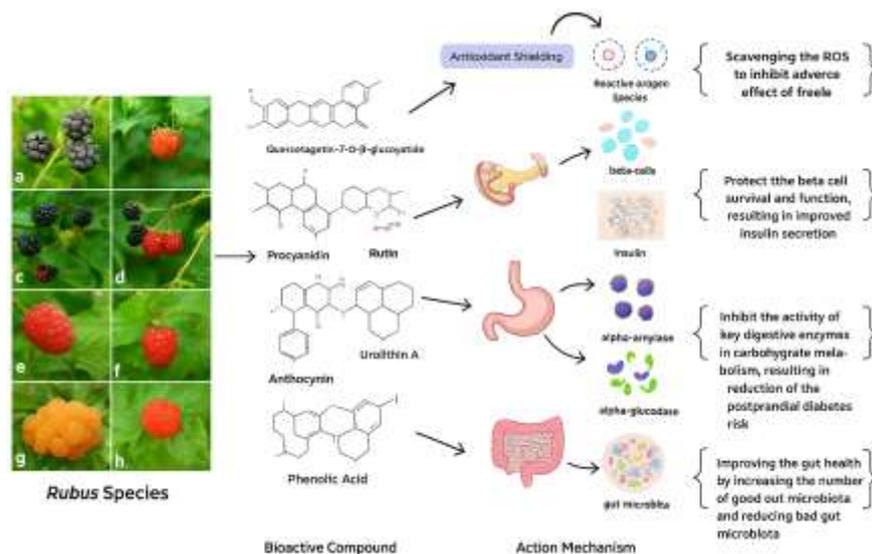
Mechanisms of action:Fig2: from <https://fppn.biomedcentral.com/articles/10.1186/s43014-024-00263-3>

Fig 2.

The way Rhus species work in lowering blood sugar levels. Boosting glucose absorption involves bioactive substances like ellagic acid, quercetin, and anthocyanins found in plants belonging to the Rubus genus stimulating AMP-activated protein kinase (AMPK) activity, thereby facilitating the translocation of GLUT4 proteins to the plasma membranes within muscles and fat cells. This procedure boosts sugar absorption into cells while optimizing their ability to use stored energy efficiently. Two. The extracts derived from plants like Rubus ellipticus and Rubus fruticosus demonstrate their ability to inhibit carbohydrate-digesting enzymes such as α -glucosidase and α -amylase. These substances slow down carbohydrate metabolism, thereby mitigating subsequent increases in blood sugar levels after meals. Three items have been mentioned in this context.

III. ENHANCEMENT OF INSULIN RECEPTIVITY:

Flavonoids found in certain Rubus plants influence crucial aspects of insulin signaling by activating peroxisome proliferator-activated receptor gamma (PPAR- γ) and insulin receptor substrate 1 (IRS-1). It enhances insulin sensitivity and promotes more efficient absorption of blood sugar in various body parts. Four. Antioxidant compounds like phenolic acids and ellagitannins present in Berberis exhibit potent protective effects on pancreatic beta cells by mitigating oxidative damage. This safeguard ensures steady production of natural insulin and healthy functioning of the pancreas. Five. Inhibition of hepatic glucose synthesis: Certain rubus extract compounds suppress gluconeogenesis through their effects on key enzymes like glucose-6-phosphate dehydrogenase and pyruvate carboxylase, thus decreasing excess glucose output by the liver and aiding in maintaining stable blood sugar levels.

IV. TRADITION USES:

Raspberries, belonging to the Rubus genus, have historically served as antidiabetic agents in several ancient medical traditions like Ayurvedic, Traditional Chinese Medicine, Ancient Greek pharmacology, and Indigenous healing practices across North America. These cultures utilized them for treating diverse conditions, particularly focusing on managing blood sugar levels related to diabetes. In 2002; see also Latha et al. In 2015; see also: Sasikumar et al. In 2015. Various components within the Rubus ellipticus plant - including its roots, fruits, and leaves - have historically been used as remedies due to their potential benefits in treating diabetes. Research into phytochemicals has shown that R. ellipticus possesses multiple active ingredients that contribute to its ability to combat diabetes. Compounds of phenol class (14) were extracted from plant parts like roots and fruits through methods involving methanol alone and an alcohol-water mixture in a 4:1 ratio (Vadivelan et al.). In 2009; Badhani et al. In 2015; see also: Sasikumar et al. In 2015.

Phenolic compounds are recognized for their ability to combat oxidative stress and inhibit enzymes, thereby aiding in better blood sugar control. Consequently, these compounds known as flavonoids contribute to plant colors such as red, blue, or yellow (Galeotti et al.). Reports of these substances were made in association with consumption of fruit and root parts of R. ellipticus plants. Five specific polyphenol components (compounds numbered five through six), including compound number five and compound number six, have been isolated one derived from ethyl acetate of fruits using a Soxhlet apparatus and another extracted directly from ethanol-based preparations containing roots (as reported by Vadivelan et al.). In 2009; see also: Sasikumar et al. In 2015. These compounds influence glucose handling by regulating metabolic processes and improving the body's response to insulin. Moreover, numerous triterpenoids - organic molecules consisting of thirty carbon atoms linked together by hydrocarbon chains (terpene units totaling forty-eight carbons) - have been discovered extensively within plant root tissues. A total of thirteen terpene-like substances (719 in number) was discovered through methanol-based extractions by Wei et al. In 2009. These substances demonstrate hypoglycemic properties through enhanced insulin release and decreased oxidative damage, thereby reinforcing the historical application of R. ellipticum in treating diabetes.

V. PHARMACOLOGICAL ACTIVITY

Antidiabetic Activity:

Another strategy for managing diabetes involves reducing carbohydrates' rate at which they're broken down into sugars within the intestines via enzyme inhibitors such as pancreatic amylase. Research examined various solvents like methanol, water, acetone, and hexane as possible inhibitors against α -amylase in plants belonging to the genus *Rubus sanctus*. Out of all substances tested, the methanol extract demonstrated the most potent inhibitory effect, achieving an IC_{50} concentration of 20 units. At concentrations equivalent to those found in the control substance glibenclamide (with an IC_{50} value of approximately 7), there were slight discrepancies observed compared to the reference medication acarbose. A concentration of 56 micrograms per milliliter suggests encouraging enzyme inhibitory properties as reported by Jaradat et al. In 2021(a). Consequently, extracts derived from *Rubus ellipticus* leaves in ethanol form showed modest activity against amylase enzymes, with an inhibitory concentration at half maximal being approximately 269 units. Concentration: 0.094 milligrams per liter. Research indicated that *R. ellipticus* might exhibit anti-diabetic properties due to its potent antioxidant effects. In 2019. An antioxidant compound derived from *Rhus chinensis* seeds exhibited significant hypoglycemic properties when administered to diabetic mice treated with STZ injections.

Forcing daily consumption of an extracted juice made from fruits over a period of fifteen days significantly reduced blood sugar levels while safeguarding the body's insulin-producing cells against destruction by a specific chemical substance called STZ. It also kept individual's leaner without losing their muscles. The results indicate that species *R. may* assist in managing high blood sugar levels and associated diabetes-related issues. In 2021. A separate investigation examined whether various stages of *Rubus fruticosus* L. fruits could hinder amylase activity. The ethanol and water-based samples exhibited notable enzyme suppression; however, the intermediate-ripening-stage water extract demonstrated superior efficacy compared to others. When compared to carbozole, these samples showed significant improvement in blood sugar levels after meals, indicating potential use of *R. fruticosus* fruit extract as an alternative treatment option for diabetes management. Furthermore, researchers examined *rubus rosifolius* extract samples prepared using n-hexane, ethanol, and methanol on diabetic animals. When administered at a dosage level of 50 milligrams per kilogram body weight, the n-hexane extract demonstrated an exceptionally potent hypoglycemic action compared to the standard diabetic medication metformin (administered in doses ranging up to 15 milligrams per kilogram), significantly enhancing its efficacy early on in the experiment. Additional scrutiny indicated that oxidation of triglycerides in the hexane extract played a significant role in increasing efficacy; it suggests promising properties as an effective glucose-lowering agent (Rambaran et al.). In 2020.

The pharmacological effects of plants belonging to the *Rubus* genus in treating diabetes.

Plants such as raspberries and blackberries belong to the *Rubus* genus; they have garnered significant attention due to their demonstrated ability in managing diabetes. The advantageous outcomes stem primarily from the inclusion of active ingredients like ellagic acid, quercetin, kaempferol, and anthocyanins, all of which influence various physiological processes for managing blood sugar levels and enhancing overall bodily function.

An important process includes boosting sugar absorption into cells. The polyphenols stimulate AMP-activated protein kinase (AMPK), an important player in regulating metabolic processes such as glucose uptake by muscles and fat cells. Enhancing cellular glucose uptake leads to decreased blood sugar levels.

Moreover, *Rubus* imparts an inhibition on digestive enzymes like α -amylase and α -glucosidase, thereby delaying carbohydrate metabolism into glucose and aiding in managing post-meal high blood sugar levels. Phytonutrients found abundantly in Raspberry help safeguard beta cells of the pancreas against oxidative stress while promoting cell renewal, resulting in enhanced insulin production and better control over blood sugar levels.

Numerous research findings indicate that extracts of *Rubus* species boost glucose uptake efficiency through enhanced interaction with insulin receptors and alleviate inflammatory-induced insulin insensitivity. Further evidence supports their ability to manage blood sugar levels through reduced oxidative damage and inflammation caused by specific compounds like antioxidants and anti-inflammatories, thereby mitigating diabetes-related health issues.

Additionally, plants of the *Rubus* genus contribute to managing blood lipids by reducing triglycerides and low-density lipoprotein cholesterol concentrations simultaneously enhancing high-density lipoprotein cholesterol levels. Phenolic compounds inhibit AGEs production, thereby safeguarding diabetic tissues from injury linked to prolonged disease state.

Empirical data corroborates this conclusion. To illustrate, consider Jouad et al. In 2001, research showed that an extract of *Rubus fruticosus* effectively reduced high blood sugar levels observed in diabetic animals compared to previous studies by Boscaro et al. Studies conducted in 2018 demonstrated enhanced glucose metabolism and better insulin function among animals and humans after consuming fruits containing *Rubus* extract

Caruso et al. A study by [67] indicated that regular intake of red raspberries improved blood sugar control among both pre-diabetic female subjects who exhibited insulin sensitivity issues and those classified as overweight yet still metabolically healthy, demonstrating reduced peaks in glucose and insulin concentrations. Consequently, ethanol derived from *Rubus ellipticus* fruit extract decreased the amount of sugar present after 2 hours compared to control groups and enhanced how well animals processed blood sugars. [68]. The suggested anti-hypoglycemic outcomes stem from various processes including stimulation of beta cell proliferation, lowering of postprandial glucose levels, enhancement of insulin release efficiency, activation of glucose sensors, thereby optimizing cellular absorption of sugars in tissues and overall metabolic function.

Furthermore, studies indicate that *Rubus* extract supplements exhibit glucose-lowering properties and enhance insulin responsiveness among male Wistar rats; they also boost fat breakdown within their abdominal tissues significantly - particularly

noted for its impact on female subjects [70]. Studies indicate that compounds extracted from blackberry guts enhance sugar uptake while boosting energy reserves like glycogen stores; they reduce harmful effects by lowering reactive oxygen species production, damaging mitochondria, and depleting glutathione levels within liver cancer cell lines subjected to elevated blood sugars paired with saturated fats [71].

Furthermore, research indicates that consuming fruits belonging to the genus *Ricinus lentis* exhibits beneficial effects on diabetic conditions in mouse models through enhanced antioxidant defenses specifically via an increase in the GPx:SOD ratio and reduction of oxidative damage [72]. Zahra Safar zad et al. Further research revealed that extracts of *R. anatolicus* improved glucose absorption into pancreatic CRI-D1 cells by stimulating insulin production. Moreover, Ayele et al. Observing that *R. erlangeri* leaf extract significantly lowered blood sugar levels while avoiding both body fat reduction and low blood sugar conditions was noted by [74].

VI. PHYTOCHEMISTRY OF RUBUS GENUS SPECIES

Anthocyanins

Various polyphenol molecules contribute to the vivid hues found in numerous plant species, blooms, and produce. In addition to serving as primary colorants in nature, these substances have been identified for their substantial therapeutic efficacy. Analysis performed using chromatography identified several anthocyanins in *Rubus fruticosus*, such as cyanidin pentoside, cyanidin-3-O-glucoside, and cyanidin-O-hexoside

(Vega et al.). In 2021.

In-depth analysis of methanol-based fruit extract compositions derived from hybrid *Rubus* species (*Rubus idaeus* x *R. occidentalis*) revealed various anthocyanins in different *R. occidentalis* varieties as well. Study of various species within the genus *Rubus*. The Shufeng sample exhibited exceptionally elevated levels of anthocyanins; its primary constituents were determined to be cyanidin and pelargonidin by Zhao et al. In 2023.

Different research using quantitative nuclear magnetic resonance analysis on edible plants like *Ribes fruticosum*, *Ribes palmatum*, *Rubus x medius*, *Ribes trifidum*, *Ribes hirtuosa*, *Ribes ideacephala*, and *Ribes minutifolium* found that *Ribes hirtuosa* had the greatest overall content of anthocyanins. Amongst these organisms, the most abundant anthocyanins included cyanidin-3-glucoside and pelargonidin-3-glucoside (as reported by Kumazawa et al.). In 2024. Furthermore, researchers measured the quantitative levels of anthocyanins in Korean black raspberries through liquid chromatography analysis.

Numerous studies indicate that Korean black raspberries predominantly consist of compounds such as cyanidin-3-O-rutinoside, pelargonidin-3-O-glucoside, and cyanidin-3-O-glucoside in their primary anthocyanin content (Kim et al.). In 2024. A different plant called *Rubus chingii* was discovered; it's also referred to as the Chinese raspberry and is naturally occurring in parts of China, Japan, and Korea. This particular plant contains compounds like cyanidin derivatives within its main anthocyanins, which include glucosides, sophorosides, rutinosides, sambubiosides, and their glycoside forms such as glucosylrutinosides. In 2023. For *Rubus discolor* (a wild blackberry species), researchers found that cyanidin-3-rutinoside and cyanidin-3-glucoside constituted the primary anthocyanins in this plant variety

(Kopjar et al.). In 2024.

Tannins

Phenolic substances found within plant cells contribute significantly due to their tannic properties, which give them an astringent taste characteristic of many botanicals. Hydrolysable tannins usually fall under category A while condensed ones belong to group B; both types resist decomposition by water but differ significantly in their stability against enzymatic breakdown (Pizzi, 2021). Numerous studies indicate that *Rhus vulgare* possesses tannins primarily in the form of tannic acid. In 2024, *Rubus* was predominantly characterized by its presence of ellagic acid according to Schmidt-Duran et al. In 2023.

Analysis of unripened fruit extracts from *R. chingii* identified pedunculagin, casuarin, casuarinin, and casuarictin as key ellagitannins (Li et al.). In 2019. Moreover, researchers discovered that

R. chamaerops foliage contained significant amounts of 4-O- α -L-arabinofuranosyl ellagitannins along with catechins as its primary tannic compounds (Whaley et al.). In 2021. The primary tannins in *R. ellipticus* (a yellow Himalayan raspberry) were determined to be ellagic acids, notably including lambertine A and sangquarin B2 (from Burlando et al.). In 2023.

An examination into plant chemicals found multiple substances related to tannins in *R. ulmifolius*. A hydromethanolic fruit extract harbored chlorogenic acid, whereas an ethanol-based extract boasted abundant hydrolyzable tannins like pedunculagin and geranin (Candela et al.). In 2021.

Terpenoids

Terpene derivatives constitute an important class of active phytochemicals widely distributed among plants belonging to the genus *Rubus*. Studies on phytochemistry revealed the presence of rubusoside in both *R. suavissimus* and *R. chingii* plants; this compound is classified as a diterpene glycoside and serves as an alternative natural sweetening agent. In 2023; Liu et al. In 2024.

Several unique compounds called goshonosides have been discovered within *Rhodomyrtus chinensis*; specifically, goshonoside G is found exclusively in its fruit tissue while goshonosides F1 through F5 can be detected across various parts of this plant including leaves. This discovery was made by He et al. In 2023, researchers including Z. Liu et al. published their findings. In 2023.

Analysis of *R. idaeus* leaf steam-distillates identified various terpenoids such as the sesquiterpene β -caryophyllene and the monoterpenes β -linalool, geraniol, 1,8-cineole, and α -citral (De Santis et al.). In 2022. *R. rosifolius*'s essential oil is characterized primarily by its terpenoids: linalool, α -terpineol, and geraniol; alongside δ -cadinene being recognized as the major sesquiterpenoid component in this plant species' volatile compounds (Rambaran & Ginigini, 2020). Furthermore, during research on *T. gondii*-killing properties by using *R. idaeus* extracts, it became apparent that methyl cymenol and limonene functioned as terpenoids while α -terpineol served as another type of terpenoid compound. In 2020.

Phenolic Acids and Flavonoids

Various *Rubus* plant varieties contain polyphenol substances, characterized by benzene rings attached to at least one hydrogen atom capable of forming an alcohol group, thereby enhancing their anti-oxidant effects and medicinal qualities. Research into varieties of *Rosa fruticosus* identified numerous polyphenols such as kaempferol-3-O-glucoside, myricetin, ellagitannins like ellagic acid, catechins, choleric compounds including chlorogenic acid, coumarinic substances in form of p-coumarate esters, rutinoides derived from quercetin, along with other hydroxycinnamic acids. In 2024.

Kaempferol emerged as a significant constituent in species of *R. ellipticus* according to Muniyandi et al. In 2019, it was observed that the aerial portions of *Rhododendron niveum* contained gallic acid, quercetin, and rutin (Pancholi & Rana, 2020). Analysis of *R. ulmifolius* Schott revealed gallic acid as the major phenolic compound, while quercetin and isorhamnetin were found to be among the highest in content. (Schulz et al.). In 2019.

R. glaucus contained primarily β -sitosterol and campesterol within its fruit extract samples (Alvarez & Hurtado, 2024); however, ethanol-based leaf extracts from *R. caesius* revealed multiple flavone glucosides such as rutin, hyperoside, naringenin-7-O-glucoside, tiliroside, astragaloside, and luteolin present therein

(Hering et al.). In 2022.

VII. MAEKETED PREPARATION:

Rubus Species	Marketed Preparation	Major Bioactive Compounds	Pharmacological Uses
<i>Rubus amabilis</i>	Powder, extract	Flavonoids, phenolic acids	Antioxidant, anti-inflammatory
<i>Rubus anatolicus</i>	Capsules, syrup	Anthocyanins, ellagic acid	Antidiabetic, cardioprotective
<i>Rubus chingii Hu</i>	Dried fruit, extract	Ellagitannins, triterpenoids	Anti-aging, hepatoprotective
<i>Rubus caesius</i>	Extract, tea	Polyphenols, flavonoids	Antioxidant, antimicrobial
<i>Rubus corchorifolius</i>	Tincture, juice	Catechins, phenolic glycosides	Anti-inflammatory, anticancer
<i>Rubus ellipticus</i>	Juice, capsule	Quercetin, kaempferol, gallic acid	Antidiabetic, antioxidant
<i>Rubus erlangeri Engl</i>	Fresh berries, extract	Anthocyanins, flavanols	Antioxidant, neuroprotective
<i>Rubus fruticosus</i>	Capsules, syrup	Cyanidin-3-glucoside, ellagic acid	Antidiabetic, antimicrobial
<i>Rubus grandifolius</i>	Extract, herbal tea	Flavonoids, phenolic acids	Antioxidant, wound healing
<i>Rubus occidentalis</i>	Powder, capsules	Cyanidin-3-rutinoside, ellagic acid	Antidiabetic, anti-obesity
<i>Rubus rosifolius</i>	Capsules, tincture	Anthocyanins, flavonoids	Antioxidant, anti-inflammatory
<i>Rubus steudneri</i>	Extract, powder	Polyphenols, triterpenes	Antimicrobial, antioxidant
<i>Rubus ulmifolius</i>	Juice, extract	Flavonoids, tannins, anthocyanins	Antidiabetic, antiulcer

VIII. FUTURE PROSPECTS:

Amongst genera like *Rubus* encompassed by taxa including *R. amabilis*, *R. anatolicus*, *R. chingii*, *R. caesius*, *R. corochinifolius*, *R. ellipticulatus*, *R. erlangensis*, *R. fruticosus*, *R. grandifolius*, *R. occidentalis*, *R. rosiophilus*, *R. stuedneri*, and *R. ulymphilous*, there is significant potential in their role as. A variety of research has demonstrated these substances' capacity to manage blood sugar by utilizing multiple strategies such as blocking crucial enzyme activities involved in breaking down carbohydrates (like amylase and glucosidase inhibitors) and enhancing how well cells respond to insulin, safeguarding beta-cell function within the pancreas, and minimizing harmful oxidation processes. Nevertheless, although promising results in experiments abound, substantial empirical support for those outcomes is lacking in clinical settings.

Future studies must concentrate on pinpointing and classifying particular phytochemical compounds like anthocyanins, flavonoids, and ellagitannins responsible for their positive impacts. Sophisticated techniques such as metabolic profiling and computer simulations aid in elucidating intricate biological processes related to blood sugar control. Additionally, creating uniform recipes, determining ideal doses, and performing meticulously controlled trials on patients using *Rubus* products is vital for validating their effectiveness and security. Further investigation into these plants might lead to useful natural remedies for managing diabetes.

IX. CLINICAL TRIALS:

Numerous laboratory tests on plants like *Rubus* indicate their ability to lower blood sugar levels; however, human trials remain scarce yet increasingly available data is accumulating. Studies examining early interventions using red raspberry (*Rubus idaeus*) and black raspberry (*Rubus occidentalis*), such as those conducted on these fruits, show encouraging outcomes in managing blood sugar levels and promoting overall metabolic wellness. Numerous studies have demonstrated that consuming powdered red raspberry regularly enhances blood sugar levels after meals for individuals diagnosed as having pre-diabetic conditions. Individuals consuming raspberries' antioxidants showed decreased fasting blood sugar, enhanced insulin response, and fewer inflammation indicators than those in the comparison cohort. Moreover, research into black raspberry supplements shows improved antioxidant levels, decreased oxidative damage, and more effective blood sugar control among individuals diagnosed with metabolic disorders like pre-diabetes or Type 2 diabetes.

The outcomes can be primarily linked to compounds like anthocyanins, ellagitannins, and flavonols found in *Rubus* fruits; these substances exhibit several advantageous functions including enhanced sugar absorption, regulation of insulin receptors, and safeguarding beta-cell health against oxidation stress. Although promising results abound, many clinical trials consist of modest sample sizes, brief interventions, and restricted taxonomic breadth – predominantly examining *R. idaeus* and *R. occidentalis*. A pressing requirement exists for enhanced, sustained research studies focusing on validating results, examining how drugs work in different bodies over time, and assessing the effectiveness of under-researched plants such as those belonging to genera *Rhodomyrtum* including *R. ellipticus*, *R. fruticosus*, and *R. chingii*. Moreover, standardizing extraction methods along with evaluating doses against responses is crucial for maintaining consistency across studies and demonstrating practical applicability in real-world scenarios. Securing this kind of proof is vital for converting *Rubus*-derived herbal remedies into effective pharmaceutical treatments for managing diabetes.

X. RESULT SUMMERY:

Several types of *Rubus* plants demonstrated notable antihyperglycemic properties along with potent antioxidant capabilities through both experimental models conducted in laboratories and animals. Samples derived from those herbs enhanced insulin release, facilitated sugar absorption into cells, and boosted liver glycogen production simultaneously by blocking digestive enzyme activities such as alpha amylase and alpha glucosidase. Substances like ellagic acid, quercetin, anthocyanins, flavonoids, and tannins contributed to improving glucose uptake by cells and safeguarding beta-cell function in the pancreas. Extracts of *Rubus fruticosus* and *Rubus rosifolius* demonstrated similar antidiabetic effects as those seen with standard medications like metformin when tested on diabetic animals. Moreover, studies revealed enhancements in blood lipids: decreased triglyceride concentrations along with lower levels of low-density lipoprotein (LDL) cholesterol while simultaneously increasing high-density lipoprotein (HDL) ratios. Two. Proteins within our body activate an enzyme called AMPK which enhances sugar uptake by muscles and adipose tissues. The inhibition of enzymes like α -amylase and α -glucosidase delays carbohydrate breakdown and reduces blood glucose levels after meals. The activation of PPAR- γ and IRS-1 enhances insulin receptor responsiveness. The antioxidant defense system in pancreatic beta cells safeguards against oxidative stress, thereby preserving their ability to produce insulin. Inhibition of the liver's ability to produce new sugars helps maintain steady blood sugar concentrations. Three items have been listed for consideration. Genus *Rubus* boasts an abundance of phytonutrients including anthocyanins, flavonoids, tannins, terpenes, and phenols. Important substances consist of cyanidin-3-galacturonic acid, petunia flavone, gallic acid, quercetin, vitexin, caffeic acid, and raspberry glycosides—each associated with anti-inflammatory properties and blood sugar regulation capabilities.

XI. CONCLUSION:

A thorough examination reveals that numerous members within the *Rubus* genus possess significant medicinal value for managing conditions such as Type 2 Diabetes Mellitus. This genus includes various plant species like *Rhus elliptica*, *Rhus cotinus*, *Rhus typhina*, *Rhus glabra*, among many more, which were historically used in herbal remedies alongside other ancient medical traditions such as Ayurvedic, TCM, and indigenous healers' methods due to their ability to manage blood sugar levels effectively. Current research in modern pharmacy and plant chemistry substantiates these traditional botanical assertions convincingly. *Rubus* species exhibit hypoglycemic properties due to their extensive array of bioactive compounds such as anthocyanins, flavonoids, phenols, tannins, and terpenes. These substances influence various pathways simultaneously via actions like boosting insulin release, improving cell responsiveness to insulin, activating AMPK enzymes, and encouraging glucose absorption in muscle and fat cells. Furthermore, these substances suppress crucial enzyme activities like α -amylase and α -glucosidase, thus controlling blood

sugar spikes after meals. These compounds exhibit enhanced effectiveness through additional antioxidants and anti-inflammatories which safeguard pancreatic beta cells against oxidative damage, maintain insulin production capabilities, and enhance systemic metabolic equilibrium. Studies conducted on RbUs utilizing cell cultures and living organisms showed notable reductions in blood sugar levels, cholesterol content, and anti-oxidant activity across different samples tested. Several species including *R. fruticosus*, *R. rosifolius*, and *R. ellipticus* exhibit outcomes similar to those of conventional antidiabetic medications like metformin when tested experimentally; this suggests they may serve as viable natural therapies or complementary treatments for diabetes. Additionally, compounds like rubus-derived antioxidants including ellagitannins, flavonoids, anthocyanins, glucopyranosides, and hydroxycinnamic acids play significant roles in achieving those therapeutic outcomes. Although encouraging results have been observed in this area of study, investigations into the medical applications of *Rubus* species remain underexplored compared to other fields. A substantial number of investigations focus primarily on studying species like *R. ideaus* and *R. occidentalis* for their effects on blood sugar after meals, insulin response times, and indicators of oxidation within individuals who may be at risk of developing diabetes. Moreover, extensive, cross-sectional research involving multiple centers over extended periods is required to validate these results, ascertain appropriate doses, and elucidate any potential risks.

Prioritizing standardization of plant extract compositions, identifying key biomarkers for efficacy, and conducting thorough mechanistic analyses is crucial for ensuring consistent results and reliable treatment outcomes. To summarize, the *Rubus* family serves as a crucial biological treasure trove containing potent medicinal substances with notable effects on diabetes treatment. Concocting those bioactive compounds within dietary items like supplements or refined herbs might serve as an economical and secure addition to current diabetic treatment protocols. Advanced metabolic analysis integrated with molecular modeling combined with clinical testing might lead to the creation of substantiated, naturally sourced medicinal compounds originating from plants like *Rubus*. The amalgamation of indigenous wisdom and contemporary technological methods offers potential in tackling the escalating prevalence of type 2 diabetes worldwide by implementing eco-friendly strategies.

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