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Review Article

Ethno-Medicinal Perspectives of Antidiabetic Plants from Sikkim-Himalaya: An Integrative Updated Review

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ABSTRACT

Sikkim state is considered as one of the hot spots in the northeast state of India. Talking to the richness of the biodiversity, there are about 490 medicinal plants were recorded only in Sikkim Himalaya till now. Traditional healers select these herbal remedies based on appropriate disease indications and symptoms. It is the precise time to compile Sikkim's traditional medicine documentation process for future use. A thorough literature search was conducted to gather the data, and reputable web resources like PubMed, ScienceDirect, ResearchGate, Google Scholar, Core, and 1library were consulted. In the first stage, we used broad keywords related to "ANTI-DIABETIC," followed by targeted searches for plants that are found in Sikkim-India. The review process only covered papers published in the recent 35 years, beginning in the 1990s. We employed Boolean operators like "AND," "OR," and "NOT" to narrow down our search results. In this review paper, we have highlighted 62 antidiabetic medicinal plants belonging to 36 families for the first time in a single work with their botanical name, family, local name, parts used, intake process, geographical distribution throughout the world, possible Mechanism of Action (MOA) and their ethno-medicinal utilities Sikkim Himalaya. In Figure 1, we have highlighted the family wise distribution and the part used. Based on the family wise use, it was found that Asteraceae are in higher use (8%) and followed by Solanaceae, Fabaceae Rutaceae and Caesalpiniaceae (5%) and Asparagaceae, Zingiberaceae, Menispermanceae, Gentianaceae Urticaceae and Caesalpiniaceae (3%). On other hand, in case of part used, highest was leaves and root (38 and 27%). Documentation of such knowledge will definitely encourage up-coming generations to discover novel pharmaceuticals to manage the diabetic condition in the future.

Keywords: Antidiabetic, Medicinal plants, Natural medicines, Sikkim Himalaya, Updated traditional insights.

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INTRODUCTION

Sikkim is the second smallest state of India which has a diverse range of biodiversity. About 490 medicinal plant species have been identified in the hills of Sikkim and Darjelling due to which it has been recently known as the hot spot of ethnobiological plants (Banerjee *et al*., 2019). According to the World Health Organization about 80% of the world's developing countries population depends on traditional medicine for their primary healthcare needs. Due to the strong belief in herbs, many medicinal plants have been used in traditional system of medicine and its wide range of practices by the ethnic groups which includes mainly the Bhutia, Lepcha and Nepali. This region, characterized by its unique climatic and geographic conditions, hosts a diverse array of flora, many of which exhibit ethno-medicinal properties. The indigenous communities in Sikkim have long utilized these plants for therapeutic purposes, including the management of diabetes (Chettri and Kumari, 2021). This review aims to explore and compile the available knowledge on antidiabetic plants indigenous to the Sikkim Himalaya, exploring their pharmacological properties, active compounds, and potential mechanisms of action.

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Diabetes and Traditional Remedies in Sikkim

Diabetes mellitus, a chronic metabolic disorder characterized by elevated blood glucose levels, poses a significant global health challenge. The World Health Organization has projected that diabetes will be the seventh leading cause of death by 2030 (World Health Organization, 2021). Affects over 400 million people worldwide, with rapidly increasing prevalence (Standl *et al*., 2019; van Susan *et al*., 2010). Type 2 diabetes can be prevented or controlled with lifestyle changes, but type 1 diabetes has no known cure. Early diagnosis and proper management are crucial for preventing complications and maintaining quality of life. Regular check-ups are important, especially for those with risk factors like family history, obesity, or sedentary lifestyle (Butt, 2022).

The alpine state of Sikkim, which is tucked away in the eastern Himalayas, is a world of stunning scenery, abundant wildlife, and deep cultural fusion. Beyond its scenic beauty, it harbors an ancient and living tradition of healing-a sophisticated pharmacopeia woven from the threads of indigenous Lepcha knowledge, Tibetan Sowa-Rigpa (the "Science of Healing"), Nepali folk practices, and Bhutia traditions (Bhutia, 2024). For centuries, the people of Sikkim have looked to their forests, meadows, and high-altitude slopes-where a vast reservoir of medicinal plants flourishes alongside deeply ingrained spiritual beliefs-instead of far-off pharmacies (Tewari, 2025). Traditional remedies in Sikkim are not merely about symptom relief; they represent a holistic worldview where health is a dynamic balance between the individual, the community, and the natural and cosmic environment (Goyal and Chauhan, 2024; Pandey and Sharma, 2025). This system sees wellness as a balance of physical, mental, and spiritual components and is frequently passed down orally through generations of Bongthings (Lepcha shamans), Amchis (Tibetan healers), and village elders (Bhutia, 2021; Lepcha, 2020). Treatment involves a meticulous combination of local herbs, minerals, animal products, and profound diagnostic techniques like pulse reading and astrological observation, often complemented by rituals to restore balance. Today, this heritage stands at a critical and fascinating juncture (Gaonkar and Hullatti, 2020). Recognized globally as a Biodiversity Hotspot and India's first fully organic state, Sikkim's traditional knowledge is gaining renewed relevance. Modern science is increasingly validating the efficacy of its key medicinal plants, such as Panch aule (*Dactylorhiza* hatagirea), Chirata (*Swertia* chirayita), and the high-altitude Yartsa Gunbu (*Ophiocordyceps sinensis*) (Chhetri, 2014; Sharma *et al*., 2020). At the same time, biopiracy, cultural dilution, and environmental change pose threats to this priceless knowledge. In the quest for effective management strategies, there has been an interest in traditional medicine, particularly the use of medicinal plants with antidiabetic properties. The Sikkim Himalaya, with its unique biodiversity and rich cultural heritage, is home to numerous plants traditionally utilized for managing diabetes (Gupta *et al*., 2014). Research has shown that many of these plants possess bioactive compounds that can modulate glucose metabolism, enhance insulin sensitivity, and exhibit antioxidant effects (Chhetri *et al*., 2005). Sikkim's diverse flora offers a range of plants known for their antidiabetic properties, which have been utilized for generations. Notably, *Hedychium spicatum*, a crucial medicinal plant in Ayurvedic medicine, possesses a wealth of therapeutic attributes, including antidiabetic properties, making it an important candidate for managing blood sugar levels (Kumari *et al*., 2021). Studies also have highlighted the hypoglycemic effects of *Gymnema sylvestre* and *Trigonella foenum-graecum*, both of which are prevalent in the region (Baskaran *et al*., 1990). This review aims to comprehensive compilation and analyzes the antidiabetic plants found in the Sikkim Himalaya, exploring their botanical name, families, local names, parts used, intake process, geographical distribution in Sikkim-India and in the world, and their ethno-medicinal utilities traditional usability, pharmacological properties and possible Mechanism of Action (MOA).

METHODOLOGY

A thorough literature search was conducted to gather the data, and reputable web resources like PubMed, ScienceDirect, ResearchGate, Google Scholar, Core, and Library were consulted. In the first stage, we used broad keywords related to "ANTI-DIABETIC," followed by targeted searches for plants that are found in Sikkim-India. The review process only covered papers published in the recent 35 years, beginning in the 1990s. We employed Boolean operators like "AND," "OR," and "NOT" to narrow down our search results. To improve our search results, we reduced the number of terms. For instance, we utilized "AND" to locate articles that had multiple important terms, such as "antidiabetic plants and herbs," "sikkim Himalaya," "local medicinal plants,". This method helped us select some of the necessary articles from the large volumes of articles. Out of all the articles (Book, Book chapters, Research, Review Studies), we have selected 107 numbers of articles that were of our interest.

Statistics

The data were collected through an extensive literature search from reputed online scientific database such as PubMed, ScienceDirect, Research Gate, Google Scholar, 1Library, Core, and so on. The collected data were presented in a tabular and graphical presentations by using Microsoft® Excel 2013 application within the manuscript.

DISCUSSION

After reviewing a various scientific repositories-PubMed, ScienceDirect, ResearchGate, Google Scholar, Core and 1library, we have discovered a wealth of data that supports our topic on antidiabetic plants found in the Sikkim Himalayas. Our review findings identified a total of 62 antidiabetic plants species belonging to 36 families for the first time in a single work with their botanical name, family, local name, parts used, intake process, geographical distribution in Sikkim-India and the world, possible MOA and their ethno-medicinal utilities (Table 1). In Figure 1, we have highlighted the family wise distribution. Based on the family wise use, it was found that Asteraceae are in higher use (8%) and followed by Solanaceae, Fabaceae Rutaceae and Caesalpiniaceae (5%) and Asparagaceae, Zingiberaceae, Menispermanceae, Gentianaceae Urticaceae and Caesalpiniaceae (3%). On other hand, in case of part used, highest was leaves and root (38 and 27%) (Figure 2). This comprehensive analysis not

Table 1: A list of antidiabetic medicinal plants from sikkim Himalayan region.

Sl. No.	Botanical Name	Family	Local Name (NN)	Parts used	Intake Process	Geographical distribution	Possible MOA	Etnomedical usability	References
1.	*Tupistra nutans* Wall. ex Lindl.	Asparagaceae	Nakima	Flowers and roots	Decoction of root and flower as vegetable	Sikkim-India, China, Bhutan, Laos.	α-glucosidase inhibition.	Antidiabetic, reduces body pain and weakness.	Baskaran *et al.*, (1990) and Thuy *et al.*, (2022)
2.	*Asparagus racemosus* Willd.	Asparagaceae	Kurilo, Satavari	Shoot and root	Ethanolic extract of root and shoot	Sri Lanka, Sikkim-India, Himalayas.	α-glucosidase inhibition.	Antidiabetic and potent fertility enhancer.	Chung *et al.*, (2019)
3.	*Aloe vera* (L.) Burm. f.	Liliaceae	Ghew kumari	Leaves	Leaf extract	Sikkim-India, Africa, Arabian Peninsula.	α-glucosidase inhibition and suppress insulin resistance.	Antidiabetic, Anti-inflammatory.	Vadivelan *et al.*, (2019)
4.	*Azadirachta indica* A. Juss.	Meliaceae	neem patti	Leaves	Juice of leaves	Sikkim-India, South and Central America.	α-glucosidase inhibition.	Antidiabetic, anti-inflammatory.	Noor *et al.*, (2008)
5.	*Abutilon indicum* (L.) Sweet.	Malvaceae	Ghanti-phool	Stem	Stem/bark decoction	Sikkim-India, China, Australia.	promotes insulin secretion from pancreatic β-cell.	Antidiabetic.	Patil *et al.*, (2013)
6.	*Aegle marmelos* (L.) Corrêa	Rutaceae	bael	Leaves, fruit	Aq. Extract or the powdered form of leaf or fruits.	Sikkim-India, Pakistan, Sri Lanka, Nepal.	acts by increasing the level of pancreatic insulin secretion.	Anti-infective, antidiabetic.	Seetharam *et al.*, (2002)
7.	*Mikania micranta* Kunth.	Asteraceae	Lahare banmara	Leaves	Ethanolic extract of the leaf.	Sikkim-India, South America, Mexico.	stimulation of insulin-producing β cells of the pancreas.	Antimicrobial, antioxidant, anticancer.	Sabu and Kuttan (2004)
8.	*Tinospora cordifolia* Willd. (Miers.)	Menis permaceae	Gurjo	Stem, leaves	Aqueous extract of the leaf and stem	Sikkim-India, china, myanmar, Sri Lanka, South Asia.	Increases the insulin secretion.	Hepatoprotective antiperiodic, antispasmodic, anti-inflammatory, antiarthritic, antiallergic.	Jayatilake and Munasinghe (2020)
9.	Embelica officinalis Gaertn.	Phyllanthaceae	Amala	Leaves	Leaf extract	Sikkim-India, China, Sri Lanka, South-East Asia.	Mimics insulin properties.	Antioxidant.	Patel and Mishra (2011)
10.	*Oroxylum indicum* (L.) Kurz.	Bignoniaceae	Totola	Bark, seed	Decoction of stem and bark	Sikkim-India, china, South Asia.	α-amylase and α-glucosidase inhibitory activities.	Antioxidant.	Nain *et al.*, (2012)
11.	*Urtica dioica* (L.)	Urticaceae	sisnu	Leaves, flower	Hydro-alcoholic extract	Sikkim-India, Europe, Africa.	Reduces Insulin Resistance.	Antihypertensive, antioxidant.	Laloo *et al.*, (2016)
12.	*Solanum incanum* (L.)	solanaceae	Tetay bee	Root	Hydro-methanolic extract	Sikkim-India, China.	α-amylase inhibitory activity.	Anti-hyperlipidemic.	Sasan *et al.*, (2011)

Sl. No.	Botanical Name	Family	Local Name (NN)	Parts used	Intake Process	Geographical distribution	Possible MOA	Etnomedical usability	References
13.	*Crassocephalum crepidioides* (Benth.) S. Moore.	Asteraceae	Anikale jhar	Whole plant	Maceration of dried powdered of plant	Sikkim-India, Africa.	α-amylase inhibitory activity.	Anti-inflammatory, antidiabetic, antioxidant.	Andargie *et al.*, (2022)
14.	*Curcuma caesia* Roxb.	Zingiberaceae	kaalo beshar	Root	Ethanolic extract of root	Sikkim-India, Nepal, China.	Inhibition of α-glucosidase by inhibiting the transport of glucose and fructose in the GLUT 2 transporter.	Antioxidant, Antidiabetic.	Bahar *et al.*, (2017)
15.	*Physalis angulata* (L.)	solanaceae	Jangali mewaa	Fruit	The dried, powdered fruits.	Sikkim-India, Argentina, California.	Stimulate insulin secretion from pancreatic beta-cells.	Antidiabetic, antioxidant.	Kartini *et al.*, (2023)
16.	*Smilax zeylanica* (L.)	Smilacaceae	Kukur daino	Leaves	Methanolic extract of leaf.	Sikkim-India, Nepal, Bangladesh, Malaysia.	Increases peripheral glucose uptake and increases insulin secretion.	Antidiabetic, anti-leprotic, antioxidant.	Raju *et al.*, (2015)
17.	*oxalis corniculate* (L.)	Oxalidaceae	Chariamilo	Whole plant	Aqueous extract	Sikkim-India, Mexico.	Pancreatic Amylase Inhibitory.	Antioxidant, antidiabetic.	Rajesh *et al.*, (2010)
18.	*Stephania glabra* (Roxb.) Miers.	Menispermaceae	Tmarkey	Root	Ethanolic extract	Sikkim-India, China, Nepal, Thailand.	α-amylase inhibitory activity.	Antidiabetic, antioxidant.	Sarkar *et al.*, (2020)
19.	*Trigonella foenum-graecum* (L.)	Fabaceae	Methi	Seeds and whole plant	Ethanolic extract	Sikkim-India, Canada, Russia, Pakistan.	Enhanced Peripheral Insulin Action.	Anti-lipidemic, Antioxidant, anti-inflammatory, Anticancer.	Semwal *et al.*, (2010)
20.	*Moringa olifera* Lam.	Moringaceae	Sajana	Whole plant	Aqueous ethanolic extracts of plant	Sikkim-India, Philippines, Florida, Ethiopia.	promotes glucose uptake by skeletal muscle cells and inhibition of glucose synthesis in hepatic cells.	Antioxidant, hepatoprotective	Yadav and Baquer (2014)
21.	*Artemesia vulgaris* (L.)	Asteraceae	Khempa,Tetay patti	Whole plant	Hydroalcoholic extracts of *Artemisia vulgaris*	Sikkim-India, Europe, Africa.	amylase and-glucosidase inhibition activity.	Antidiabetic, anti-inflammatory.	Irfan *et al.*, (2017)
22.	*Nasturtium officinale* R. Br.	Brassicaceae	Simrayo	Leaves	Aqueous and ethanolic extract	Sikkim-India, Eurasia, Europe, America, Africa.	Inhibits the action of glucose transporters in the intestine.	Antidiabetic, antioxidant.	Sharma and Adhikari (2023)

Sl. No.	Botanical Name	Family	Local Name (NN)	Parts used	Intake Process	Geographical distribution	Possible MOA	Etnomedical usability	References
23.	*Ageratina adenophora* (Sprengel) R. M. KingandH. Rob.	Asteraceae	kali jhar	Aerial parts	Hydro-alcoholic extract	Sikkim-India, Mexico, Central America.	α-glucosidase and α-amylase inhibitory activity.	Antidiabetic, anti-inflammatory.	Andargie *et al.*, (2022)
24.	*Plantago rugelii* Decne.	Plantaginaceae	Chamche jhar	Aerial parts	Methanol extract	Sikkim-India, Canada United States	Inhibition of intestinal absorption of glucose, facilitation of glucose-induced insulin release, enhancement of peripheral glucose uptake.	Antioxidant, antidiabetic, antiobesity, and neuroprotective.	Chanu *et al.*, (2023)
25.	*panax ginseng* C. A. Meyer	Araliaceae	Panch patay	Aerial parts	Alchololic extract	Sikkim-India, china,	Suppressing blood glucose levels and modulation of glucose transport.	Anti- hypercholesterolemic, anti-hyperlipidemic.	Ogbiko (2021)
26.	*Gymnema sylvestre* (Retz.) R. Br. ex Sm.	Asclepiadaceae	Gurmar	Aerial parts	Alcoholic extract	Sikkim-India, china	Regeneration of beta-cells.	Antidiabetic, antidiabetic.	El-Khayat *et al.*, (2011)
27.	*Drymaria cordata* (L.) Willd. ex Schult.	Caryophyllaceae	Abhijalo	Leaves	Alcoholic extract	Sikkim-India, china, South Asia.	α-glucosidase and α-amylase inhibitory activity.	Antidiabetic.	Baskaran *et al.*, (1990).
28.	*Ricinus communis* (L.)	Euphorbiaceae	Rairi	Leaves, root	Ethyl acetate extract	Sikkim-India, Europe, Africa.	Pancreatic amylase inhibitory.	Antioxidant antidiabetic.	Patra *et al.*, (2020)
29.	*Zingiber officinale* Roscoe	Zingiberaceae	Aduwa	Rhizome	Rhizome decoction	Sikkim-India, China, Nepal	Increase insulin release.	Antidiabetic, anti-inflammatory.	Shokeen *et al.*, (2008)
30.	*Tamaarindus indica* (L.)	Caesalpiniaceae	Teet-teetee, Imli	Fruit pulp	Extract or decoction of fruit pulp	Sikkim-India, China, Nepal,	α-amylase and α-glucosidase inhibition, enhances insulin secretion, improves glucose uptake,	Antioxidant, Hypolipidemic Antidiabetic,	Nepal and Chakraborty (2021)
31.	*Syzygium cumini* (L.) Skeels.	Myrtaceae	Kyamuna	Bark	Decoction or extract of stem bark	Sikkim-India, South-East Asia.	Increases insulin secretion, reduces blood glucose levels.	Antidiabetic.	Meher *et al.*, (2014)

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32.	*Ficus semicordata* Buch. -Ham. ex Sm.	Moraceae	Khasrey khaneu	Root, fruit, leaves	Extract or decoction	Sikkim-India, Nepal, Bhutan.	inhibitors of α-amylase and α-glucosidase.	Antioxidant Antidiabetic	Kumar (n.d.)
33.	*Fagopyrum esculentum* Monch.	Polygonaceae	Mithey phapur	Branch	Powdered form or extract	Sikkim-India, China, Russia.	Reducing blood glucose levels, improving insulin sensitivity, and inhibiting glucose absorption.	Antioxidant Hypolipidemic Antidiabetic.	Gupta and Acharya (2018)
34.	*Edgewotthia gardener* (Wallich) Meisner.	Thymelaeaceae	Argaily	Flower, stem bark	Decoction or extract	Sikkim-India, Nepal, Bhutan.	inhibiting α-glucosidase and α-amylase, enhancing glucose consumption, and improving insulin resistance.	Antidiabetic	Al-Snafi (2017)
35.	*Anthocephalus cadamba* (Roxb.) Miq.	Rubiaceae	Kadam	Leaves	Extract or infusion	Sikkim-India, China, Southeast Asia.	help lower blood glucose and lipid levels in diabetic models.	Antioxidant, Antidiabetic.	Zhang *et al.*, (2019)
36.	*Bauhinia vahlii* Wight and Arn.	Caesalpiniaceae	Verla	Stem, bark	Decoction	Sikkim-India, Nepal.	Strong α-amylase and α-glucosidase inhibition	Antidiabetic.	Singh *et al.*, (2017)
37.	*Dioscorea alata* (L.)	Dioscoreaceae	Ghartarul	Fruit	Powder or extract	Sikkim-India, South-East Asia, China.	Reducing blood glucose, improving insulin sensitivity, and reducing weight loss in diabetic models.	Antioxidant, Antidiabetic.	Das *et al.*, (2012)
38.	*Chenopodium album* (L.)	Chenopodiaceae	Bethu saag	Root	Extract or decoction	Sikkim-India, China, Pakistan	Reducing blood glucose, enhancing insulin levels, and inhibiting key digestive enzymes like α-amylase and α-glucosidase.	Antidiabetic Anti-hyperlipidemic.	Kaur *et al.*, (2021)

Sl. No.	Botanical Name	Family	Local Name (NN)	Parts used	Intake Process	Geographical distribution	Possible MOA	Etnomedical usability	References
39.	*Garuga pinnata* Roxb.	Burseraceae	Dubdabay	Bark	Decoction or extract	Sikkim-India, South-East Asia	Reduce blood glucose, decrease serum cholesterol/ triglycerides, and increase liver glycogen and serum insulin in diabetic rat models.	Antidiabetic.	Kant *et al.*, (2018)
40.	*Rubus ellipticus* Roxb.	Rosaceae	Aeiselu	Fruit	Fresh or extract	Sikkim-India, Nepal, Bhutan.	Antioxidant, Improves Insulin Function.	Antidiabetic, Antioxidant.	Shirwaikar *et al.*, (2006)
41.	*Cannabis sativa* (L.)	Cannabaceae	bhang, ganja	Leaves	Leaf extract	Sikkim-India, Central Asia.	Modulates Insulin Signaling Pathways	Potential Antidiabetic Effects.	Pandey and Bhatt (2016)
42.	*Catharanthus roseus* (L.) G. Don.	Apocynaceae	Sada- bahar	Leaves	Leaf extract	Sikkim-India, Madagascar.	Stimulates Insulin Secretion	Antidiabetic.	Haddou *et al.*, (2023)
43.	*Litsea cubeba* (Lour.) Pers.	Lauraceae	Siltimmur	Fruit	Extract or essential oil	Sikkim-India, China, Southeast Asia.	Regulates blood sugar levels.	Potential Antidiabetic Activity.	Tiong *et al.*, (2013)
44.	*Swertia angustifolia* Buch. -Ham. ex. D. Don.	Gentianaceae	Patlay-Chireto Bhale chiraito	Whole plant	Infusion of whole plant	Sikkim-India, Nepal, Bhutan.	Enhances insulin secretion, α-glucosidase inhibition.	Antidiabetic.	Chakraborty and Mandal (2018)
45.	*Swertia chirayita* (Roxb.) H. Karst.	Gentianaceae	Chireto	Whole plant	Infusion of the whole plant	Sikkim-India, Nepal, Bhutan.	Enhances insulin secretion, α-glucosidase inhibition.	Antidiabetic	Roy *et al.*, (2015)
46.	*Girardiana heterophylla* (Vahl) Decne.	Urticaceae	Bhangre sisnu	Root	Root decoction	Sikkim-India, Nepal	Improves Glucose Utilization.	Antidiabetic.	Dey *et al.*, (2020)
47.	*Paederia foetida* (L.)	Rubiaceae	Birilahara	Leaves	Leaf infusion	Sikkim-India, South-East Asia.	Regulates Insulin Function.	Antidiabetic.	Dhung *et al.*, (2019)
48.	*Polygonum viviparum* (L.)	Polygonaceae	Ratnaula	Root	Extract or decoction	Sikkim-India, China, Nepal	Stimulates pancreaticβ-cells.	Antidiabetic.	Kumar *et al.*, (2014)
49.	*Zanthoxyllum alatum* (Roxb.)	Rutaceae	Bokey timbur	Fruit	Extract	Sikkim-India, China, Nepal.	Stimulating*β*-cells to release insulin.	Antidiabetic.	Li *et al.*, (2021)
50.	Withania *somnifera* (L.)	solanaceae		Leaves, roots	Extract	Sikkim-India, Middle East.	Insulin release from pancreatic β cells.	Antidiabetic.	Khan *et al.*, (2018)

Sl. No.	Botanical Name	Family	Local Name (NN)	Parts used	Intake Process	Geographical distribution	Possible MOA	Etnomedical usability	References
51.	*Ginkgo biloba* (L.)	Ginkgoceae	Balkumari	Leaves	extract	Sikkim-India, China.	Inhibition of α-amylase and α-glucosidase activity.	Antidiabetic.	Gorelick *et al.*, (2015)
52.	*Glycyrrhiza glabra* (L.)	Fabaceae	Jethi madhu	Roots	Root decoction	Sikkim-India, Middle East Asia.	potent PPAR-γligand binding activity thus, reduces the blood glucose level.	Antidiabetic	Shankar *et al.*, (2005)
53.	*Allium sativum* (L.)	Amaryllidaceae	Lasoon	Bulb	Alcoholic extract, Infusion	Sikkim-India, China, Nepal.	Stimulates pancreaticβ-cells	Antidiabetic, Anti-Inflammatory.	Yang *et al.*, (2020)
54.	*Buddelja asiatic* (Lour.)	Scrophulariaceae	Bheemsingpati	Whole plant, leaves	Methanolic extracts	Sikkim-India, Nepal, Bangladesh, Malaysia.	α-amylase inhibition,	Antioxidant, Antidiabetic.	Eidi *et al.*, (2006)
55.	*Pterocarpus marsupium* Roxb.	Fabaceae	Bijaysal	Root and seeds	Ethanolic extract	Sikkim-India, Nepal, Sri Lanka, India.	Inhibit α-amylase and α-glucosidase enzymes.	Antidiabetic, antioxidant, anti-inflammatory, and antimicrobial properties.	Chemjong and Subba (2022)
56.	*Allium cepa* Linn.	Amaryllidaceae	Pyaj	Bulb	Ethanolic extracts	Sikkim-India, Central Asia, including Turkmenistan and Afghanistan.	Inhibiting α-amylase activity.	Antidiabetic, anti-hyperlipidemic, anti-inflammatory, anticancer properties.	Esakki *et al.* (2024) and Mekala *et al.*, (2020)
57.	*Bombax ceiba* Linn.	Bombacaceae	Simal	Root, flowers, Bark, leaves.	Ethyl acetate extract, *ethanol, water.*	Sikkim-India, Asian tropic.	α-glucosidase inhibitors.	Hypotensive, and antimicrobial, anti-inflammatory, antidiabetic.	Bhavsar and Talele (2013), Hassan *et al.*, (2024), Khurshid *et al.*, (2018), Mir *et al.*, (2017), Teshika *et al.*, (2019) and Yasien *et al.*, (2022)
58.	*Hibiscus rosa-sinensis* Linn.	Malvaceae	Rakta Pushpee, China rose, Japa kusum	Flower, root	Ethanol extract, Root, Aqueous-water extract	Sikkim-India, Subtropical and Tropical region.	Inhibiting α-amylase and α-glucosidase enzymes.	Anti-inflammatory, antimicrobial, antioxidant, anti-ulceration.	Ansari *et al.*, (2020), Kumar *et al.*, (2013), Mandade and Sreenivas (2011), Mir *et al.*, (2017), Moqbel *et al.*, (2011) and Venkatesh *et al.*, (2008)

Sl. No.	Botanical Name	Family	Local Name (NN)	Parts used	Intake Process	Geographical distribution	Possible MOA	Etnomedical usability	References
59.	*Mangifera indica* Linn.	Anacardiaceae	Aap (NN)	Bark, and leaves	Ethanolic, water extracts	Indo-Burma-Malay, Sikkim-India and myanmar	Inhibiting α-amylase and α-glucosidase, enzymes involved in carbohydrate digestion	Antioxidant, antidiabetic, anti-inflammatory, antimicrobial effects	Harini (2024), Irondi *et al*., (2016), Kulkarni and Rathod (2018), Mistry *et al*., (2023), Ngo *et al*., (2019), Saleem *et al*., (2019) and Villas Boas *et al*., (2020)
60.	*Dioscorea bulbifera* Linn.	Dioscoreaceae	Githe tarul (NN)	Tuber	Methanol extracts, ethanol extracts, ethyl acetate extracts	Sikkim-India, Africa and Asia	α-amylase and α-glucosidase	Analgesic, antioxidant, antimicrobial, anti-inflammatory, anticancer properties.	Bhow *et al*., (2009), Ghosh *et al*., (2012), Ghosh *et al*., (2014) and Samanta *et al*., (2019)
61.	*Carica papaya* Linn.	Caricaceae	papaya (NN)	Leaves, seeds	Aqueous extract, hydroethanolic extract	Sikkim-India, Central and South America, particularly southern Mexico and Central America.	Lowering blood glucose levels and inhibiting enzymes involved in diabetes.	Antioxidant, anticancer, and anti-helminthic, anti-inflammatory.	Maniyar and Bhixavatimath (2012), Mbagwu *et al*., (2022), Okon and Ofeni (2013) and Prabhakar *et al*., (2023)
62.	*Bergenia ligulata* (Wall.) Engl.	Saxifragaceae	Pakhanbhed	Rhizome, root	Ethanolic extract	High-altitude areas of Sikkim-India, Bhutan, Nepal.	Inhibit the enzyme α-glucosidase.	Insecticidal, anti-inflammatory, antitussive, diuretic, antidiabetic.	Fazal *et al*. (2022), Igbashio *et al*., (2024), Nizamudeen *et al*., (2024), Saijyo *et al*., (2008) and Singh *et al*., (2009)

*NN. **Abbreviations:** MOA: Mechanism of Action; NN: Nepali name.

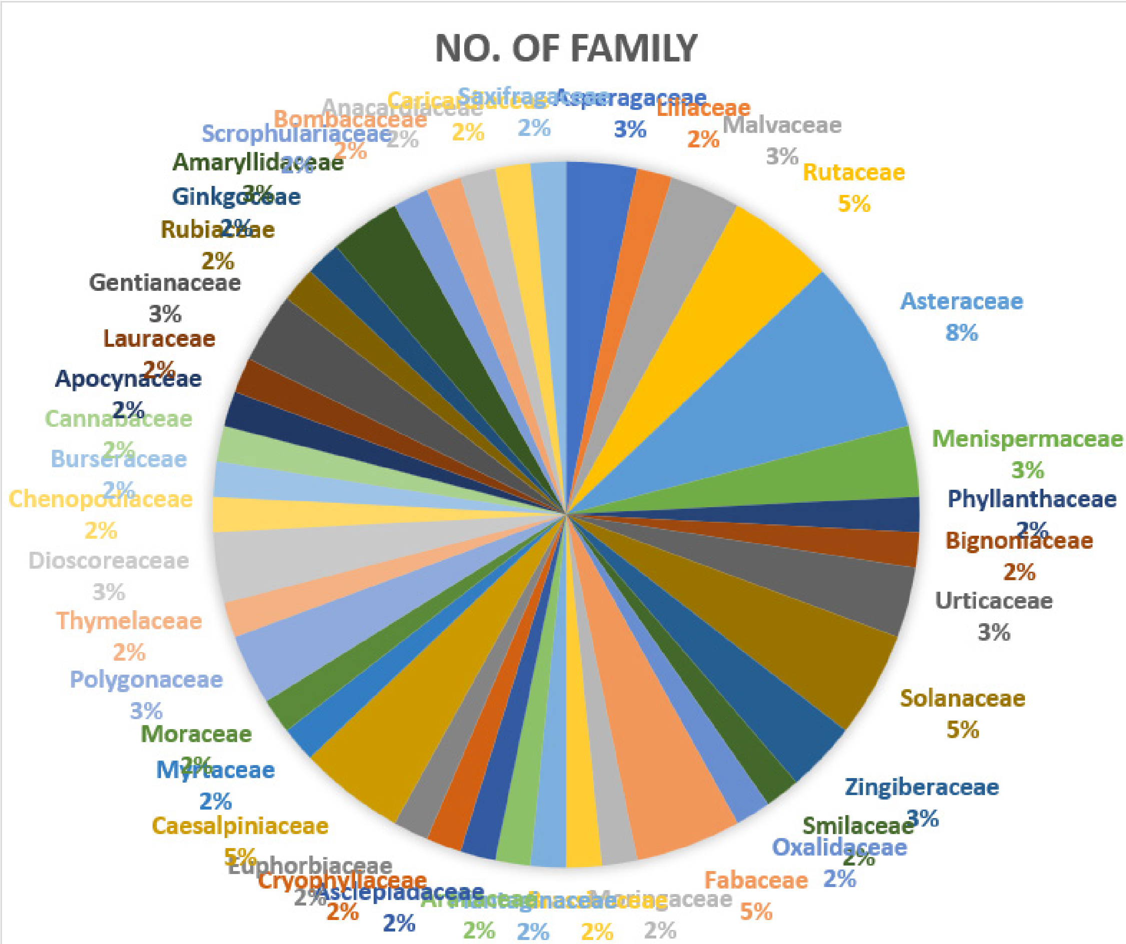

Figure 1: Family wise distribution of the medicinal plants.

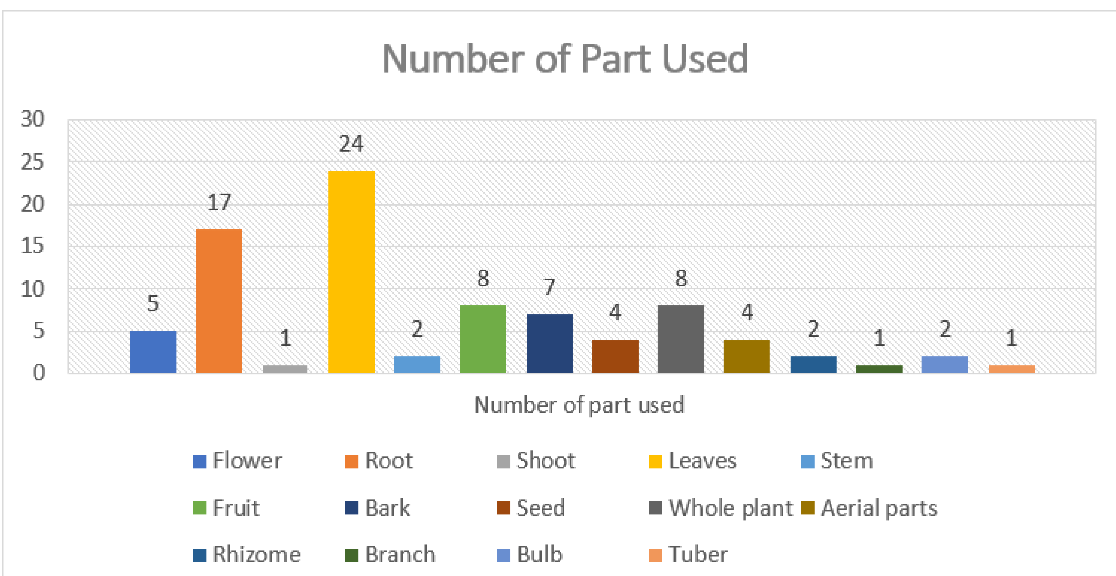

Figure 2: Parts used of the medicinal plants.

only highlights the diversity of antidiabetic flora in the region but also emphasizes their significance in traditional medicine and potential therapeutic applications. As compared to the previous studies (Chettri *et al*., 2005), highlighted about 37 plant species from 28 families were utilized as antidiabetic medicines in traditional medical practices in Sikkim and Darjeeling hills together and described in detail about their Botanical name family, voucher specimen numbers, habits, vernacular names, method of use and administration. Similarly, Nepal and Chakraborty (2021), reported about 36 antidiabetic medicinal plants belonging to different families from Sikkim Himalayan region in the review article. Study also provided the brief discussion of their Botanical name family, local names (Nepali), part used, traditional uses and pharmacological activities. Another study, Mitra *et al*., 2020 work from Sikkim also highlighted about antidiabetic medicinal plants and recorded the 44 out of 52 number of the plant species having the antidiabetic activity. Therefore, based on our literature finding, we have collected more than earlier number of plant species that is, 62 number of plant species belonging to 36 families distribution in this single review article and apart from their botanical name, family, local name, parts used we have discussed about the intake process, geographical distribution in the world also, possible MOA and their ethno-medicinal utilities. Some plants are very rare and reported for the first time in this review article which are need to be conserved in their natural habitats.

CONCLUSION

The present work is to document medicinal resources which are used naturally as antidiabetic from Sikkim Himalaya. As far as research concerned, we have to focus on the sustainable uses and documentation of such medicinal plants for the future research. Furthermore, the plants that exhibit the most potential antidiabetic efficacy in previous *in vitro* and *in vivo* studies can be the subject of additional research, which could result in the development of low-cost plant-derived drugs to combat the rising diabetes epidemic in the future.

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ABBREVIATIONS

WHO: World Health Organization; **MOA:** Mechanism of Action; **AND:** Boolean Operator "AND"; **OR:** Boolean Operator "OR"; **NOT:** Boolean Operator "NOT".

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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AUTHORS' CONTRIBUTIONS

S. B, CNB, PLB, RM, responsible for selection of the review topic and designing of literature review protocol. SB and CNB, involved in the major data collection from extensive literature search from reputed online databases. SB, responsible for the guidance of the survey work till the end. SB, PC, A.G, AS contributed for drafting, designing, formatting and referencing of this draft review article and communicating with scientific esteemed journal having good reputation in the scientific fields. All authors have read and approved the manuscript.

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