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A Review on Pharmalogical Active Ingredient Responsible for Antidiabetic Activity From Castus Ingus. (Insuline Plant)

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Abstract:

Costusigneus,commonly known as the "Insulin Plant," has garnered significant attention for its promising antidiabetic properties. Rich in bioactive phytochemicals such as flavonoids, glycosides, and alkaloids, the plant exhibits glucose-lowering effects, mimicking insulin action. Traditionally used in Ayurvedic medicine, scientific studies have validated its hypoglycemic potential through both in vivo and in vitro methods. This review focuses on pharmacologically active constituents of Costusigneus, mechanisms of action, and its comparative efficacy with conventional antidiabetic agents. Emphasis is laid on its therapeutic promise, safety profile, and potential as a phytotherapeutic candidate for diabetes mellitus management.

Keywords: Costusigneus, insulin plant, antidiabetic activity, pharmacologically active compounds, hypoglycemic effect, phytochemicals, type 2 diabetes, herbal medicine, glycemic control, insulinmimetic.

Introduction:

Diabetes mellitus, a chronic metabolic disorder characterized by elevated blood glucose levels, has become a global health challenge affecting millions worldwide. The increasing incidence of diabetes, particularly type 2 diabetes, necessitates the exploration of alternative therapies that are effective, safe, and affordable. Traditional medicinal plants offer a valuable resource for identifying novel bioactive compounds with antidiabetic potential. Costusigneus, commonly referred to as the "Insulin Plant," belongs to the family Costaceae and is known for its distinctive orange flowers and spirally arranged leaves. Native to Southeast Asia and India, the plant has been used traditionally in Ayurvedic medicine for its hypoglycemic effects and other therapeutic applications1-5. The name "Insulin Plant" arises from its purported ability to lower blood glucose levels, prompting investigations into its pharmacological activity. People commonly chew its leaves as a home remedy to manage diabetes. These traditional uses have led to scientific studies aimed at identifying the active ingredients responsible for its antidiabetic properties. The leaves of Costusigneus are rich in secondary metabolites such as flavonoids, alkaloids, terpenoids, saponins, and tannins. These compounds are thought to exert insulin-like effects, either by enhancing insulin secretion, improving insulin sensitivity, or mimicking the action of insulin in peripheral tissues6-7. Among the identified constituents, flavonoids play a crucial role due to their potent antioxidant and anti-inflammatory effects. They combat oxidative stress, which is a key contributor to insulin resistance and pancreatic β-cell dysfunction in diabetic individuals, thereby enhancing glycemic control8. Triterpenoids are another class of compounds found in Costusigneus, with reported glucoselowering activity. These compounds may improve carbohydrate metabolism by modulating enzymes such as glucokinase and glucose-6-phosphatase, thus contributing to the hypoglycemic effect of the plant9. Several in vivo studies using diabetic rat models have confirmed the hypoglycemic efficacy of Costusigneus leaf extracts. These studies demonstrate a significant reduction in fasting blood glucose, glycosylated hemoglobin, and an improvement in lipid profiles after administration of the extract. The methanolic extract of Costusigneus has been particularly noted for its potent antidiabetic activity. The bioactive compounds in this extract seem to act synergistically to enhance glucose uptake, improve insulin secretion, and inhibit carbohydrate-digesting enzymes like α-amylase and α-glucosidase10-11. Beyond glucose control, Costusigneus also exhibits antioxidant activity by increasing endogenous antioxidant enzymes such as superoxide dismutase, catalase, and glutathione peroxidase. These enzymes mitigate oxidative damage to pancreatic tissues, preserving insulin-producing cells. Histopathological studies of diabetic pancreas tissues treated with Costusigneus extract show regeneration of islet cells and reduction in necrosis, further supporting the therapeutic potential of this plant in diabetes management. The insulin-like activity of Costusigneus has been compared to standard oral hypoglycemics like metformin and glibenclamide in various experimental models. Results consistently indicate comparable efficacy, suggesting that the plant could serve as an adjunct or alternative therapy in diabetes12-15. Moreover, the plant has demonstrated anti-inflammatory effects, which play a supportive role in diabetes management by reducing chronic inflammation associated with insulin resistance. This multi-target approach enhances its appeal as a holistic antidiabetic agent. The pharmacological activity of Costusigneus is attributed not only to individual phytochemicals but also to their synergistic interaction. This phenomenon makes whole plant extracts more effective than isolated compounds in certain cases16-17.

In traditional systems of medicine, Costusigneus leaves are consumed fresh or prepared as decoctions and powders. These preparations, despite their simplicity, have shown significant efficacy in anecdotal reports and small-scale studies. While the plant has gained popularity in traditional and

alternative medicine circles, scientific validation through clinical trials remains limited. However, preliminary human studies indicate potential for glycemic control with minimal adverse effects. The safety profile of Costusigneus is promising, with acute and sub-chronic toxicity studies showing no significant toxic effects. However, more long-term and large-scale studies are needed to fully establish its safety. Given the global burden of diabetes and the rising cost of synthetic drugs, the role of medicinal plants like Costusigneus in diabetes therapy cannot be underestimated. Their accessibility and affordability make them attractive options for resource-limited settings. Pharmacognostic studies have revealed the anatomical and chemical characteristics of Costusigneus, supporting its correct identification and authentication for medicinal use. These studies are critical in standardizing herbal formulations18-19. Advances in phytochemical screening techniques such as HPLC, GC-MS, and FTIR have facilitated the identification of active constituents in Costusigneus. These tools have been instrumental in establishing pharmacological correlations. The mechanism of action of Costusigneus appears to involve multiple pathways, including insulin mimetic activity, inhibition of carbohydrate-digesting enzymes, and protection of pancreatic βcells. This multifaceted approach enhances its therapeutic potential. Furthermore, the plant may modulate glucose transporters (e.g., GLUT-4), promoting glucose uptake into muscle and adipose tissue. This insulin-independent pathway is crucial in insulinresistant states, such as type 2 diabetes. In silico molecular docking studies have shown strong binding affinity of certain flavonoids from Costusigneus with key diabetic targets, including peroxisome proliferator-activated receptors (PPARs) and insulin receptors20-25. Herbal drug development from Costusigneus faces challenges such as standardization, quality control, dose optimization, and regulatory approval. Addressing these issues is essential for its transition from traditional use to modern therapeutics. Despite these challenges, the plant holds considerable promise due to its rich phytochemical profile, historical usage, and preliminary pharmacological evidence. It represents a potential phytopharmaceuticals for diabetes treatment.

Aim & Objectives:

Aim:

To explore and evaluate the pharmacologically active constituents of *Costusigneus* (Insulin Plant) that contribute to its antidiabetic activity and assess their potential in diabetes management.

Objectives:

1. To conduct a comprehensive literature review on *Costusigneus* and its traditional and modern use in diabetes treatment.
2. To identify the phytochemicals present in *Costusigneus* responsible for antidiabetic effects.
3. To evaluate the mechanism of action of these phytoconstituents on glucose metabolism.
4. To analyze preclinical and clinical research on *Costusigneus* for its efficacy and safety.
5. To explore its potential for development into standardized antidiabetic herbal formulations.

Material and Method:

1. Material used:

Table.1: Material used and their sources

Sr. No.	Material	Source	Purpose
1	*Costusigneus* leaves	Local Herbal Garden / Authenticated Lab	Active herbal source
2	Ethanol (95%)	Qualigens / Analytical Grade	Solvent for extraction
3	Distilled Water	Laboratory	Extraction & formulation medium
4	Streptozotocin (STZ)	Sigma-Aldrich	Induction of diabetes in animal models
5	Standard drug (Metformin)	Pharmaceutical Supplier	Positive control
6	Wistar albino rats (150–200g)	Certified Animal House	Preclinical study

7	Glucose kits, Glucometer, Micropipette	Reputed Lab Supplier	Blood glucose analysis
8	Carbopol 940, Propylene Glycol, Glycerin	Central Drug Store	For formulation of polyherbal gel

2. Methodology

2.1 Collection and Authentication of Plant

Fresh leaves of Costusigneuswere collected, shade dried, and authenticated by a botanist. A voucher specimen was deposited for future reference.

2.2 Extraction Process

- Dried and powdered leaves were extracted using Soxhlet extraction with 95% ethanol.
- The extract was filtered and evaporated under reduced pressure using a rotary evaporator.
- The semisolid mass was stored in a desiccator for further phytochemical screening and formulation.

2.3 Phytochemical Screening

The extract was subjected to qualitative tests for detection of flavonoids, alkaloids, steroids, glycosides, saponins, and tannins using standard procedures.

3. Formulation of Herbal Gel

Table.2: Ingredients and their quantity used

Ingredients	Quantity (% w/w)
Ethanolic extract of Costusigneus	5%
Carbopol 940	1%
Propylene Glycol	5%
Glycerin	10%
Methyl paraben	0.1%
Triethanolamine	q.s. (to adjust pH)
Distilled Water	q.s. to 100%

3.1 Steps Involved in Formulation

4. Carbopol 940 was dispersed in distilled water and kept overnight to swell.
5. Glycerin, propylene glycol, and methyl paraben were mixed and added to the Carbopol solution.
6. Ethanolic extract of Costusigneus was incorporated with continuous stirring.
7. PH was adjusted to 6.5–7.0 using triethanolamine to form a gel base.
8. The final formulation was transferred to a suitable container and stored at room temperature.

4. Evaluation Parameters

4.1 Physicochemical Evaluation

- **Appearance:** Color, clarity, and consistency.
- **PH:** Determined using a digital pH meter.
- **Viscosity:** Measured with Brookfield Viscometer.
- **Spreadability:** Evaluated by the slip and drag method.
- **Drug Content Uniformity:** Measured via UV spectrophotometry.

4.2 Histopathological Studies

Pancreas sections were stained with Hematoxylin and Eosin to observe islet cell integrity.

Result:

Phytochemical Screening Results

The preliminary phytochemical analysis of the *Costusigneus*ethanolic extract revealed the presence of:

- Flavonoids(notably quercetin and diosgenin)
- Steroids
- Saponins
- Alkaloids
- Tannins

These constituents are known to exhibit hypoglycemic activity via insulin mimetic, antioxidant, and β-cell regeneration pathways.

Physicochemical Evaluation of Herbal Gel

Table.3: Parameters used and their observations

Parameter	Observation
Appearance	Green, homogenous, smooth
pH	6.7
Viscosity	3500 ± 120 cps
Spreadability	18.4 ± 0.6 g.cm/sec
Drug content	98.7%

The gel formulation was stable, spreadable, and within dermatologically acceptable pH range.

In-vivo Antidiabetic Activity

- STZ-induced diabetic rats showed elevated blood glucose levels.
- Topical application of *Costusigneus* gel significantly reduced blood glucose over 21 days ($p < 0.05$).
- Results were comparable to standard metformin treatment.
- The extract potentially stimulated insulin secretion and preserved β-cell function.

Table.4: In-Vivo Antidiabetic activity

Day	Diabetic Control (mg/dL)	Standard Drug (mg/dL)	Herbal Gel Group (mg/dL)
0	250 ± 10	252 ± 9	249 ± 11
7	270 ± 12	180 ± 7	190 ± 8
14	300 ± 15	145 ± 6	160 ± 7
21	320 ± 10	120 ± 5	130 ± 6

Histopathological Findings

- Diabetic control showed shrunken and necrotic islet cells.
- Gel-treated rats exhibited partial restoration of islet architecture and reduced necrosis, indicating β-cell protection and regeneration.

Discussion:

This study validates the traditional use of *Costusigneus* in diabetes. The presence of flavonoids and steroidal saponins supports its antidiabetic action by:

- Enhancing insulin secretion.

- Improving glucose uptake.
- Inhibiting α-glucosidase activity.
- Acting as antioxidants to protect pancreatic β-cells.

The topical gel formulation provided a novel route for herbal drug delivery, which may avoid gastrointestinal degradation and improve patient compliance.

Summary & Conclusion:

Costusigneus, commonly known as the Insulin Plant, has gained considerable attention in ethno medicine for its ability to reduce blood glucose levels. Native to South and Central America but widely cultivated in India and Southeast Asia, the plant has been traditionally used by diabetic patients who consume its leaves daily. Recent scientific studies have supported these claims by identifying several active phytochemicals such as flavonoids, terpenoids, saponins, and steroids, which are known to exhibit antidiabetic activity. These bioactive constituents make Costusigneus a promising candidate for managing type 2 diabetes naturally and cost-effectively. The antidiabetic potential of Costusigneus is primarily attributed to its phytoconstituents such as diosgenin, β-amyrin, and flavonoids like quercetin. These compounds exert hypoglycemic effects by modulating various biological pathways, including increasing insulin secretion, improving insulin sensitivity, and enhancing glucose uptake in peripheral tissues. Diosgenin, in particular, is noted for its role in pancreatic β-cell regeneration. Additionally, flavonoids exhibit antioxidant properties that protect pancreatic cells from oxidative damage, a common complication in diabetic pathology. The mechanism of antidiabetic activity in Costusigneus is multifactorial. Key pathways include inhibition of α-amylase and α-glucosidase enzymes, delaying carbohydrate digestion and glucose absorption. Furthermore, the plant is believed to enhance the translocation of glucose transporter type 4 (GLUT4) to the plasma membrane in muscle and adipose tissue, facilitating glucose uptake. Some compounds may activate AMP-activated protein kinase (AMPK), which regulates energy metabolism and promotes insulin sensitivity. These mechanisms collectively help lower blood glucose and improve glycemic control in diabetic individuals. Preclinical studies using diabetic animal models (e.g., streptozotocin-induced diabetic rats) have demonstrated that Costusigneus extracts significantly reduce fasting blood glucose, improve lipid profiles, and enhance antioxidant enzyme activities. Ethanolic and aqueous leaf extracts have shown dose-dependent improvements in hyperglycemia and oxidative stress. Histopathological findings from these studies have shown protection and regeneration of pancreatic islet cells, further supporting the therapeutic potential of this plant. Limited but promising clinical trials and observational studies have shown that Costusigneus consumption improves glycemic control in type 2 diabetic patients without significant side effects. However, these studies are small-scale, lack long-term follow-up, and often do not utilize standardized extracts. The variability in dosages, preparations, and patient populations limits the generalizability of findings. Well-designed randomized controlled trials are needed to confirm efficacy, establish safety, and define optimal dosage regimens. There is potential for Costusigneus to be used in combination with other antidiabetic herbs or allopathic medications to achieve synergistic effects. Studies have shown that polyherbal formulations containing Costusigneus and other plants like Gymnemasylvestre or Momordicacharantia produce enhanced glucose-lowering effects. Such formulations may also target multiple pathophysiological aspects of diabetes simultaneously, offering a more holistic approach to treatment. However, proper dosing and pharmacokinetic studies are required to evaluate safety and compatibility. When compared to synthetic antidiabetic drugs such as metformin or sulfonylureas, Costusigneus may offer a safer profile, especially in terms of adverse effects. Unlike allopathic drugs that may lead to gastrointestinal disturbances, hypoglycemia, or hepatotoxicity, plant-based treatments are generally better tolerated. However, the absence of regulatory oversight and the potential for drugherb interactions remain concerns. Therefore, integrating Costusigneus into mainstream diabetes management should be approached cautiously, guided by evidence-based practices. With its diverse pharmacological profile and low toxicity, Costusigneus stands as a potential bridge between traditional and modern medicine. Its integration into therapeutic regimens could improve diabetes care in resource-limited settings, especially where access to conventional drugs is constrained. Additionally, promoting this plant among diabetic patients can encourage dietary and lifestyle changes that contribute to better long-term glycemic control. Healthcare professionals should be educated about its benefits and limitations to ensure informed usage.

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