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Original Article

Glucose and Insulin Activities in the Leaf Extracts of *Aloe vera*, *Bryophyllum*, and Ivy Gourd

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ABSTRACT

Objectives: Allopathic medicines, although they play a crucial role in controlling blood sugars among diabetic patients, alone may be insufficient for the effective management of diabetes. Therefore, it is essential to explore the food for its anti-diabetic potential and delay the development of long-term complications of this debilitating disease. *Aloe vera*, *Bryophyllum*, and Ivy gourd are edible and, if included in daily food, could contribute to preventing and managing diabetes. In this study, we have estimated the glucose and insulin concentrations of *A. vera*, *Bryophyllum*, and Ivy gourd plant extracts.

Materials and Methods: The leaf extracts of *A. vera*, *Bryophyllum*, and Ivy gourd were assessed for glucose and insulin. Glucose was estimated using the glucose-oxidase peroxidase method and insulin was measured using the enzyme-linked immunosorbent assay.

Results: Ivy gourd leaf extract revealed the highest concentration of both glucose and insulin at concentrations of 56 mg/dL and 46.46 μIU/mL, respectively. *Bryophyllum* leaf extracts revealed moderate concentrations of insulin (24.14 μIU/mL) and glucose (23.11 mg/dL). Among the extracts tested, the *A. vera* extract revealed the lowest concentrations of glucose (22 mg/dL) and insulin (10.87 μIU/mL).

Conclusions: *A. vera*, *Bryophyllum*, and Ivy gourd leaves have reasonable concentrations of insulin which could be explored for pharmacological purposes. Moreover, being edible, these could be included in the diet as alternative methods to prevent and manage diabetes.

Keywords: *Aloe vera*, *Bryophyllum*, Ivy gourd, Diabetes, Plant extracts, Anti-diabetic, Edible

INTRODUCTION

Medicinal plants synthesize phytochemicals that help their defense against parasites such as insects, fungi, other microbial diseases, and herbivorous mammals.[1] The phytochemicals contain plant-based essential components which could become a source of nutrients to humans and, therefore, included in the diet.[2] Phytochemicals are being used as supplements to manage diseases.[3] By composition, phytochemicals may be alkaloids, glycosides, polyphenols, and terpenes among others.[4] However, these may be toxic (phytotoxin) and carcinogenic in nature.[5] Most phytotoxin-containing plant material is avoided by humans or processed to eliminate the toxins before they are consumed as food.[6] The phytochemicals are thermolabile and, hence, are lost in cooking and food processing techniques.[7] The phytochemical constituents of plants help in lowering blood glucose levels by regulating glucose and also

could delay associated complications.[8] Diabetes is the most prevalent non-communicable disease and billions of people are affected by it throughout the world.[9] There are several causes for the development of diabetes. The predisposing factors for diabetes include sedentary lifestyles, lack of physical activity, consuming a high-sugar and fat diet, insulin resistance, and inadequate secretion of insulin by the pancreas among others. Moreover, genetic predisposition is also an established factor for diabetes. Furthermore, persons with diabetes are prone to long-term health complications and suffer from uncontrolled diabetes despite treatment.[10] Therefore, it is essential to explore alternative methods in the form of naturally available and edible resources like plants for their role in controlling and preventing diabetes.

Aloe vera (Aloe barbadensis miller) is a shrubby, perennial, succulent, xerophytic, and perennial plant belonging to the *Liliaceae* family. It grows in topical, sub-tropical, and arid regions of the world. It has been known for more than 2000 years and is popular as a plant with medicinal properties.[11] The *Bryophyllum* (*Kalanchoë*) plants belong to the family Crassulaceae and are found throughout the world. *Bryophyllum* species have been identified as plants with potential medicinal properties that can be used as complementary/alternative medicine.[12] Ivy gourd is scientifically called *Coccinia grandis* and belongs to the *Cucurbitaceae* family. It grows in tropical regions of the world including India where it is consumed as a vegetable. The leaf extract and fruit of *C. grandis* have been explored for their medicinal properties.[13]

The present study is carried out to assess the glucose and insulin concentrations in the leaf extracts of *A. vera*, *Bryophyllum*, and Ivy Gourd.

MATERIAL AND METHODS

The leaves of *A. vera*, *Bryophyllum*, and Ivy gourd were collected from the households [Figure 1].

The leaves were carefully cleaned to remove the dust before being processed. The leaves were then ground using mortar and pestle and by adding little quantities of water as needed. The extract was filtered using filter paper and the filtrate was used for the quantitative measurements of glucose and Insulin.

The glucose levels in the filtrate obtained from leaf extract were measured by the glucose-oxidase peroxidase (GOD-POD) method in a colorimeter. The insulin concentrations were measured using Enzyme-Linked Immunosorbent Assay using Qayee – bio kit for life science.

The potential mechanism of the action and effects of the *A. vera*, *Bryophyllum*, and ivy gourd extracts on the GOD-POD assay are shown in [Figure 2].

Procedure for measuring the insulin concentrations

In a microwell, 40 µL of diluent is mixed with 10 µL of leaf extract. Similarly, 50 µL of standard reagent was added into another well that is used for standard reading. A 50 µL of horse radish peroxidase was added to both wells. The plate was, then, sealed with aluminum foil. The microwell plate was carefully shaken and incubated at 37°C for 60 min. The contents in the microwells were discarded and a diluted wash liquid was added to the wells. The microwell plate was shaken and the contents were discarded. The microwells were tapped on an absorbent paper and allowed to dry completely. This process was repeated 5 times. Later, 50 µL of chromogen A was added to each well followed by the addition of chromogen B. The microwell plate was shaken and incubated at 37°C for 10 min away from light. A 50 µL stop solution was added to each well and the optical density values were measured at 450 nm.

RESULTS

Ivy gourd leaf extract revealed the highest concentration of both glucose and insulin at concentrations of 56 mg/dL and 46.46 µIU/mL, respectively. *Bryophyllum* leaf extracts revealed moderate concentrations of insulin (24.14 µIU/mL) and glucose (23.11 mg/dL). Among the extracts tested, the *A. vera* extract revealed the lowest concentrations of glucose (22 mg/dL) and insulin (10.87 µIU/mL). The glucose and insulin concentrations observed in the plant

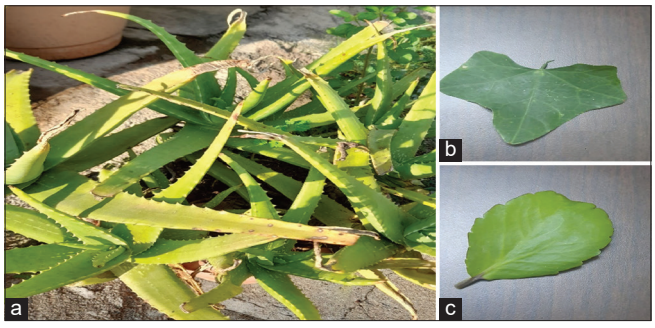

Figure 1: Leaf extract, (a): *Aloe vera*, (b): Ivy gourd, (c): *Bryophyllum*.

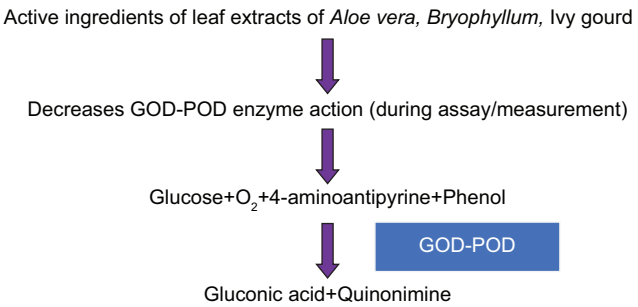

Figure 2: Flow chart depicting action of active ingredients of leaf extract on glucose-oxidase peroxidase assay.

extracts of *A. vera*, *Bryophyllum*, and Ivy gourd are shown in [Table 1].

The bar diagram showing glucose and insulin concentrations in the leaf extracts concerning the absorbance is shown in [Figures 3 and 4], respectively.

Table 1: Glucose and insulin concentrations of leaf extracts.

Source of extract	Glucose levels	Insulin levels
Aloe vera	22 mg/dL	10.87 µIU/mL
Bryophyllum	23.11 mg/dL	24.14 µIU/mL
Ivy gourd	56 mg/dL	46.46 µIU/mL

DISCUSSION

Diabetes is a non-communicable disease that previously was commonly noticed among older persons. However, in recent times, diabetes has been a frequent cause of concern among young adults and middle-aged persons. This could be attributed to the changing food habits and dormant/sedentary lifestyles. Uncontrolled diabetes can lead to several complications that include cardiovascular and kidney diseases, among others.

The constituents of plant phytochemicals and their benefits to human health have been adequately established. Alkaloids are natural organic compounds that possess at least one nitrogen atom. They are bitter and are products of nitrogen metabolism in plants. Alkaloids (synthetic/semi-synthetic) are used as drugs to enhance the primary effects of drugs and to reduce unwanted side effects.[14] The medically important alkaloids and their potential applications are depicted in [Table 2].

Table 2: Alkaloids and their medical applications.

Alkaloid	Application
Morphine	Analgesic
Nicotine	Stimulant, and nicotine-acetyl choline receptor agonist
Reserpine	Antihypertensive
Vinblastine	Anti-tumor
Quinine	Antipyretic and antimalarial

Glycosides are phytochemical compounds that are made up of sugars that are interconnected by glycoside bonds. Plants store chemicals in the form of inactive glycosides which are activated by hydrolysis. Many glycosides are used in medications.[15] Plant glycosides and their medical applications are shown in [Table 3].

Table 3: Glycosides and their medical applications.

Glycosides	Application
Alcoholic glycosides	Analgesic, antipyretic
Phenolic glycosides	Anti-inflammatory effects, urinary antiseptic effects
Flavonoid glycosides	Antioxidant effects, decreases capillary fragility
Coumarin glycosides	Blocks calcium channels, dilates coronary arteries
Cardiac glycosides	Treatment of cardiac diseases

Polyphenols are organic compounds that contain many phenol units (C_6H_5OH). These are abundantly present in plants. Polyphenols are structurally diverse and can be further classified as flavonoids (present in apples, onions, etc.), phenolic acids (fruits, vegetables, etc.), polyphenolic amides (pepper, oats, etc.), and other polyphenols (sesame seeds, flax seeds, red wine, etc.).[15,16] Polyphenols help in protection against ionizing radiation and microbial infections, maintain the green pigment in plants, and regulate the growth hormone during the fruit ripening process.[17,18] Polyphenols contribute to normal vascular endothelial function and also protect blood lipids from oxidative damage in humans.[19,20]

Terpenes are a group of unsaturated hydrocarbons produced by plants, especially conifers.[21] They are mediators of ecological interactions and help plants in their defense against herbivores and diseases. They are major biosynthetic building blocks that include steroids, which are derivatives of triterpenes. Terpenes are the primary constituent of the essential oil of plants and their flowers.[22] They facilitate the growth and elongation of plants, membrane permeability, and fluidity control.[23] Terpenes act as natural rubber (polymer of isoprene) and have commercial value. They are used as constituents of ink, varnishes, and adhesives, and as fragrances in perfumes, cosmetics, and cleaning products.[24,25] Terpenes are used as components of traditional medicine such as aromatherapy.[26] They are also used as pesticides in agriculture.[27]

Some plants produce active ingredients known as saponins (pseudo prototinosaponin, prototinosaponin). The saponins act on glucose uptake as well as insulin release affecting hepatic gluconeogenesis or glycogenolysis.[28] It was experimentally proved in diabetic rats that bitter content aloin, a saponin of *A. vera* has a hypoglycemic effect.[29] In addition, the beneficial effects of *A. vera* in the management of diabetes were explored both *in vitro* and by animal experiments in a previous study by Abo-Youssef and Messiha.[30] The results of this study had clearly indicated the efficacy of *A. vera* extracts over the traditional drug (glimiperide) in the control of blood sugar (93.66 ± 26.92 mg/dL vs. 117.43 ± 21.96 mg/dL) and in the regulation of insulin activities (6.78 ± 0.98 ng/mL vs. 6.26 ± 0.65 ng/mL). The saponins present in medicinal plants are known for their hypolipidemic, hypoglycemic, and anti-cancerous

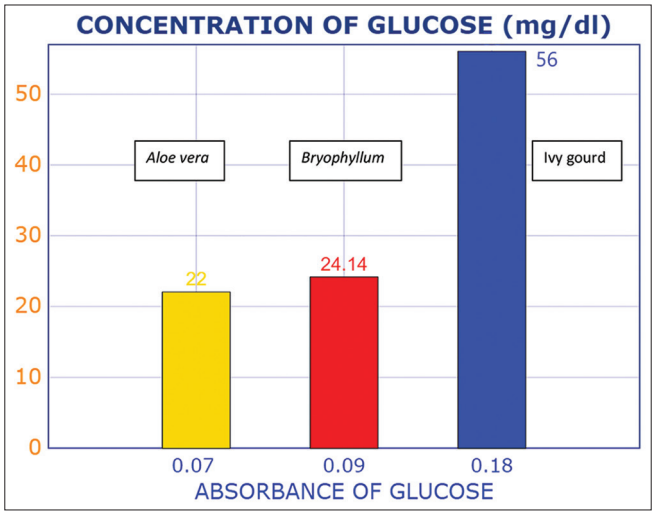

Figure 3: The glucose concentrations of leaf extract concerning absorbance.

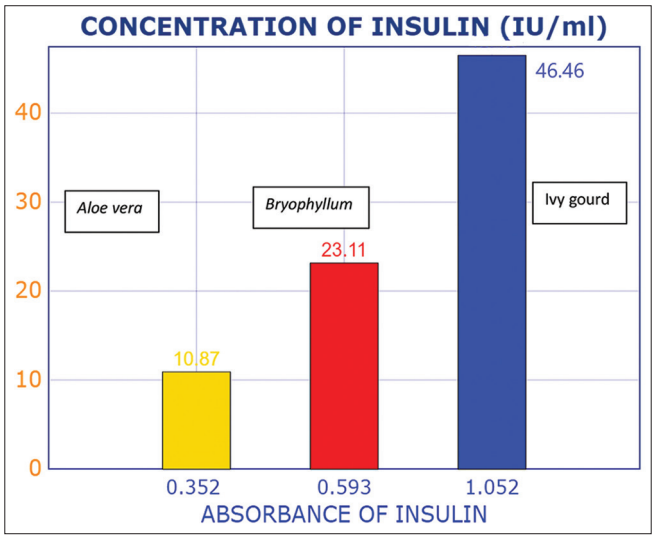

Figure 4: The insulin concentrations of leaf extract concerning absorbance.

agents.[31] The drugs used for various health issues are manufactured using saponin contents.

The saponins are amphipathic plant products with diverse functions. The attachment of sugar to sterol or triterpenes makes saponin amphipathic and is also the reason for forming a gel-like or soapy substance. Saponins are used both in conventional and traditional medicine.[32-34]

Bryophyllum is known to possess bufadienolide, which is a glycoside that confers various health benefits.[35,36] It exerts secretagogue (a substance that causes secretion of another substance) action on beta-cells of the pancreas by the closure of potassium-adenosine triphosphate channels which stimulate the release of insulin similar to sulfonylurea.[37]

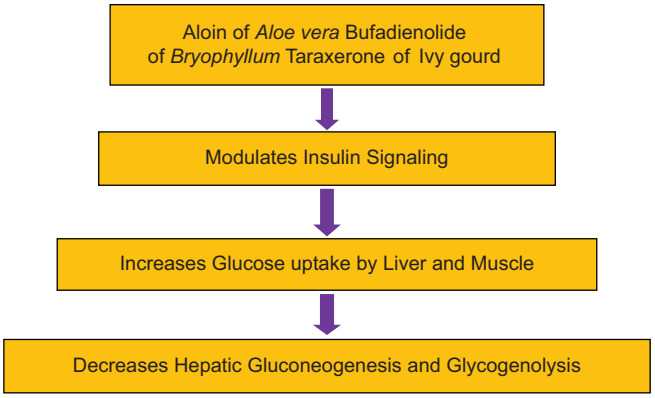

Figure 5: Flow chart depicting the probable mechanism of action of leaf extract active ingredients on insulin activities and blood glucose concentrations.

The Ivy gourd is a plant with anti-anaphylactic and antihistaminic properties and is used as a traditional medicine. The active constituents are taraxerone and taxero (triterpenoid), amyran, and lupeol.[38] The compounds present in Ivy gourd are noted to regulate blood glucose levels by inhibiting the glucose-6-phosphatase enzyme.[39]

The coordinated activity of the liver and muscle helps in glucose homeostasis. In postprandial states, the liver helps in glycogenesis and leads to glycogenolysis in the fasting state.[40] The imbalance between the uptake of glucose in muscle and the overproduction of glucose in the liver creates insulin sensitivity.[41] The saponins stimulate AKT/protein kinase B signaling pathway, leading to hypoglycemic effects. The AKT improves glucose uptake of skeletal muscle by activating Glucose Transporter 4.[42] The probable mechanism by which the *A. vera*, *Bryophyllum*, and Ivy gourd plant extracts have on the management and control of blood glucose and insulin activities is depicted in [Figure 5].

CONCLUSION

A. vera, *Bryophyllum*, and Ivy gourd leaf extracts have reasonable concentrations of insulin which could be explored for pharmacological purposes. The active ingredients including saponins, alkaloids, glycosides, polyphenols, and terpenes present in these plants could be investigated for their pharmacological potential and medicinal properties. Moreover, being edible, these could be included in the diet as alternative methods to prevent and manage diabetes and its related long-term complications.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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