



## Anti-diabetic effect of *Solanum virginianum* extract on alloxan induced diabetic rats

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### Abstract

Diabetes mellitus is a chronic endocrine disorder, characterized by hyperglycaemia resulting from absolute or relative insulin deficiency. There are a number of different causes of diabetes but by far the majority of cases are classified as either type 1 or type 2 diabetes. In the present study *S. virginianum* plant is used for the evaluation for its anti-diabetic potential in alloxan induced diabetic rats. The rats were divided into seven groups and were given a dose of 50,100,150, and 200 mg per kg of *S. virginianum* extract. The anti-diabetic effect was evaluated by various bio-chemical methods. The results revealed that the drug extract has anti-diabetic potential and can be considered as a strong medicine for the treatment of diabetes

**Keywords:** diabetes, *S. virginianum*, alloxan

### 1. Introduction

Diabetes mellitus (DM) is a heterogeneous combination of disorders that commonly occur with episodes of hyperglycemia and glucose intolerance, resulting from lack of insulin, faulty action of insulin or both. These complications arise due to changes to storage regulatory systems and mobilization of metabolic fuels, including carbohydrate, fat and catabolism and anabolism proteins from defective insulin secretion, insulin action, or both. In adults, type 2 diabetes is more common than type 1 and is mainly characterized by peripheral insulin resistance and inadequate functional mass of  $\beta$  cells. Type 2 diabetes (DM) is a metabolic disorder which is characterized by hyperglycaemia caused by insulin secretion deficiency and insulin secretion resistance in varied tissues. In type II diabetic patients, insulin can be produced and secreted by pancreas, but the body can only partially, or even completely unable to use the insulin produced. Urination is also increased due to high blood glucose levels.<sup>1</sup> Hyperglycaemia is thought to be one among the most contributors to oxidative stress by the direct generation of excessive reactive oxygen species (ROS), resulting from associate imbalance between antioxidants and oxidants. It has affected 5% people worldwide and accounts for about 10% of the total health spending in many countries. The prevalence of Diabetes for all age groups worldwide was estimated at 2.8% 2000, and is expected to increase to 4.4% in 2030. Diabetes is one of the top five causes of death worldwide and around six deaths from minute are attributable to complications of diabetes. WHO estimates that 7.1 million deaths worldwide could be attributed to high blood pressure, 4.4 million at high cholesterol and 2.6 million at excessive body weight.<sup>2</sup> Traditionally available therapeutic drugs for the treatment of the diabetes mellitus are oral hypoglycemic agents and insulin which are not up to mark for the condition and present a wide array of side effects with them. Herbal medicines have always proven to be the best alternative for the treatment of the various diseases and are very effective with minimal amount of the side effects.<sup>3</sup> The genus *Solanum* is composed of grasses or shrubs, rarely small

trees, and sometimes under heating or climbing without arms or thorny. The leaves are whole and lobed. The flowers are lateral or terminal. The fruit is a elongated berry. *Solanum virginianum* L. is a diffuse and very thorny bush which belongs to Solanaceae family. It usually develops in several regions of the world in sandy soils and distributed throughout India. It is commonly called the night shadow of yellow berries in English, kantakari in Sanskrit and Nelagulla in Kannada. The thorns are straight, compressed and yellowish. The leaves are up to 10 × 6 cm, oval or elliptical to acute apex, and pinnate halfway. The petioles have long pickles, and the base is very uneven. The flowers are on top of some flowers. The calyx is spiny with oval or lanceolate lobes. The corolla is purple and about 2 cm in diameter. The berry is globose, 2 cm in diameter, and yellow or white with green spots<sup>[4]</sup>. A wide range of phytochemicals such as alkaloids, phenolics, flavonoids, sterols, saponins, glycosides, fatty acids, tannins, and amino acids have been identified from different parts of the plant. The plant is extensively used in various systems of medicine including Ayurveda. The plant is used traditionally to treat asthma, chest pain, leucoderma, scorpion bite, and sterility in women. Roots are much used in medicine. The oil from seeds is used to treat arthritis. The ash from dried fruits is used to relieve toothache. The plant is shown to exhibit various bioactivities such as antimicrobial, anthelmintic, antioxidant, haemolytic, anti-inflammatory, antidiabetic, cytotoxic, phytotoxic, hepatoprotective, and immune-stimulatory activities. In the present study, antidiabetic effect of the *Solanum virginianum* L was designed and tested in the alloxan induced diabetic rats<sup>[5]</sup>.

### 2. Materials and methods

#### 2.1 Plant material

The field grown plant of the *S. virginianum* was collected from the M.J.P.R.U campus, Bareilly during the month of the August to November. The plant was identified and authenticated from standard sources. The plant was brought to the laboratory and

thoroughly washed in running tap water to remove the debris and dust. The leaves were then washed with the distilled water and dried under shade, coarsely powdered and stored in the air tight container.

## 2.2 Preparation of the Plant extract

The collected parts (stem, leaf and fruits) of the medicinal plant were cleaned and dried under shade. The dried plant materials were then ground well to fine powder. Powdered plant materials were successively extracted with petroleum ether, alcohol and acetone (60- 80 °C) using soxhlet extractor. The extraction was continued for 24 hours. The petroleum ether, alcohol and acetone extracts were then filtered and kept in oven at 400 °C for 24 hours to evaporate the solvent from it. Greenish brown and greenish black residues were obtained.

## 2.3 Experimental Animals

Adult male Wistar rats weighing around 180-200 g were procured from the animal house. The animals were kept in polypropylene cages (three in each cage) at an ambient temperature of (25±2) °C and 55%-65% relative humidity. (12±1) h light and dark schedule was maintained in the animal house till the animals were acclimatized to the laboratory conditions, and were fed with commercially available rat food and had free access to water. The experiments were designed and conducted in accordance with the institutional guidelines [6]

## 2.4 Experimental induction of diabetes

Diabetes was induced in male albino rats intraperitoneal injection of aloxan monohydrate (150 mg /kg) in normal saline by the method described by Nagappa *et al* [7]. Aloxan was the first weighed individually for each animal by weight then solubilized with 0.2 ml of saline solution (154 mM NaCl) alone before injection. Two days after the injection of aloxan, the blood was taken from the tip of the tail vein and blood sugar was measured using the Gluco Chek glucose estimation kit 48 hours after the injection of aloxan, the rats examined for diabetes glycosuria and hyperglycemia with a glycemia of 300 to 400 mg / dL were collected for the study<sup>8</sup>. All the animals were allowed free access to the water and granule regime and maintained at room temperature in polypropylene cages. Treatment with the plant extracts were started 48 hours after the injection of aloxan.

## 2.5 Experimental design

The animals were divided into following groups comprising 6 animals in each group.

Group I : Normal rats;

Group II : Diabetic (Aloxan induced) control rats;

Group III: Diabetic induced rats treated with drug extract of *S. virginianum* (50 mg/kg bw) for 25 days;

Group IV: Diabetic induced rats treated with drug extract of *S. virginianum* (100 mg/kg bw) for 25 days;

Group V: Diabetic induced rats treated with drug extract of *S. virginianum* (150 mg/kg bw) for 25 days;

Group VI: Diabetic induced rats treated with drug extract of *S. virginianum* (200 mg/kg bw) for 25 days;

Group VII: Diabetic positive control animals treated with glibenclamide (600 µg/kg bw)

The leaves extract and the drug glibenclamide were given in aqueous solution daily using an intragastric tube for 25 days. Fasting blood glucose was monitored for every week throughout the experiment. At the end of the experimental period, the animals were deprived of food overnight and then sacrificed by decapitation. Blood was taken from the jugular vein and collected in two tubes [9].

## 2.6 Estimation of blood glucose and body weight

The fasting blood glucose level was determined after 25 days of treatment with drug extracts and drug control. The blood was collected from the tip of the tail vein from the overnight fasted rats and the blood glucose was measured using Gluco Chek glucose estimation kit. The results were expressed in terms of milligrams per deciliter (mg/dL) of blood. Body weight of all experimental animals was recorded using a digital weighing scale [10].

## 3. Result

Table 1 describes the body weight, blood glucose and serum insulin levels in normal and experimental animal groups. In aloxan induced diabetic animals, the body weight was significantly decreased when compared to the levels in normal animals. After administration of the drug extract, the animals regained the body weight to near normal which is comparable with the control and glibenclamide treated animals.

The level of the insulin in Group II aloxan induced diabetic control animal was decreased by 65.13% when compared with Group I animals. In Group III, and IV animals, insulin levels were found to have increased significantly by 74.87% and 81.28%, respectively when compared to the aloxan induced diabetic animals. Similarly a sharp insulin raise was seen in Group V and VI animal by 104.90% and 115.84%, when compared Group II aloxan induced diabetic animals. This increase was almost equal to the levels of insulin in glibenclamide administrated Group VII animals, which was 108.56% when compared to diabetic control. In aloxan induced Group II diabetic animals, the levels of blood glucose were increased significantly by 218.74% compared with normal control group. After administration of methanol drug extract *S. virginianum* to Group III, and IV the level of glucose were decreased by 37.47%, and 43.72%, In *S. virginianum* administrated Group V, and VI animals, the levels of glucose were found to have decreased greater extent by 44.21% and 59.32%, where as in glibenclamide treated animals the glucose levels were decreased by 51.61%, compared to diabetic control.

**Table 1:** The effect of *S. virginianum* extract on the body weight, blood glucose and serum insulin levels of control and experimental group of animals ( Mean±SEM,n=6)

Groups	Body weight(g)	Blood glucose (mg%)	Serum insulin (µU/ml)
I	175±8.01	118±4.62	13.75±1.19
II	183±5.44 <sup>^^</sup>	461.00±20.00 <sup>^^</sup>	7.10±0.77 <sup>^^</sup>
III	191±3.4	224±20.26	12.50±0.86
IV	182±4.91 <sup>*</sup>	183±12.45 <sup>*</sup>	13.00±0.39 <sup>*</sup>
V	179±3.88 <sup>**</sup>	186±11.08 <sup>**</sup>	14.71±1.35 <sup>**</sup>
VI	193±5.41 <sup>**</sup>	127±5.77 <sup>**</sup>	16.03±0.49 <sup>**</sup>
VII	188±3.45 <sup>**</sup>	129±5.79 <sup>**</sup>	16.06±0.58 <sup>**</sup>

<sup>^^</sup>P<0.001 vs. normal control group, <sup>\*</sup>P<0.01, <sup>\*\*</sup>P<0.001, <sup>\*\*\*</sup>P<0.0001 vs. diabetic control group.

#### 4. Discussion

Treatment of diabetes with medicinal herbs which has proven to be much safer than synthetic drugs is an integral part part of many cultures around the world and won importance in recent years. India has a rich history of use of various herbs and powerful herbal components for treatment of various diseases, including diabetes <sup>[11]</sup>. The proximal analysis shows that *S. virginianum* are a good source of carotenoids, carbohydrates, proteins, fats and minerals. The results indicate that *S. virginianum* contain a higher concentration of these components. There is evidence that minerals such as potassium, sodium, manganese and iron play a vital role in many metabolic activities and responsible for normal growth and function of various organ systems. Potassium is necessary for muscle weakness associated with malaria, and also slows sclerosis of the vascular system. It helps fight bacteria and cleans the digestive system <sup>[12]</sup>. Sodium participates in the metabolism of water, promotes digestion, assimilation, osmosis, cleans. The digestive system fights stomach acid and alkalizes the blood. Lack of magnesium may be responsible for tetany, tuberculosis, diabetes, cancer and all the nerves diseases. Manganese, according to Claude and Paule, 1979 is necessary for the functioning of the pituitary gland. The pineal gland and the brain promotes hepato-renal works, fights anemia and is also essential for growth. Iron is an energizer, but excess can cause fatigue <sup>[13]</sup>. It has little excess if it is taken from a natural source. The result of the mineral composition clearly suggests that extract of *S. virginianum* contain a rich source of minerals indicating the usefulness of the sheets to complete the healing of various ailments during treatment with this plant product. The decrease in body weight with diabetes mellitus has attributed to gluconeogenesis, i.e. catabolism protein and fat, which is associated with the characteristic loss of body weight due to increased muscle wasting and loss of tissue proteins. Diabetes affects both glucose and lipid metabolism. <sup>14</sup>Administration of extracts in rats showed a significant decrease in blood sugar and increased body weight, serum insulin levels. The possible mechanism by which *S. virginianum* provides its hypoglycemic action by enhancing the Insulin plasma effects by increasing the pancreas insulin secretion from or through existing beta cells <sup>[15]</sup>. The present investigation clearly concludes that the leaves extracts of *S. virginianum* has a pronounce effect in controlling the hyperglycemic condition and having the ability to combat the complications associated with diabetes mellitus. The extract of the *S. virginianum* has potential to cure diabetes and can be further considered for its properties for treatment.

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