



Antidiabetic Effects of a Decoction of Leaves of *Sansevieria trifasciata* in Alloxan-Induced Diabetic White Rats (*Rattus norvegicus* L.)

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Abstract. Diabetes mellitus is a metabolic disorder characterized by hyperglycemic episodes. One approach for controlling hyperglycemia is to use natural compounds derived from plants, such as *Sansevieria trifasciata* leaves, which are presumed to contain hypoglycemic agents. *Sansevieria trifasciata* leaves are widely used by the Sabah community in Malaysia. The aim of the present study was to investigate the effects of a decoction of *Sansevieria trifasciata* leaves on blood glucose levels and the density of granules in pancreatic β cells in alloxan-induced hyperglycemic rats. This study used a completely randomized design and 30 male Wistar rats that were 2 months old, and had a body weight in the range of 150-200 gram. The rats were divided into a group of normal rats as the control group and five groups of alloxan-induced hyperglycemic rats, each with 5 animals per group. The five groups of hyperglycemic rats were administered by aquadest, respectively: saline, as a diabetic control; 5mg/kg bw glibenclamide; 100 mg/kg bw, 150 mg/kg bw, and 200 mg/kg bw of the *S.trifasciata* leaf decoction, using 1 ml per 200 g body weight for 30 days. Histological examination of the pancreas was performed by paraffin section and Victoria Blue staining. The results of this study show that all doses of the *Sansevieria trifasciata* leaves decoction decreased the level of blood glucose and increased the granule density in the β cells of the islets of Langerhans of the alloxan-induced hyperglycemic (diabetic) rats.

Keywords: *alloxan diabetes; blood glucose; β granule cells; Sansevieria trifasciata.*

1 Introduction

Changes in lifestyle, due to the successful lowering of mortality rates, are shifting disease patterns; from infectious diseases to chronic degenerative diseases. One metabolic-associated disease that is rising in number is diabetes

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mellitus. The causes of this disease not only include genetic factors but also environmental or lifestyle factors, such as diet, obesity and lack of exercise [1]. This disorder is found throughout the world and its incidence is rapidly increasing. Diabetes mellitus can be controlled by changing the diet and by exercising, or by providing the oral hypoglycemic agents [2]. However, excessive administration of oral hypoglycemic agents derived from synthetic materials can result in side effects such as lactic acid intoxication, with symptoms of tiredness, gastrointestinal disorders and hypoglycemia. Natural compounds that contain hypoglycemic substances, such as those used in traditional Chinese medicine, are being considered as alternatives to synthetic hypoglycemic agents [1]. Such alternative treatments, for example using natural ingredients, are easily available, cheap and likely to have fewer side effects. One of the natural ingredients that can lower the blood glucose level is *Sansevieria trifasciata* Prain leaf. Decoctions of *Sansevieria* leaves and other herbs are commonly used by the people of Sabah, Malaysia [3].

Sansevieria is usually used as a decorative plant or as the source of fibers. However, some countries also use these plants in traditional medicine. Medical efficacy of *Sansevieria* leaves relates, among others, to the treatment of diabetes mellitus, ear-ache, pharyngitis, skin itches, and urinary diseases as analgesic and antipyretic [4-7]. Recently, active components from several medicinal plants, food and agricultural products have been empirically reported to have biological activity in treating diabetes [8]. Hypoglycemic effects of the bioactive components of plants can restore the function of pancreatic β cells, thereby increasing the insulin secretion, inhibiting glucose absorption in the intestine and inhibiting the action of the enzyme α -glucosidase. Plants that contain bioactive components, such as: glycosides, alkaloids, terpenoids, flavonoid and ceratenoids, are mostly likely to have anti-diabetic activity [9]. There is still limited scientific information about the properties of the leaves of *Sansevieria trifasciata* Prain. Most of the studies to date have sought to determine their chemical contents and utilization by people in certain areas (ethnobotany or ethnomedicines) [5-6]. *Sansevieria* is relatively easy to find and is a cheap plant but its utilization for lowering the blood glucose levels has not been studied. The research reported here was conducted to investigate the effects of a *Sansevieria* leaves decoction on blood glucose levels, pancreatic β cell granule density and doses that could decrease blood glucose levels effectively.

2 Materials and Methods

2.1 Preparation of *Sansevieria trifasciata* Leaves Decoction

Sansevieria leaves were previously washed and cut into small pieces. After that they were dried until the water was evaporated, they were roasted or put in an oven at a temperature of 45°C until its dry weight was 11,89% of the total fresh/wet weight. The *Sansevieria* leaves decoction doses were 100 mg/kg bw, 150 mg/kg bw and 200 mg/kg bw. Two, three and four grams dried leaves were weighed respectively and each sample was boiled in 100 ml distilled water for 15 minutes, and stirred occasionally. Subsequently, the decoction was filtered.

2.2 Diabetic Induction and Treatment

Thirty white rats were divided into 6 groups, each containing 5 rats. A normal control group was injected with 1 ml of 0.9% saline solution. All treated rats were given a single dose of 130 mg/kg bw of alloxan monohydrate, in 0.9% fresh saline to induce hyperglycemia. Five groups of hyperglycemic rats were administered by aquadest, as the diabetic control group; 5 mg/kg bw glibenclamide as the control drug; and doses of 100 mg/kg bw, 150 mg/kg bw, and 200 mg/kg bw of the decoction of *S. trifasciata* leaves as the experimental group, using 1 ml per 200 g body weight for 30 days. The rats were fasted for 16-18 hours and anesthetized with ketamine before the blood was taken from the orbital sinus. Blood glucose levels were measured on day 0, day 15 and day 30, using the GOD-PAP method (*enzymatic photometric test*) λ 500 nm [10].

2.3 Histological Study

The pancreases were fixed using Bouin's solution. Histological examination of the pancreas was performed by paraffin section with Victoria Blue staining and counterstaining with Phloxine. The microanatomy of the pancreases was observed under the microscope and analyzed descriptively and semi-quantitatively [11,12].

2.4 Statistical Analyses

The data obtained in this study are qualitative data and quantitative data. The response to the treatment was calculated for each subject during treatment on 0 day, 15 day and 30 day. Differences among the six groups were tested by ANOVA. If the *p* value was ≤ 0.05 , changes in the treatment groups were compared with the normal control group using an LSD test to control for multiple comparisons. Statistical calculations were performed using the SPSS 17.0 software. Values are expressed as means \pm SD.

3 Result and Discussion

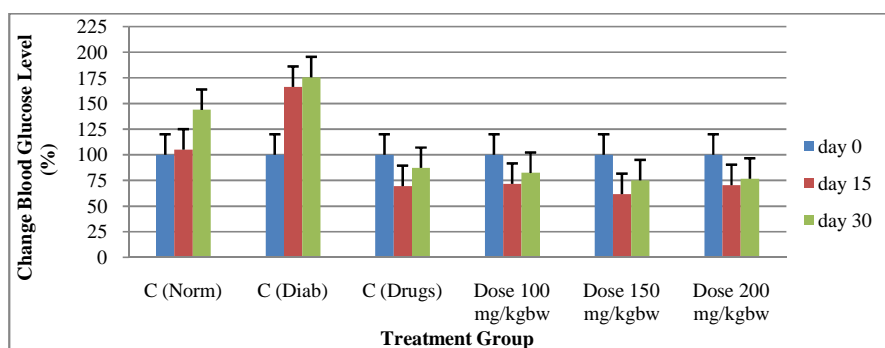
Blood glucose levels were measured before induction as the initial level, after induction or hyperglycemic condition on day 0, day 15 and day 30 after oral treatment. Table 1 presents the results of the blood glucose level and the percentage changes after 30 days of treatment. A histogram of the percentage changes in blood glucose level of each treatment group is shown in Figure 1.

Table 1 Mean blood glucose levels (mg/dL) between treatment groups before the induction of alloxan monohydrate (pre-treatment), on day 0, 15 and 30 after administration of the *Sansevieria trifasciata* leaf decoction.

Group	Pre-treatment	Day -0	Day -15	Day -30
Normal Control	50.74 ± 12.09	68.76 ± 7.76 ^a	71.24 ± 5.34 ^a	97.44 ± 2.85 ^a
Diabetic Control	37.86 ± 12.47	146.26 ± 5.29 ^b	245.60 ± 51.99 ^b	248.06 ± 91.99 ^b
Drugs Control	41.58 ± 5.83	129.22 ± 16.01 ^b	88.26 ± 12.38 ^a	110.12 ± 19.48 ^a
Dose 100 mg/kg	34.14 ± 5.31	124.68 ± 33.18 ^b	89.86 ± 26.29 ^a	102.74 ± 28.00 ^a
Dose 150 mg/kg	43.70 ± 8.69	142.18 ± 15.23 ^b	87.34 ± 11.37 ^a	105.68 ± 11.63 ^a
Dose 200 mg/kg	40.8 ± 11.96	128.78 ± 26.83 ^b	86.66 ± 16.98 ^a	96.94 ± 13.57 ^a

Note: Numbers followed by the same letter in the same column indicate no significant difference ($P > 0.05$).

P value between normal control group and diabetic control group can be seen in the legend figure.



P Value between Normal Control and Diabetic Control Groups:

	0 day		15 day		30 day	
	F	Sig.	F	Sig.	F	Sig.
Value	43.365	.000	6.572	.033	13.389	.006

Figure 1 Histogram of blood glucose levels alteration average (%) on day 0, day 15 and day 30 after treatment, C (Norm) for normal control group, C (Diab) for diabetic control group, C (Drug) for control-drug group, and treatment groups.

Microanatomy was used to determine the granule density in the pancreatic β cells and the color intensity of Victoria Blue absorbed by the β cells of the islets of Langerhans was estimated (see Table 2 and Figure 2).

Table 2 The mean density of pancreatic β cells of white rats (*Rattus norvegicus* L.) and intensity of color preparations stained with Victoria Blue.

Group	n	Stained Cell Density (%)	Mean Color Intensity	Color Intensity
Normal Control	12	80.83 \pm 10.62 ^a	3.67	++++
Diabetic Control	12	11.08 \pm 6.64 ^b	1.00	+
Drugs Control	12	41.67 \pm 23.10 ^c	1.92	++
Dose 100 mg/kg	12	56.50 \pm 10.30 ^d	2.42	+++
Dose 150 mg/kg	12	58.33 \pm 10.30 ^{de}	2.58	+++
Dose 200 mg/kg	12	69.33 \pm 16.84 ^{ae}	3.17	++++

Note: Numbers followed by different letters in the same column indicate significant differences ($P < 0.05$)

Table 1 shows that the blood glucose levels after induction had increased up to 3-fold from the initial levels. Increased blood glucose after induction is likely to be caused by the action of alloxan damaging the nuclear DNA of the pancreatic β cells through the accumulation of oxygen radicals or by DNA alkalization [13]. The pancreatic β cells' effort to repair the DNA is considered a suicide response, because the induction of DNA repair involves the activity of poly ADP-ribose polymerase, which depletes the cell of NAD^+ substrates. As a result, the intracellular NAD^+ concentration drops, inhibiting cellular activity, including insulin synthesis and secretion, which furthermore causes pancreatic β cell death. This, in turn, causes insulin deficiency, reducing the glucose intake by the body's cells, enhancing-mobilization of fat from storage and inducing protein turnover. Since the fat and protein are broken down and converted to glucose by gluconeogenesis, blood glucose levels continue to rise.

The effect of administering the *Sansevieria* leaf decoction on blood glucose levels in hyperglycemic rats was monitored over a 30-day period. This resulted in a decrease in blood glucose levels compared with the glucose level of day 0. On day 0, the blood glucose levels of the diabetic control group, the control-drug group and the treatment groups, showed statistically significant differences ($P > 0.05$). Blood glucose levels after oral treatment with the decoction had decreased on day 15. The blood glucose levels had increased on day 30 but were still within the normal range. Statistical analysis did not show significant difference ($P > 0.05$) with the normal control group however, it did show a significant difference with the diabetic control group ($P < 0.05$). The mean percentage change in blood glucose levels, see Table 2, shows that the blood glucose levels in the control-drug group and the decoction treatment groups had decreased compared with the blood glucose level on day 0, while the blood

glucose levels of the normal control and diabetic control groups had increased. The increased blood glucose levels in the normal control group were most likely due to the influence of stress as a result of the treatment and aging during the study, whereas the much higher blood glucose levels in the diabetic control group resulted from alloxan-induced hyperglycemia.

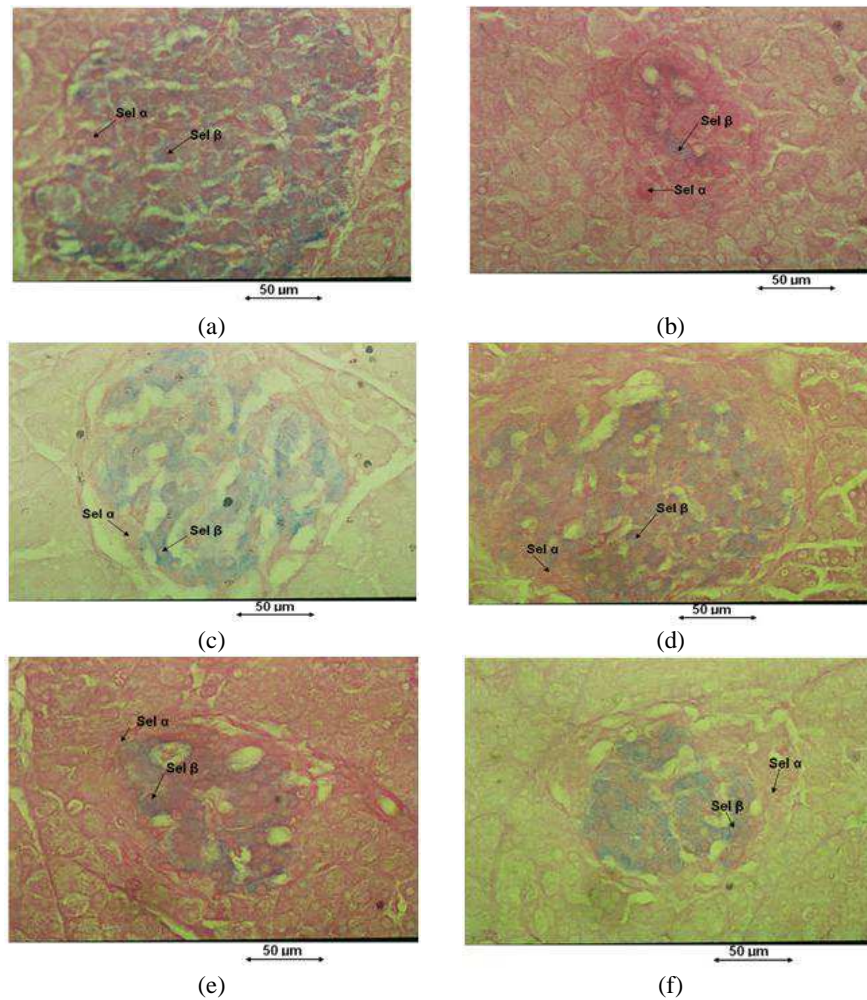


Figure 2 Histology of islet of Langerhans in rat pancreas stained with Victoria Blue. Normal control group (A), diabetic control group (B), control-drug group (C), treatment groups of *Sansevieria trifasciata* leaf decoction, dose 100 mg/kg bw (D), 150 mg/kg bw (E), and 200 mg/kg bw (F).

The administration of the decoction to alloxan-induced hyperglycemic (diabetic) rats resulted in an increase in the granule density in the β cells of the islets of Langerhans. This was demonstrated by an increase in Victoria Blue staining, compared to the diabetic control group. Figure 2 shows the overall comparison of the white rat pancreas microanatomy of the treatment groups stained with Victoria Blue. The β cell granule density and intensity of staining with Victoria Blue (Figure 2) was the lowest in the diabetic control group, where few of the β cells of the islets of Langerhans were stained; compared with other groups. Victoria Blue staining stains the granules of pancreatic β cells [14]; and the absence of such staining in the diabetic control group is consistent with β cell function disrupted by alloxan. In the control-drug group (given 5mg/kg bw glibenclamide), and the treatment groups (given a decoction of *Sansevieria* leaves at doses of 100 mg/kg bw, 150 mg/kg bw and 200 mg/kg bw) an increase in the density and intensity of staining with Victoria Blue was observed.

The decrease in the blood glucose levels and the increase in the granule density in the β cells of the islets of Langerhans in the groups that were given a synthetic hypoglycemic drug or a decoction of *Sansevieria* leaves were due to the drug or components in the *Sansevieria* leaf decoction. The magnitude of the reduction in the blood glucose levels was in the range of 60-70% on day 15 and 75-87% on day 30 (Table 2). All doses of the decoction lowered the blood glucose levels (Figure 1). The decreased blood glucose levels in the treatment groups were most likely due to the active substance(s) contained in the *Sansevieria* leaf decoction. *Sansevieria trifasciata* leaves extracted in ethanol or water contain various phytochemical compounds, which are generally grouped in form of alkaloids, flavonoids, saponins, glycosides, terpenoids, tannins, proteins, and carbohydrates [7]. Flavonoids are known as a natural hypoglycemic. They include, polyphenols, which is one type of flavonoid that can also function as an antioxidant. Several studies have shown that the polyphenols of some plants can improve insulin sensitivity, or increase the activity of insulin. The mechanism of action of this natural hypoglycemic compound is not known for certain [15,16]. This substance is expected to increase insulin release or increase the glucose uptake by peripheral tissues. Natural compounds that have anti-diabetic activity depend on the frequency of the presence of certain substances such as: complex carbohydrates, alkaloids, glycopeptides, terpenoids, peptides, amines, steroids, flavonoids, lipids, coumarins, sulfur compounds and inorganic ions [17].

The presence of flavonoids, including polyphenols in the *Sansevieria* leaf decoction may explain the improvement in insulin sensitivity, or insulin activity. According to the results of previous research, anti-hyperglycaemic or anti-diabetic medications can involve numerous mechanisms, for example a

direct competitive antagonist to insulin, stimulation of insulin secretion, stimulation of hepatic glycogenolysis and glycolysis, blockage of potassium ion channels in pancreatic β cells, stimulation of cAMP (cyclic adenosine monophosphate), and modulation of glucose absorption by the intestine. In addition to flavonoids, alkaloids are also capable of lowering blood glucose through a number of possible mechanisms that include: (1) stimulating insulin proliferation and secretion, (2) inhibiting α -glucosidase activity and reducing the absorption of glucose, (3) improving glucose metabolism via glycolysis [18] or the possibility to restore the function of pancreatic tissue [19]. The flavonoids and alkaloids in the *Sansevieria* leaf decoction were possibly responsible for lowering the blood glucose levels.

4 Conclusion

A decoction of *Sansevieria trifasciata* Prain leaves was found to lower the blood glucose levels and increase the granule density in the β cells of the islets of Langerhans in alloxan-induced hyperglycemic (diabetic) rats. The *Sansevieria* leaf decoction lowered the blood glucose levels to the same extent as a synthetic hypoglycemic drug (glibenclamide).

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