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RESEARCH ARTICLE

Antidiabetic Activity of Aqueous Extract of Sonchus asper Used As Anti-Hyperglycemic Herb in Kenya

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Abstract

Medicinal plants have been shown to manage diabetes mellitus. *Sonchus asper* is a medicinal herb that has been used in folk medicine to manage diabetes mellitus however there no scientific evaluation regarding its efficacy. This study aimed at establishing *in vivo* antidiabetic effect of *S. asper* in male albino mice. The antidiabetic effect of aqueous plant extract of *S. asper* was investigated in diabetic mice. The plant extract was accessed for antidiabetic effect by both oral and intraperitoneal administration. The experiment used 8 groups (5 mice in each) of mice in either route of administration. Decrease in plasma glucose relative to the initial values was determined after intraperitoneal and oral administration of *S. asper* aqueous extract at 25, 48.4, 93.5, 180.9, and 350 mg/kg. The reference drugs used in the study were 1 IU/kg insulin (intraperitoneal) and 200 mg/kg glibenclamide (oral). Blood sugar level was measured before administering the drug then repeated at the interval of two hours (for 10 hours) after drug administration and at 24 hours post drug administration. Significant reduction in blood glucose relative to their initial values was determined for all treated diabetic groups at the end of experiment. Screening of the phytochemicals present in extract was by use of standard procedures. The extract administered intraperitoneally and orally demonstrated antihyperglycemic potential. The observed antihyperglycemic is associated by the phytochemicals which were present in the extract. The results indicate that *V. lasiopus* is promising in development of phytomedicine for the management of diabetes mellitus.

Keywords: Diabetes mellitus; Antidiabetic activity; Aqueous extracts; *Sonchus asper*; Antihperglycemic.

List of abbreviations

SD: Standard Deviation

IU: Insulin units

SPSS: Statistical Package of Social Sciences

HbA1C: Glycated haemoglobin

ANOVA: Analysis of variance

Introduction

Diabetes mellitus is of health concern worldwide because by 2014 about 382 million people were affected and the number is expected to rise to about 592 million in about 25 years' time [1]. The disorder results due to the inability of the body to utilize or make insulin. Transportation of glucose from the systemic circulation into the cells is facilitated by insulin hormone. The main characteristic of diabetes mellitus is hyperglycemia (high blood sugar level) [2]. Hyperglcemia is associated with increased risks of macrovascular (stroke, peripheral vascular diseases and ischemic heart disease) and microvascular (nephropathy, neuropathy and retinopathy) complications [3]. Diabetes mellitus is classified into insulin dependent (type 1) and non-insulin dependent (type 2) diabetes mellitus. Destruction of beta cells of pancreas causes type 1 diabetes mellitus while tissue resistance to insulin is responsible for type 2 diabetes mellitus [4]. Symptoms of diabetes mellitus are weight loss, polyuria, polydipsia blurred vision, and fatigue [5].

Diagnosis of diabetes mellitus is based on; fasting plasma glucose of above 11Mm, glycated haemoglobin (HbA1C) level of between 6.1-7.0, and two hour oral glucose tolerance test ranging 7.8 to 10.0 [6]. The current dugs used (insulin and oral hypoglycemic agents) in management of diabetes mellitus are expensive and have numerous side effects such as brain atrophy, fatty liver, insulin resistance, and anorexia nervosa [6]. There is need therefore for the alternative drugs especially from plant sources because they safe, cheap and readily available to the local population.

Plants are a possible source of medicines because they contain bioactive constituents. A number of plants are known to have antiyhperglycemic effect. For instance *Pterocarpus marsupium* and *Pappea capensis* have been demonstrated to have antidiabetic activity [7]. Some conventional drugs have plant origin such as metformin, which is obtained from Galega officinalis, a common folkloric remedy in management of diabetes mellitus [8,9]. Efficacy of most of the plants used

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in management of diabetes mellitus needs to be evaluated scientifically [10]. Experimental test of herbs using animals provides important information on efficacy and dose which can be translated to human studies [11].

S. asper is used in folkloric medicine to manage diabetes mellitus. Scientific evidence regarding its efficacy needs to be evaluated to support its traditional use. This scientific study therefore aimed at providing the data to support its folk use.

Plant Materials Collection

Plant materials (Stems and leaves) of *S. asper* were collected from their habitat in Nakuru County. Identification of the herb was done at Kenya National Museum by a taxonomist.

Preparation of Extract

The collected plants were shade dried to a constant dry weight. An electric grinder was used to grid the dried plant material to powder. Powdered plant material was put in closed containers in the laboratory. A liter of distilled water at 60°C was used to extract 100 g of powdered plant material in a metabolic shaker for six hours. The cold mixture was then decantation into conical flask. Filtration of the suspension over folded cotton gauze stuffed into a funnel was then done. The filtrate was freeze-dried in 200 ml portions for 48 hours. The freeze-dried samples of *S. asper* were stored in air-tight containers at -20°C.

Experimental Animals and Experimental Diabetes Induction

Three to four weeks Swiss White male Albino mice having a weight of 23-27 g were used in the experiment. The animals were housed at room temperature and fed with standard pellets and fresh water ad libitum. Hyperglycemia was induced by intraperitoneal administration of a single dose of 186.9 mg/kg body weight of 10% alloxan-monohydrate. Blood glucose level was then measured 48 hours after induction of hyperglycemia and diabetic mice were considered to be those whose blood sugar level was above 11 mm/L. The mice to be induced hyperglycemia were fasted for 8 to 12 hours before this experiment was done.

Experimental Design

For either route of administration (oral or intraperitoneal) the experimental animals were put into 8 groups each group having five mice.

Group I - normal control (normal mice administered orally and intraperitoneally with 0.1 ml saline).

Group II - negative control (diabetic mice administered orally or intraperitoneally with 0.1 ml saline)

Group IIIa - positive control (reference drug) for the oral route (diabetic mice administered orally with 200 mg/kg of Glibenclamide).

Group IIIb - positive control (reference drug) for intraperitoneal route (diabetic mice administered intraperitoneally with 1 insulin units per kilogram).

Group IV- 25 mg/kg of extract in 0.1 ml saline

Group V- 48.4 mg/kg of extract in 0.1 ml saline

Group VI- 93.5 mg/kg of extract in 0.1 ml saline

Group VII- 180.9 mg/kg of extract in 0.1 ml saline

Group VIII- 350 mg/kg of extract in 0.1 ml saline

The same design was repeated but the treatment was administered intraperitoneally.

Sample Collection, Blood Glucose, Rate Constant and Half-Life Determination

Blood samples were drawn from sterilized mice tail (with 10% alcohol). A drop of blood from the tail was squeezed into a glucometer for blood sugar determination. This experiment was repeated after 2 hours for a period of 10 hours and finally after 24 hours. Natural log concentration of plasma sugar level for the first four hours against time was plotted in order to determine the rate constant (k). Pseudo-first order rate constant (k/2.303) was produced by plotted plots. The constant was indicated by the point where the straight line meets with natural log of plasma glucose concentration axis (indicating initial concentration of plasma sugar before drug administration) [12,13]. Substituting the rate constant in the formula $t0.5=0.693/k$ helped in determining the half-life (t0.5). Half-life (t0.5) is the time taken by the drug to reduce blood sugar level to half [14]. The dosage to be administered after certain duration of time was obtained from the exponential decay equation [15].

Phytochemical Screening

Standard procedures were used to establish the presence of phytochemicals present in aqueous extract of *S. asper* such as saponins, alkaloids, flavonoids, tannins and total phenols [14,15].

Statistical Evaluation of the Collected Data

The data was evaluated statistically by use of Statistical Package of Social Sciences (SPSS) software. Results were expressed as the Mean ± standard deviation (SD) for 5 mice used per group. ANOVA followed by by Bonferroni-Holm multiple comparison test were used so as to compare the normal control group mean with those of diabetic group administered with saline, diabetic group administered with the conventionally used drugs, diabetic group administered with *S.asper* at five different dosage (at 25, 48.4, 93.5, 180.9, and 350 mg/kg). Statistical significant was considered at $p \leq 0.05$.

Results

S. asper aqueous extracts yielded a dark green paste of concentration 67.5 mg/g dry weight. A dose independent decrease in blood sugar level was observed after oral administration of *S. asper* at 25, 48.4, 93.5, 180.9, and 350 mg/kg as from the second hour. During this hour, percentage reduction in blood glucose levels by extract of *S. asper* at 25, 48.4, 93.5, 180.9, and 350 mg/kg was 74.9, 67.2, 78.2, 75.8 and 78.4%, respectively, while glibenclamide-treated

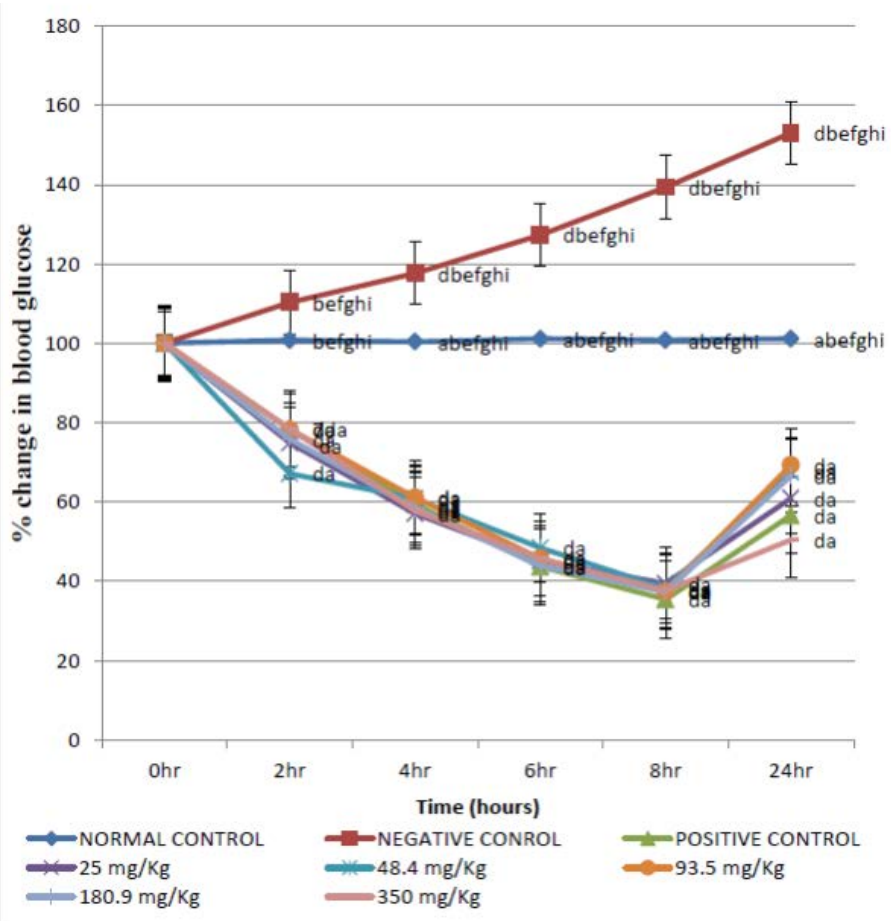

Figure 1: Percentage reduction in blood glucose levels after oral administration of the extracts of *Sonchus asper* in diabetic mice.

animals blood sugar levels was decreased to 78.4% (Figure 1). The normal levels of blood glucose were not attained by all the doses administered at this hour ($d\rho < 0.05$) (Table 1). Significant reduction in blood glucose was however shown by the doses relative to negative control group ($a\rho < 0.05$) (Table 1).

By the fourth hour the percentage decrease in blood glucose level observed from the five doses (25, 48.4, 93.5, 180.9, and 350 mg/kg) of extract of *S. asper* was 57.1, 60.9, 61.1, 58.4 and 57.8%, while glibenclamide-administered diabetic mice showed 59.4% blood sugar level decrease. By the sixth hour all the extract doses decrease blood sugar level to normal ($^{d}\rho>0.05$). The percentage blood glucose reduction at this hour was 45.2, 48.4, 45.8, 44.0 and 45.7%, respectively, relative to glibenclamide-treated mice whose blood sugar levels was lowered to 43.7%. At the sixth hour, the five doses of aqueous extracts were as effective as glibenclamide ($^{b}\rho<0.05$) especially by the 180.9 mg/kg body dose. Similar trend was observed during the 8th hour where the five doses of *S. asper* decreased blood sugar levels to 39.4, 38.2, 37.4, 37.3 and 37.8%, respectively, compared to glibenclamide-administered diabetic mice whose blood sugar levels was lowered to 35.4% (Figure 1). The mice treated with orally administered extracts of *S. asper* at 25, 48.4, 93.5 and 180.9 mg/kg doses had returned to hyperglycemic state at the 24th hour but those administered with 350 mg/kg had not (Table 1).

Intraperitoneal administration of aqueous extracts of *S. asper* at 25, 48.4, 93.5, 180.9, and 350 mg/kg in mice showed a dose independent decrease in blood sugar level as from the second hour. The percentage reduction of plasma sugar levels at this hour by the five doses of *S. asper* (at 25, 48.4, 93.5, 180.9, and 350 mg/kg) was 72.5, 64.0, 69.3, 72.3 and 70.3%, respectively, compared to insulin-administered diabetic mice which decreased to 45.4%. At this hour, however normal blood sugar levels were not attained by all the doses of the aqueous extracts of *S. asper* ($^{C}\rho<0.05$) (Table 1). Significant reduction in blood sugar level by the doses was however shown relative to negative control ($^{A}\rho<0.05$).

The percentage blood sugar reduction by the fourth hour from the five doses of *S. asper* aqueous extract was 52.2, 52.9, 54.2, 53.3 and 53.2%, respectively, compared to insulin-administered diabetic mice whose blood sugar levels decreased to 42.0%. Normal blood sugar levels were attained in mice by all the administered doses by the 6th hour ($^{C}\rho>0.05$). The percentage reduction in blood sugar level from the five doses of aqueous extracts of *S. asper* was 44.8, 44.2, 44.5, 42.8 and 42.6%, respectively, relative to insulin-administered mice whose blood glucose levels was decreased to 37.2%. Effectiveness of

Treatment	Route	Levels of Glucose at Varying Times (mmol/L)					
		0 hour	2 hour	4 hour	6 hour	8 hour	24 hour
Normal control	IP	5.24 ± 0.05^{ABDEFGH}	5.26 ± 0.06^{ADEFGH}	5.24 ± 0.04^{ADE}	5.24 ± 0.06^{A}	5.28 ± 0.04^{A}	5.30 ± 0.03^{ADEFG}
	Oral	5.16 ± 0.04^{abefgi}	5.20 ± 0.04^{fabeghi}	5.18 ± 0.02^{a}	5.22 ± 0.04^{a}	5.20 ± 0.03^{a}	5.22 ± 0.04^{aefgh}
Negative control	IP	15.24 ± 0.78^{C}	16.54 ± 0.84^{CBDEFGH}	17.36 ± 0.78^{CBDEFGH}	18.36 ± 0.90^{CBDEFGH}	19.50 ± 0.82^{CBDEFGH}	21.86 ± 0.75^{CBDEFGH}
	Oral	14.94 ± 1.17^{befghid}	16.48 ± 1.45^{bdefghi}	17.58 ± 1.54^{dbefghi}	19.02 ± 1.69^{dbefghi}	20.82 ± 1.81^{dbefghi}	22.86 ± 1.65^{dbefghi}
Positive control (insulin)	IP	14.46 ± 0.62^{C}	6.56 ± 0.21^{ADG}	6.06 ± 0.19^{A}	5.38 ± 0.07^{A}	5.02 ± 0.07^{A}	7.06 ± 0.09^{ADE}
Positive control (glibenclamide)	Oral	15.18 ± 1.59^{d}	11.90 ± 1.80^{d}	9.02 ± 1.21^{a}	6.64 ± 0.65^{a}	5.38 ± 0.22^{a}	8.60 ± 0.70^{de}
Extract dose (mg/kg body weight)							
25	IP	15.14 ± 0.77^{C}	10.98 ± 0.74^{CAB}	7.90 ± 0.43^{CA}	6.78 ± 0.36^{A}	5.86 ± 0.33^{A}	9.20 ± 0.45^{CABH}
	Oral	15.06 ± 1.06^{d}	11.28 ± 0.55^{da}	8.60 ± 0.49^{a}	6.80 ± 0.18^{a}	5.94 ± 0.29^{a}	9.18 ± 0.61^{da}
48.4	IP	14.74 ± 0.62^{C}	9.44 ± 0.33^{CA}	7.80 ± 0.25^{CA}	6.52 ± 0.21^{A}	5.86 ± 0.14^{A}	9.60 ± 0.49^{CABH}
	Oral	14.62 ± 1.08^{d}	9.82 ± 0.94^{a}	8.90 ± 0.67^{a}	7.08 ± 0.38^{a}	$5.58 \pm .024^{a}$	9.88 ± 0.46^{da}
93.5	IP	13.74 ± 059^{C}	9.52 ± 0.44^{CA}	7.44 ± 0.30^{A}	6.12 ± 0.26^{A}	5.34 ± 0.13^{A}	9.00 ± 0.49^{CAH}
	Oral	13.42 ± 0.86^{d}	10.50 ± 0.67^{da}	8.20 ± 0.53^{a}	6.14 ± 0.47^{a}	5.02 ± 1.59^{a}	9.30 ± 0.48^{da}
180.9	IP	13.84 ± 0.60^{C}	10.00 ± 0.72^{CAB}	7.38 ± 0.34^{A}	5.92 ± 0.25^{A}	5.04 ± 0.10^{A}	8.92 ± 0.42^{CAH}
	Oral	13.56 ± 1.11^{d}	10.28 ± 0.62^{da}	7.92 ± 0.40^{a}	5.96 ± 0.27^{a}	5.06 ± 0.06^{a}	9.04 ± 0.67^{da}
350	IP	13.38 ± 0.60^{C}	9.40 ± 1.05^{CA}	7.12 ± 0.85^{A}	5.70 ± 0.37^{A}	4.86 ± 0.20^{A}	6.54 ± 0.34^{ADEFG}
	Oral	13.16 ± 1.14^{d}	10.32 ± 1.11^{da}	7.60 ± 1.03^{a}	6.02 ± 0.52^{ia}	4.96 ± 0.14^{a}	6.64 ± 0.32^{a}

Results are presented as Means ± SD (n=5). Means accompanied by similar upper case letters (Intraperitoneal) and similar lower case letters (oral) in the same column are significantly different at $\rho \leq 0.05$ by ANOVA and Bonferroni-Holm holm multiple comparison test.
Value followed by *$p<0.05$ is considered statistically significant when the mean of the oral group is compared to intraperitoneal group by T-test.

Table 1: Hypoglycemic effect of aqueous plant extracts of *S. asper* at five doses on blood glucose levels in mice.

the five doses at this hour is comparable to insulin ($^{B}\rho < 0.05$). During the 8th hour, the same trend by five aqueous extracts doses of *S. asper* was observed where blood glucose levels was lowered to 38.7, 39.8, 38.9, 36.4 and 36.3%, respectively, relative to insulin-administered mice whose plasma glucose level decreased to 34.7% (Figure 2).

In the 24th hour, the blood glucose levels in diabetic mice administered with aqueous extracts of *S. asper* at 25, 48.4, 93.5 and 180.9 mg/kg body weight had returned to the diabetic state but those administered with aqueous extracts of *S. asper* at 350 mg/kg body weight had not (Table 1). Oral and intraperitoneal administration of the aqueous *S. asper* at all the five doses lowered blood glucose in diabetic mice (Table 1).

Values are represented as % means ± SEM (n=5). $^{d}\rho<0.05$ with respect to normal control; $^{a}\rho<0.05$ with respect to negative control; $^{b}\rho<0.05$ with respect to positive control; $^{e}\rho<0.05$ with respect to 25 mg/kg; $^{f}\rho<0.05$ with respect to 48.4 mg/kg; $^{g}\rho<0.05$ with respect to 93.5 mg/kg; $^{h}\rho<0.05$ with respect to 180 mg/kg; $^{i}\rho<0.05$ with respect to 350.

Values are represented as % means ± SEM (n=5). $^{C}\rho<0.05$ with respect to normal control; $^{A}\rho<0.05$ with respect to negative control; $^{B}\rho<0.05$ with respect to positive control; $^{D}\rho<0.05$ with respect to 25 mg/kg; $^{E}\rho<0.05$ with respect to 48.4 mg/kg; $^{F}\rho<0.05$ with respect to 93.5 mg/kg; $^{G}\rho<0.05$ with respect to 180 mg/kg; $^{H}\rho<0.05$ with respect to 350 mg/kg.

Antihyperglycemic effect pharmacokinetics for the first four hours of the plant extracts of *S. asper* at the five tested doses is shown in Table 2. Results shows that the pseudo-first order rate constants for the orally administered doses of the plant extracts of *S. asper* at 25, 48.4, 93.5, 180.9 and 350 mg/kg body weight doses were 0.2801, 0.2482, 0.474, 0.2689 and 0.2745, respectively, and their corresponding half-lifes were 2.47, 2.79, 1.46, 2.58, and 2.52 hours, respectively. The half-life of 48.4 mg/kg dose is higher while those of the other doses were lower than that of glibenclamide. Pseudo-first order rate constants for the intraperitoneally administered doses of aqueous extracts of *S. asper* at 25, 48.4, 93.5, 180.9 and 350 mg/kg body weight doses were 0.3252, 0.3182, 0.3067, 0.3144 and 0.3154, respectively, and their corresponding half-lifes were 2.13, 2.18, 2.26, 2.20 and 2.20 hours, respectively. The half-lifes of all the doses were higher than that of insulin. Orally administered aqueous extract rate constant at five doses ranged from 0.2482 to 0.474 per hour while their accompanying half-lifes ranged from 2.79 to 1.46 hours. Intraperitoneal administered extracts showed a rate constant range of 0.3067 to 0.3252 per hour and their corresponding half-lifes were 2.26 to 2.13 hours. Reference drugs rate constant were 0.4348 (for insulin) and 0.2603 (for glibenclamide) and their accompanying half-lifes were 1.59 and 2.66 hours, in the same order.

Quantitative Screening Results of the Phytochemicals Present in the Extracts of *Sonchus Asper*

The screening results (Table 3) showed that the phytochemicals present the extracts of *S. asper* were phenols, alkaloids, tannins, saponins and flavonoids.

Representation of data was Mean ± SD (Standard Deviation) n=3. The phytochemical quantities were expressed as mg/g of dry extract

Discussion

S. asper was screened to explore the scientific use of the herb in management of diabetes mellitus. Diabetic mice used in the study showed increase in blood glucose level of up to

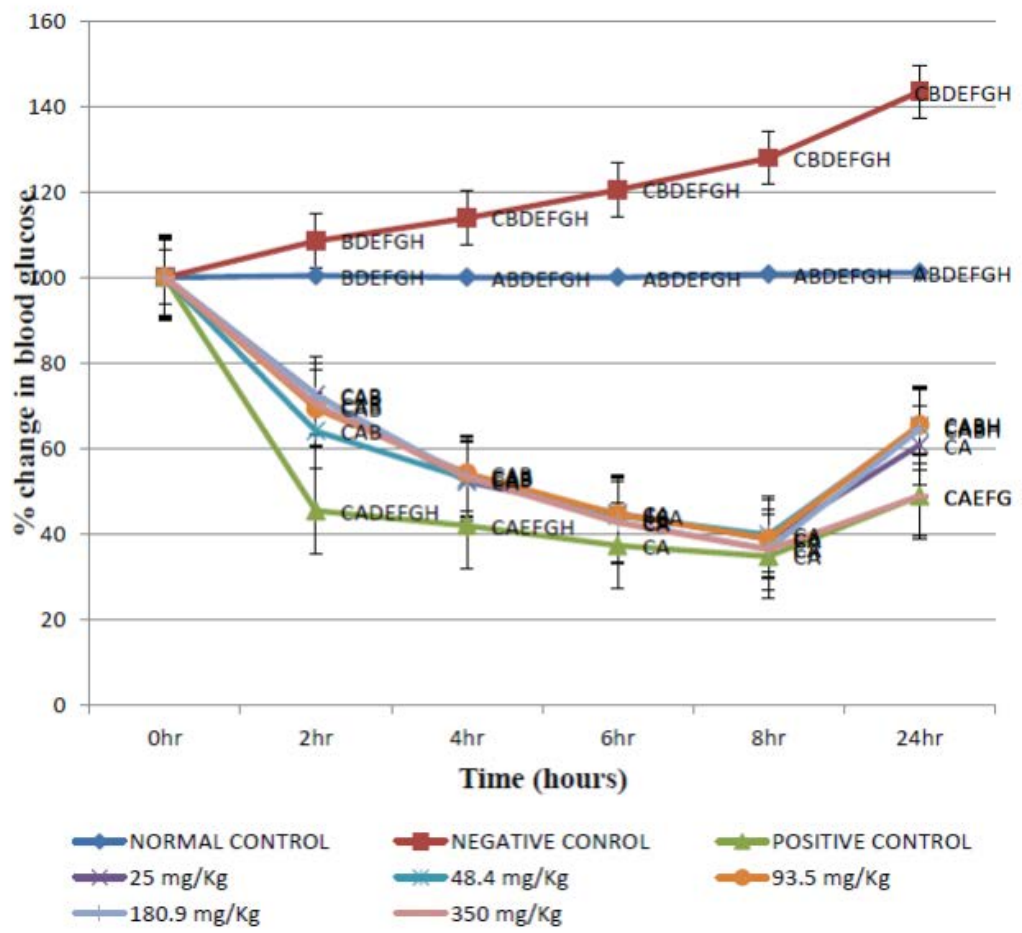

Figure 2: Percentage reduction in blood glucose levels after intraperitoneal administration of the extracts of *S. asper* in diabetic mice.

Drug (dose)	Route	Rate constant (hour^{-1})	Half-life (hours)
Insulin	IP	0.4348	1.59
Glibenclamide	Oral	0.2603	2.66
Extract (mg/kg bw)			
25	IP	0.3252	2.13
	Oral	0.2801	2.47
48.4	IP	0.3182	2.18
	Oral	0.2482	2.79
93.4	IP	0.3067	2.26
	Oral	0.4740	1.46
180.9	IP	0.3144	2.20
	Oral	0.2689	2.58
350	IP	0.3154	2.20
	Oral	0.2745	2.52
Results are expressed as Means of 5 mice for each time point; bw represents body weight.			

Table 2: Pharmacokinetics of antihyperglycemic effect for the first four hours of the aqueous extracts of *S. asper.*

4.6 times higher (23mM) compared to normal control group (5mM). The alloxan treatment leads to an increase in blood sugar level because as it destroys the beta cells of pancreas through formation of reactive oxygen species. This destruction affects insulin synthesis and release making it insufficient and unavailable thus inducing type I diabetic state [16,17].

Antidiabetic potential was observed after oral and intraperitoneal treatment with the plant extracts of *S. asper* at 25, 48.4, 93.5, 180.9 and 350 mg/kg in a dose independent response. This indicates that the plant extract contained hypoglycemic constituents. Similar blood sugar decreasing by other plants have been previously studied and reported by other researchers [18]. The antihyperglycemic effect of plants extract of *S. asper* orally or intraperitoneally administered to diabetic mice independent of the dose suggests a saturable active transport for the uptake of active constituents or may be an indicator of maximum antidiabetic effect at the lowest dose (25 mg/kg body weight). The return to diabetic state in mice

Sample	Phytochemical Content (mg/g)				
	Total Phenols	Tannins	Flavonoids	Saponins	Alkaloids
Sonchus asper	12.21 ± 0.60	3.43 ± 0.16	1.51 ± 0.04	63.53 ± 1.17	7.30 ± 0.61

Table 3: Quantitative screening results of phytochemicals present in the extract *S. asper*.

24 hours after administration with aqueous extract (orally and intraperitoneally) is due to decrease of hypoglycemic constituents in systemic circulation and is important in defining the frequency of dosing. This may be as a result of liver metabolism and renal clearance or degradation based on the short half-life of the antidiabetic constituents [19].

Similar antidiabetic effect has been reported by plants studied by other researchers. Water and ethanolic extracts of *Caesalpinia bonducella* showed antidiabetic activity by enhancing secretion of insulin in the isolated inslets, when administered to type II diabetic [20]. *Tribuluks terrestris* aqueous extract significantly decreased the plasma sugar levels in diabetic and normal mice by enhancing the secretion of insulin [21]. Diabetic rats administered with Propanone extract of *Elephantopus scaber*, showed a significant decrease in blood sugar because the extract improves insulin sensitivity, revitalize glucose dependent insulin secretion and enhance regeneration of islet of pancreas [22].

Aqueous plant extract administered intraperitoneally at 25, 48.4, 180.9 and 350 mg/kg in diabetic animals showed higher rate constants and shorter half-lifes compared to orally administered extract. This is because the intraperitoneal route provides the hypoglycemic constituents immediately and at high concentration into the blood. In the oral route, the active antihyperglycemic constituents' concentration reduced in the systemic circulation because of liver metabolism, limited absorption through the gut mucosal epithelial cells or the slow transportation of antidiabetic constituents across the intestinal wall. When the extract is orally administered mucosal cells of the gut absorb the active constituents which enter the hepatic portal system, this transports them to the liver where metabolism occurs and reduced unmetabolized active constituents are released into the systemic circulation [23].

The study demonstrated that various doses of *S. asper* (25, 48.4, 93.5, 180.9 and 350 mg/kg) showed antidiabetic effect against alloxan-induced diabetic animals. This shows that the extract contained the antihyperglcemic constituents. The high levels of the antihyperglycemic constituents in the plant could be due to the soil composition and the environmental stress at the sites where the plant was growing and harvested. Bioactive constituents of plants are secondary products produced to help them survive the stress induced to them by the environment. They are products of inducible genes [24].

The blood sugar decreasing effect of the *S. asper* extract may be associated with phytochemicals such as flavonoids, total phenols, alkaloids, saponins, and tannins that have been shown to have hypoglycemic activity [25]. As reported by Ghule et al. [26], flavonoids have been shown to have insulinomimetic effect hence stimulate lipogenesis as well as glucose transport in the adipocytes tissues hence decreasing the blood glucose level [27]. Flavonoids stimulate transport of glucose in the adipocytes and lipogenesis, hence decreasing blood glucose. Flavonoid glycosides of *Psidium guajava* such as strictinin, isostrictinin and pedunculagin manage diabetes by improving the sensitivity of insulin [22]. Flavonoid fractions from *Pterocarpus marsupium* cause pancreatic beta cell regulation [27]. Epicatechin and catechin flavonoids from *Pterocarpus marsupium* have been reported to demonstrate antidiabetic properties [27].

As demonstrated by Kimura and Suzuki [28] saponin lowers blood glucose in normal and diabetic mice. Saponins from *Entada phaseoloides* seeds reduced fasting blood sugar and alleviated diabetic state in type II diabetic rats as reported by Abdirahman et al. [21]. *Acanthopanax senticosus saponins* which were extracted from leaves when administered into mice (100, 200 mg/kg, intraperitoneally) decreased experimental hyperglycemia without affecting plasma glucose levels in normal mice as reported by Sui et al. [29]. Oral administration of Citrullus colocynthis on normalglycemic rabbits at a dose of 50 mg/kg demonstrated that a saponin-component reduced glycemia after 1, 2, 3 and 6 hour. Graded doses of saponin extract (10, 15 and 20 mg/kg) caused a marked hypoglycemic effect in diabetic rabbits [30]. The alkaloids have been shown to promote islet of pancreas regeneration after beta cells destruction this restores insulin production correcting the diabetic state [25].

Conclusion

Oral and intraperitoneal administration of aqueous extract of *S. asper* at 25, 48.4, 93.5, 180.9 and 350 mg/kg in alloxan induced diabetic mice caused significant antidiabetic activity. Similar antidiabetic potential was observed for the two routes of administration (oral and intraperitoneal) in alloxan-induced diabetic mice. The study therefore confirms that of *S. asper* plant extract is suitable in management of diabetes mellitus.

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