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ANTIDIABETIC EFFECT OF ALOE VERA IN ALLOXAN INDUCED DIABETIC RAT

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ABSTRACT

Oral anti-diabetic agents have a number of serious adverse effects, thus, managing diabetes without any side effects is still a challenge. Therefore, the search for many effective and safer hypoglycemic agents has continued to be an important area of investigation. Besides, drug classically used for the treatment of diabetes (insulin, sulphonylureas, biguanides and thazolidinediones), several species of plants have been described in the scientific and popular literatures having a hypoglycemic activity. The aim of this research was to investigate the effect of Aloe vera on blood glucose level in rats in diabetic condition. In this study a total of 150 rats (50 normal rats and 100 alloxan induced diabetic rats) were used for five trials. The rats were divided into three groups for each trial, each containing 10 individuals as follows: Group A is the control, Group B as diabetic control and Group C were diabetic rat received Aloe vera. Then alloxan injection was injected at a dose rate of 100 mg/kg body weight through intra-peritoneal route to each rat to induce diabetes in groups B and C. Aqueous extract of Aloe vera were fed by gavage at a dose of 300 mg/kg body weight daily for 21 days in group C. On the 10th day blood glucose level and the body weights were measured for the first time to ensure diabetic induction. Then all the rats of this group were kept for more 21 days for the treatment of diabetic condition. During experimental period, day 0, 7, 14 and 21 blood samples were collected from all groups and determined their blood sugar level using diabetic kit. After 3 weeks of treatment the blood glucose level significantly ($P<0.001$) reduced in the group C compared to B from 260± 11.53 mg/dl to 91.21 ± 3.67 mg/dl. On the other hand, the average body weight was increased significantly ($P<0.001$) from 260±3.95 gm to 279.88±7.13 gm in the group C compared to that of B. From our findings, it is concluded that Aloe vera can be used as anti-diabetogenic agent in food.

Keywords: Aloe vera, anti-diabetic, anti-hyperglycemic, rat

INTRODUCTION

Diabetes is one of the major degenerative diseases in the world today. It is considered as one of the five leading causes of death in the world. Diabetes mellitus (DM) is characterized by elevated plasma glucose concentrations resulting from insufficient insulin, insulin resistance or both leading to metabolic abnormalities in carbohydrates, lipids and proteins (Hernandez-galicia *et al*., 2002). It is a major risk factor for the development of cardiovascular disease. About 70-80% of deaths in diabetic patients are due to vascular disease. In particular, hyperglycemia, the primary clinical manifestation of diabetes, is thought to contribute to diabetic complications by altering vascular cellular metabolism, vascular matrix molecules and circulating lipoproteins. It can be hereditary and environmental which leads to metabolic abnormalities mainly characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both. Being a major degenerative disease, diabetes is found all over the world, and it is becoming the third most lethal disease of mankind and increasing rapidly (King and Herman 1998). It is the most common endocrine disorder, affecting 16 million individuals in the United States and as many as 200 million individuals worldwide (IDF, 2019).

For instance hyperglycemia increases diacylglycerol levels and activates protein kinase C activity in the aorta of streptozotocin induced diabetic rats (Inoguchi *et al*., 1994) and dogs (Xia P *et al,* 1994). Thickening of the basement membranes in renal glomeruli and peripheral capillaries has been observed in stz. induced diabetic rats (Olgemoller *et al*, 1993) and hyperlipidemia is a feature of drug induced diabetes in rats (Still *et al.,* 1964) and rabbits (Nordestgaard *et al,* 1988; Miller and Wilson, 1984).

Although, oral hypoglycemic agents and insulin are the main treatment of diabetes with prominent side effects and fail to significantly alter the course of diabetic complications. The common side effects

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associated with oral hypoglycemic agents are hypoglycemia, weight gain, gastrointestinal disorders, peripheral edema and impaired liver function, in addition to the cost of treatment. Since natural remedies are somehow safer and more efficacious than pharmaceutically derived remedies. Complementary and alternative medicine involves the use of medicinal plant alternatives to mainstream treatment. A recent study has estimated that up to 30% of patients with DM use complementary and alternative medicine (Mukharje and Karati 2023; Villarruel-López *et al*., 2018).
According to the World Health Organization, more than 70% of the world's population must use traditional medicine to satisfy their principal health needs (Farnsworth et al., 1985). A great number of medicinal plants used in the control of the DM have been reported (Baily and Day 1989).Aloe vera (synonym *A. barbadensis* Miller) (Liliaceae) is a fleshy plant filled with a clear viscous gel and it may exert its blood glucose lowering effect by preventing the death of β-cells and/or recovering the destroyed β-cells. It may also have initiated cell proliferation (Noor *et. al.,* 2013). Five phytosterols in Aloe vera gel like lophenol, 24-methyl-lophenol, 24-ethyl-lophenol, cycloartanol, and 24-methylene-cycloartanol are believed to have anti-hyperglycemic effect in diabetes (Tanaka *et al.,* 2006).The aim of the present research proposal is to elucidate the possible antidiabetic activity of *Aloe vera* and its medicinal potency responsible for the protection of different organs.

MATERIALS AND METHODS

This study was conducted in the Department of Anatomy, Histology and Physiology, Sher-e-Bangla Agricultural University, Dhaka to evaluate the efficacy of Aloe vera extract in diabetic rats.

Collection and acclimatization of rats*:*

Total 150 mixed male albino rats (aged 2-3 months) were collected from Jahangirnagar University, Savar, Dhaka. For five experimental trials, all the rats were grouped into three each containing 50 rats. Each group of rats was housed at serene bottomed wire cages arranged in rows and kept in the animal house of this department. The animals were fed with pellet at a recommended dose of 100 gm/kg. Drinking water was supplied *ad libitum.* The rats were reared in this condition for a period of three weeks to acclimatize them prior to experimental uses.

Induction of diabetes:

To induce diabetes mellitus, alloxan injection was given through intra-peritoneal route and this increased the blood glucose level ($P<0.05$) and at the same time body weight was decreased also. Single dose of alloxan administered intraperitoneally @100 mg/kg body weight (Junod *et al.,* 1996). In this experiment, polyuria, polydipsia and polyphagia after 24 hours of alloxan injection were observed. Rats with serum glucose level ranging between 150 mg/dl or above considered as hyperglycemic (Reeves et al., 1993).

Experimental design:

In that study, a total of 150 rats (50 normal rats and 100 alloxan induced diabetic rats) were used for five trials. The rats were divided into three groups for each trial, each containing 10 individuals (N=10) as follows:

Group A: Normal control group

Group B: Diabetic control group

Group C: Diabetic with Aloe vera treated group

After 18 hours of starvation, body weights and blood glucose were measured after acclimatization of rats. Then alloxan injection was injected at a dose rate of 100 mg/kg body weight through intra-peritoneal route to each rat to induce diabetes in groups B and C. All the groups of rats were reared under normal diet and water *ad libitum* from Day 1-10, on 10th day blood glucose level and the body weights gaining were measured for the first time to ensure diabetic induction. Then all the rats of this group were kept for more 21 days for the treatment of diabetic condition. During that period on Day 0, 7, 14, and 21st the body weight and blood glucose level were measured. Aqueous extract of Aloe vera fed by gavage at a dose of 300mg/kg body weight daily for 21 days in group C.

Statistical analysis:
All data were expressed as mean ± SEM (N=10) and differences among the groups of animals were compared using one-way analysis of variance (ANOVA) test. P-values less than 0.05 were considered significant.

RESULTS AND DISCUSSION

To the best of our knowledge, this is the first study of anti-hyperglycemic activity of aqueous extract of Aloe vera in normal and alloxan diabetic rat. The study was carried out to evaluate the effects of Aloe vera on blood glucose and body weight. Changes in blood glucose level of rats were summarized in Table 1 describing that treatment of diabetic rats with Aloe vera induced a significant decrease in fasting blood glucose levels compared with diabetic untreated group. At the day of 21, aqueous solution of Aloe vera extract was significantly ($P<0.001$) found to reduce blood glucose levels in group C compared to B from 260± 11.53 to 91.21 ± 3.67 mg/dl.

Table 1. Effect of Aloe vera on studied blood sugar in diabetic rats, compared to normal control (Values are expressed in Mean ± SEM, N= 10 for each group)

Grs	Day 0	Day 7	Day 14	Day 21
	ABSL (mg/dl)	ABSL (mg/dl)	ABSL (mg/dl)	ABSL (mg/dl)
A	95.50±5.21^{c}	90.15±5.4 ^{c}	91.89±5.5^{c}	92.98±9.5^{c}
B	188.00±2.55^{a***}	193.15±5.7^{a***}	210.68±1.74^{a***}	260±11.53^{a***}
C	94.55±2.88^{b***}	96.5±1.3 ^{b***}	94.1±3.1^{b***}	91.21±3.67 ^{b***}

a***Significantly different from control at $P < 0.001$, b***Significantly different from DM (Diabetic mellitus) at $P < 0.001$

Legends: Grs: Group, Group A: Normal Control; Group B: Diabetic control; Group C: Alloxan + Aloe vera treated; ABSL: Average blood sugar level

Aloe vera treatment induced a significant increase in body weight compared with diabetic untreated group (Table 2). The average body weight was increased significantly ($P<0.001$) from 260±3.95 to 279.88±7.13 gm in group C compared to B after 3 weeks treatment.

Table 2. Effect of Aloe vera on studied body weight in diabetic rats, compared to normal control (Values are expressed in Mean ± SEM, N= 10 for each group)

Grs	Day 0	Day 7	Day 14	Day 21
	ABW (gm)	ABW (gm)	ABW (gm)	ABW (gm)
A	243.24 ±4.15^{c}	246.5±5.50^{c}	251.75±5.96^{c}	265.51±1.5^{c}
B	271.55±2.11 ^{a***}	270.44±6.51 ^{a***}	264.5±4.21 ^{a***}	260±3.95 ^{a***}
C	266.82±8.44 ^{b***}	271.43±7.5 ^{b***}	275.37±9.63 ^{b***}	279.88±7.13 ^{b***}

a***Significantly different from control at $P < 0.001$, b***Significantly different from DM (Diabetic mellitus) at $P < 0.001$

Legends: Grs: Group, Group A: Normal Control; Group B: Diabetic control; Group C: Alloxan + Aloe vera treated; ABW: Average body weight

Diabetes mellitus is probably the fastest growing metabolic disease in the world. As the knowledge of multifactorial nature of this disease increases so does the need for more challenging and appropriate therapies (King *et al.,* 1998; Dans *et al*., 2007). Alloxan is known for selective pancreatic islet β-cell cytotoxicity and has been extensively used to induce diabetes mellitus in animals (Fernandes *et al*., 2007). Generalized increase in the level of blood glucose during diabetes have been consistently

reported both in animal models and humans especially those suffering from insulin dependent diabetes mellitus (Mathew *et al.,* 1973; Lorenzati *et al.,* 2010).

In the present study we found that Aloe vera extract reduced the blood glucose in diabetic rats. Regarding serum glucose level, treatment of diabetic rats with Aloe vera caused significant decreases in fasting and post-prandial serum glucose levels as compared to the diabetic untreated group. There are two possible explanations for this finding. First, Aloe vera may exert its effect by preventing the death of β-cells or it may permit recovery of partially destroyed β-cells. Like Momordica charantia (Akhter *at al.,* 2018a) Aloe vera may also have initiated cell proliferation. These results are in accordance with the previous findings in Aloe vera (Noor *et al.,* 2013; Govindarajan *et al.,* 2021), Neem (Chattopadhyay *et al.,* 1987), Bitter melon (Akhter *et al.,* 2018a), Garlic (Akhter *et al.,* 2018b), Drumstick (Villarruel-López *et al.,* 2018) and Telakucha (Sarkar *et al.,* 2020).

CONCLUSION

In conclusion, the present study calls attention to the therapeutic use of A. vera in DM. The results of the current study demonstrated that Aloe vera was effective in lowering hyperglycemic activity in alloxan induced rats. Further studies are necessary in terms of different doses and longer duration of A. vera to be considered as better therapeutic option for DM.

Conflict of interest:

The authors declared there is no conflict of interest.

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