Studies on the Hypoglycemic and Hypolipidemic effect of Swertia minor (Griseb.) Knobl. (Gentianaceae) – An Endemic and Endangered Medicinal plant from The Nilgiris


Abstract

Swertia minor (Griseb.) Knobl. (Gentianaceae) is an endemic, endangered and unexploited medicinal plant found in the regions of the Nilgiris. The present study was designed to evaluate the antidiabetic and hypolipidaemic effect of methanolic extract of Swertia minor in normal and Alloxan induced diabetic rats. After the treatment, a significant reduction was observed in fasting plasma glucose levels, Urea, Creatinine in the diabetic rats. MESM treated rats were showed that considerable depletion of serum total cholesterol, triglycerides, TC/LDL-C and increase in HDL cholesterol. The results were represented as the mean ± SD and the statistical significance was set up at p<0.05 shows that the MESM possess hypoglycemic and hypolipidemic properties.

Keywords: Swertia minor, alloxan, antidiabetic, hypolipidaemic.

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Introduction

Diabetes mellitus is a chronic disease caused by inherited and/or acquired deficiency in production of insulin by the pancreas, or by the ineffectiveness of the insulin produced. Such a deficiency results in increased concentrations of glucose in the blood, which in turn damage many of the body’s systems, in particular the blood vessels and nerves. Apart from the currently available therapeutic options, many herbal medicines have been recommended for the treatment of diabetes. Herbal drugs are prescribed widely because of their effectiveness, less side effects and relatively low cost. The members of the genus Swertia (Family- Gentianaceae) are rich sources of the xanthonoids, flavonoids, irridoids and terpenoids. The herbs of this genus are extensively used as bitter tonic and febrifuge in the Ayurvedic system of medicine. A number of species from Gentianaceae have been used long in the folk medicine for the treatment of hepatitis, cholecystitis, pneumonia, malaria, dysentery and spasm; whereas the recent investigations have shown that, some xanthones possess a marked hypoglycemic activity when administered to rats. Moreover, some species of the Swertia were reported to possess CNS-depressant and principles. In the present study, Swertia minor (Griseb.) Knobl. is an endemic, endangered and unexploited medicinal plant has been undertaken to evaluate hypoglycemic and hypolipidemic property.

Material and Methods

Collection of plant material

All aerial parts and roots of S. minor (Griseb.) Knobl. (Gentianaceae) was collected during blooming season (November, 2010) from nearby sholas of Kothagiri Hills, Nilgiri District, Western Ghats, Southern India, Tamil Nadu. The plants were identified and authenticated by a plant taxonomist.

Preparation of extract

250 g of collected samples were washed 2-3 times with water followed by distilled water and shade dried. The dried parts of plants were pulverized by mechanical grinder (Willy mill) to get the powder through 100 mesh sieve and then stored in a desiccator. The shade dried and powdered plant materials were extracted with petroleum ether to remove
the resins and the residue was then extracted with methanol by using soxhlet apparatus. The methanolic extract yield was found to be 23.92g.

**Experimental animals and alloxan-induction of diabetes**

Male Wistar Albino rats weighing 180-250 g were obtained from the animal house of the laboratory of Agricultural University, Trissur, Kerala. The rats were housed in polycarbonated cages at a temperature regulated (22°C) and humidity (55%) controlled room with a 12 h light/12 h dark cycle. Water and standard pellet diet were available to the animals throughout the experimental period. The experimental protocol has been approved by the Institution Animal Ethics committee and by the Regulatory body of the government. The rats were injected intraperitoneally with Alloxan monohydrate dissolved in sterile 9% saline at a dose of 200 mg kg⁻¹ b.wt. Two weeks after the induction, moderate diabetes having glycosuria and hyperglycemia (i.e. with a blood glucose of 200-300 mg dL⁻¹) were observed in the rats.

**Experimental design**

The Alloxan induced rats were divided into four groups each contains five numbers of rats. Group 1 served as normal rats without any induction and treatment, Group 2 served as diabetic control rats. Group 3 served as diabetic rats given MESM (150 mg/kg b.wt.). Group 4 diabetic rats given glibenclamide (60 mg/kg b.wt.).

**Statistical analysis**

All data were expressed as means ± S.E. Significant differences among the groups were determined by one-way analysis of variance using the DMRT statistical analysis program. Statistical significance was considered at p<0.05.

**Results**

The methanolic extract of Swertia minor (Group III) were treated on Alloxan induced diabetic rats (Group II). The results were compared with the control (Group I) and the Standard drug treatment (Group IV) after 14 days of treatment based on biochemical parameters. Table 1 and Fig 1 displayed a significant elevation in plasma glucose level, 268.31±3.53mg/dl and reduction in insulin level in diabetic rat was observed (0.91±0.08MIu/ml). However, the allopathy drug Glibenclamide treated (112±34MIu/ml and
and plant extract of Swertia minor treated groups have shown a significant reduction in the plasma glucose and elevation in the insulin level (106.3± 9.4 mg/dl and 19.5±1.66 mg/dl). Kidney function was assessed by analyzing urea and creatinine levels of control and experimental rats. After the completion of fourteen days study Glibenclamide administration, the hepatotoxicity was manifested biochemically by measuring serum urea, creatinine and compared with control and plant extracts. MESM have shown marked decrease in urea level (16.21±16 mg/dl) and creatinine level (0.81±0.4 mg/dl). However, urea and creatinine levels were decreased when compared with Alloxan treated group II. The same levels of urea and creatinine were observed in Glibenclamide treated groups (0.98±0.03 mg/dl). As expected, diabetic induced control, rats have shown a significant elevation in serum urea (39.41± 2.4mg/dl) and creatinine level (1.53±0.08 mg/dl). However, the plant extracts and Glibenclamide treated groups have shown a decrease in the levels of kidney marker profile.

Table 1: Effect of treatment for 14 days with extract of *Swertia minor* on the insulin, blood glucose, urea, creatinine level of normal, diabatic induced adult albino rats

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Insulin (MIu/ml)</th>
<th>Blood glucose (mg/dl)</th>
<th>Urea (mg/dl)</th>
<th>Creatinine (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>20.3±1.45</td>
<td>98.3 ± 5.3</td>
<td>14.32±1.3</td>
<td>0.59±0.01</td>
</tr>
<tr>
<td>Group II</td>
<td>0.91±0.08</td>
<td>268.31 ± 12.4</td>
<td>39.41±2.4</td>
<td>1.53±0.08</td>
</tr>
<tr>
<td>Group III</td>
<td>19.5±1.66</td>
<td>106.31 ± 9.4</td>
<td>16.21±1.6</td>
<td>0.81±0.4</td>
</tr>
<tr>
<td>Group IV</td>
<td>11.4±1.39</td>
<td>112.34 ± 8.3</td>
<td>19.32±1.9</td>
<td>0.98±0.03</td>
</tr>
</tbody>
</table>

Each Value is * SEM of 5 animals     * P < 0.05

*Group I*: Rats given only saline (by using an intragastric catheter tube (IGC)).
*Group II*: Alloxan induced Diabetic rats (drug at the dose of 200 mg/ Kg body weight)
*Group III*: Alloxan induced Diabetic rats treated with methanolic extract of *Swertia minor* at the dose of 150 mg/ Kg body weight orally for 14 days
*Group IV*: Alloxan induced Diabetic rats treated with Glibenclamide at the dose of 100 mg/ Kg body weight.

Table 2 and Fig 2 shows the levels of total cholesterol, triglycerides, HDL - C, LDL - C, LDL - C/ HDL - C in serum lipid profiles and LPO in control, Alloxan induced, Glibenclamide treated and MESM treated experimental rats. Serum lipid profiles of diabetic rats showed significantly increased levels of total cholesterol (214.32±16.4 mg/dl),
triglycerides (169.4±11.4mg/dl), HDL-C (47.56±5.1mg/dl), LDL-C (138.4±6.8mg/dl), LDL-C/HDL-C (2.94±0.93mg/dl) and LPO (0.483±0.004), when compared with normal rats.

**Fig 1**: Effect of treatment for 14 days with extract of *Swertia minor* on the insulin, blood glucose, urea, creatinine level of normal, diabetic induced adult albino rats.

![Fig 1](image1)

In rats treated with Glibenclamide there was a significant decrease in the content of cholesterol 163.41±10.5, triglycerides 135.41±8.9, HDL-C 49.54±5.8, LDL-C 99.31±6.8, LDL-C/HDL-C 2.00±0.31 and LPO 0.293±0.001(mg/dl) in serum liquid profiles when compared with diabetic controlled rats. As expected, when the rats were treated with MESM resulted in a significant decrease in serum lipid profiles, total cholesterol (178.31±7.5mg/dl), triglycerides (142.44±9.4), HDL-C (56.59±3.5), LDL-C (89.31±5.7mg/dl), LDL-C/HDL (1.57±0.42mg/dl) and LPO (0.303±0.002mg/dl), when compared with Alloxan treated group II. However, in control serum lipid profile and LPO were found to be less total cholesterol (151.37±11.3mg/dl), triglycerides (113.2±9.2 mg/dl), HDL-C (50.2±6.2mg/dl), LDL-C (96.72±7.2mg/dl), LDL-C/HDL-C (191±0.81mg/dl) and LPO (0.269±0.003mg/dl) respectively.

**Fig 2**: Effect of treatment for 14 days with extract of *Swertia minor* on serum lipid profile and LPO of control, diabetic and diabetic treated rats.

![Fig 2](image2)
Table 2: Effect of treatment for 14 days with extract of *Swertia minor* on serum lipid profile and LPO of control, diabetic and diabetic treated rats.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Total Cholesterol (mg/dl)</th>
<th>Triglyceride (mg/dl)</th>
<th>HDL-C (mg/dl)</th>
<th>LDL-C (mg/dl)</th>
<th>LDL-C / HDL-C</th>
<th>LPO (n.moles/mg Protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td>151.3 ± 11.3</td>
<td>113.20 ± 9.2</td>
<td>50.2 ± 6.2</td>
<td>96.72 ± 7.2</td>
<td>1.91 ± 0.81</td>
<td>0.269 ± 0.003</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td>214.3 ± 16.4</td>
<td>169.40 ± 11.4</td>
<td>47.56 ± 5.1</td>
<td>138.4 ± 6.8</td>
<td>2.94 ± 0.93</td>
<td>0.483 ± 0.004</td>
</tr>
<tr>
<td><strong>Group III</strong></td>
<td>178.31 ± 7.5</td>
<td>142.44 ± 9.4</td>
<td>56.59 ± 3.5</td>
<td>89.31 ± 5.7</td>
<td>1.57 ± 0.42</td>
<td>0.303 ± 0.002</td>
</tr>
<tr>
<td><strong>Group IV</strong></td>
<td>163.4 ± 10.5</td>
<td>135.41 ± 8.9</td>
<td>49.54 ± 5.8</td>
<td>99.31 ± 6.78</td>
<td>2.00 ± 0.31</td>
<td>0.290 ± 0.001</td>
</tr>
</tbody>
</table>

Each Value is * SEM of 5 animals  * P < 0.05

**Group I**: Rats given only saline (by using an intragastric catheter tube (IGC)).
**Group II**: Alloxan induced Diabetic rats (drug at the dose of 200 mg/ Kg body weight)
**Group III**: Alloxan induced Diabetic rats treated with methanolic extract of *Swertia minor* at the dose of 150 mg/ Kg body weight orally for 14 days
**Group IV**: Alloxan induced Diabetic rats treated with glibenclamide at the dose of 100 mg/ Kg body weight.

**Discussion**

Diabetes mellitus is one of the most common chronic diseases associated with carbohydrate metabolism. It is also an indication of co-morbidities such as obesity, hypertension, and hyperlipidemia, which are metabolic complications of both clinical and experimental diabetes. Alloxan, a beta cytotoxin induces chemical diabetes (Alloxan diabetes) in a wide variety of animal species by damaging the insulin secreting pancreatic β-cell, resulting in a decrease in endogenous insulin release, which paves the way for the decreased utilization of glucose by the tissues. S. minor methanolic extracts reverted body and liver weight of diabetic induced albino rats to normal. The study showed that a significant result in body weight and liver weight after two weeks of alloxan induced diabetic rats. Aqueous extract of *Punica granatum* has brought increased body weight of diabetic rats to normal.

Plasma glucose, serum insulin, urea and creatinine levels were determined in control and treated rats. The administration of the crude methanolic extract of *S. minor* decreased the plasma glucose level whereas, serum insulin level was increased in treated rats compared to control rats. The methanolic extract of *Swertia minor* was found to be inducing insulin release.
from pancreatic cells of diabetic rats. Ahmed et al.,\(^7\) have fed the ethyl acetate-soluble fraction of an absolute ethanol extract of Pterocarpus marsupium wood, which significantly lowered blood sugar level with corresponding increase in blood insulin level in Alloxan induced diabetic rats. It is evident that there was an increase in insulin level in diabetic rats treated with both plant extracts. Many plants have been studied for their hypoglycemic and insulin release stimulatory effects\(^8\).

A significant elevation in serum constituents, urea and creatinine were observed in Alloxan induced diabetic rats (group II) when compared to control rats. The methanolic extract of Swertia minor was administered orally (Group III) to rats for 2 weeks reversed the urea and creatinine level to near normal.

The administration of Glibenclamide also decreased the levels of urea and creatinine to some extent\(^9\). Stabilization of serum creatinine and urea levels through administration of the extract of Swertia minor is further a clear indication of the improvement of the functional status of the liver cells. These results are also at par with the reports of Bishayee et al.,\(^10\) where the carrot extract also decreased the elevated serum urea. The present result showed that the treatment with MESM were effective in preventing Alloxan induced increase in serum creatinine level when compared with control.

Alloxan induced diabetic rats showed significantly increased serum lipid profiles, when compared with normal rats. The Glibenclamide and methanolic extract of S. minor showed a significant decrease in the content of lipid profiles, when compared with diabetic induced rats. An increase in LPO indicates serious damage to cell membranes, inhibition of several enzymes and cellular function\(^11\). In the present study, an increase in the levels of LPO was found and these levels were significantly reduced after the supplementation of the extract. Apart from the regulation of carbohydrate metabolism, insulin also plays an important role in the lipid metabolism. Insulin is a potent inhibitor of lipolysis, since it inhibits the activity of hormone sensitive lipase in adipose tissue and suppresses the release of free fatty acids\(^12\).

During diabetes, enhanced activity of the enzyme increases lipolysis and releases more fatty acids into the circulation\(^12\). The increased fatty acid concentration also increases the \(\beta\) oxidation of fatty acids, producing more acetyl CoA and cholesterol during diabetes. In
normal condition, insulin increases receptor-mediated removal of LDL-cholesterol and decreased activity of insulin, during diabetes causes hypercholesterolemia. Hypercholesterolemia and hypertriglyceridemia have been reported to occur in diabetic rats. Based on the aforementioned results, we concluded that Swertia minor has a significant hypoglycemic effect in diabetic rats and that their effect was comparable to that of Glibenclamide. Therefore, S. minor is considered as an effective and alternative treatment for diabetes. On the other hand, S. minor also has antihyperlipidemic effect.

Acknowledgement

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References


