The Effect of Desmostachya bipinnata (Linn.) Extract on Physiologically Altered Glycemic Status in Non-diabetic Rats

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Desmostachya bipinnata (Linn.) Stapf (Poaceae/Gramineae) is one of the official drugs of ayurvedic pharmacopoeia. Various parts of this plant were used in different parts of world, extensively in Indian traditional and folklore medicine to cure range of human ailments like asthma, jaundice, vaginal discharges, vesicle calculi, diseases of bladder and skin eruptions, also used as analgesic, antipyretic, anti-inflammatory, anti-diabetic, diuretic etc. Based on its folkloric anti-diabetic effect, the present study was carried out to assess the effect of its hydro-alcoholic extract on glycemic status in non-diabetic rats. In contrast to usual chemical diabetic animal models, alterations in glycemic status were induced by physiological exercises. The results showed that the hydro-alcoholic extract has no effect on euglycemic levels with minimal insignificant alterations. But, the supplementation of this extract in hypoglycemic (food deprivation or swim exercise induced) rats reduced the extent of hypoglycemia significantly. In addition, this extract reduced the degree of hyperglycemia induced by exogenous administration of dextrose significantly. Altogether, the results of current study suggest that the constituents present in Desmostachya bipinnata hydro-alcoholic extract have distinctive property of retaining euglycemic status irrespective of induced glycemic alterations. These significant findings suggest that the concomitant use or supplementation of this plant extract with current therapies will be beneficial to maintain euglycemic status. Taken together, this study supported its folkloric anti-diabetic use and lends pharmacological credence to the ethno-medical use of this plant in traditional system of medicine, demands further studies to elaborate its use, its active constituents and safety.

Key words: Hypoglycemia, glucose, herbal medicine, swim exercise

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INTRODUCTION

Diabetes Mellitus (DM) is a syndrome characterized by abnormal insulin secretion, altered metabolism of lipids, carbohydrates and proteins and is diagnosed by the presence of hyperglycemia; and an increased risk of complications from vascular disease (William and Pickup, 1991). Traditionally, diabetes has been classified into two major categories: primary, the most common form, arising from a defect in insulin production and/or action; and secondary, arising from any disease causing extensive destruction of pancreatic islets, such as pancreatitis, tumors, certain drugs, iron overload (hemochromatosis), surgical removal of pancreatic substance, or acquired or genetic endocrinopathies in which insulin action is antagonized. Symptoms of the DM are mainly polyuria, polydipsia and unexplained weight loss. In addition, co-existent hypertension, diabetes contributes to the development of major complications such as microangiopathy, retinopathy, nephropathy, neuropathy and accelerated atherosclerosis (Kumar et al., 2005). In diabetic patients, the persistence of hyperglycemia has been reported as a cause of increased production of oxygen-free radicals through glucose autooxidation and nonenzymatic glycation (Rahbani-Ninobar et al., 1999).

Pre-clinical screening of newer molecules for their anti-diabetic efficacy involves the use of alloxan or Streptozotocin induced animal models, which induce hyperglycemic status like Diabetes by destroying β-islets of pancreas. However, earlier study reported that the use of these molecules result in variable and inconsistent diabetic states and also lead to functional and structural abnormalities in their nervous system (Mohan et al., 2001). Therefore, taking this into account, the current study was carried out to evaluate the effect of a traditional ayurvedic medicinal plant, Desmostachya bipinnata, on physiologically altered glycemic levels where the nervous system is intact.

Desmostachya bipinnata (Linn.) Stapf is an official drug of ayurvedic pharmacopoeia belonging to family Poaceae, is commonly known as sacrificial grass, as it is being used in Yagnas and religious rites (Sivarajan and Balachandran, 1994). It is distributed throughout India, also found in Nubia, Egypt and Syria, Pakistan, Persia, Middle East to Indo-China and North and tropical Africa. The various parts of this plant were used extensively in traditional and folklore medicine to cure various human ailments and used as astringent, aphrodisiac, galactogogue, analgesic, antipyretic, wounds, anti-inflammatory, anti-asthma, diuretic, sedative to pregnant uterus and also useful in dysentery, diarrhea, jaundice, vomiting, dysuria, diabetes, menorrhagia, skin eruptions, urinary calculi and other diseases of bladder and skin (Joshi, 2003; Kirtikar and Basu, 1918; Ali Khan and Khamn, 2004). This plant is one of the ingredients of Tripanchamool, a composite herbal formulation found to have effective anturolithic activity (Singh and Sachan, 1989). Previous studies on this plant resulted in the isolation of some known coumarins, amino acids, carbohydrates (Hifrawy et al., 1999), flavonoids (Amani et al., 2008; Mohammed and Safwat, 2009), sterols (Shrestha et al., 2011), terpenes (Ashok et al., 2010) and triterpenoids have been reported. In addition, pharmacological studies established its anti-oxidant (Jayalakshmi et al., 2011), antiulcerogenic (Amani et al., 2008), analgesic, antipyretic and anti-inflammatory activities (Panda et al., 2009; Kumar et al., 2010), antidiarrhoeal activity (Medha et al., 2010), anti-fungal (Bajwa et al., 2002; Panda et al., 2008) and antihelicobacter activity (Mohammed and Safwat, 2009).

Considering the traditional and folkloric importance of this plant for diabetes treatment, the present study was initiated with the aim of investigating the effects of Desmostachya bipinnata hydro-alcoholic extract on glycemic status modulated by physiological and physical means in rats.

MATERIALS AND METHODS

Plant material: The plant Desmostachya bipinnata L. Stapf was collected in and around Nalgonda city, Andhra Pradesh, India. The plant material was taxonomically authenticated by Dr. T. Shankara Chary, Head of Botany Department, Government Degree College for Women, Nalgonda, India. The voucher specimen (No: DEP/GDCWN/54/2010) was deposited in the college herbarium for future reference.

Preparation of extract: The whole plant of Desmostachya bipinnata was shade dried, powdered coarsely (sieve No. 40) and then extracted in a Soxhlet extractor using 70% of Methanol as a solvent at 55°C until the extractive becomes colorless. The filtrate obtained by vacuum filtration was concentrated to dryness using vacuum evaporator under controlled temperature (40-50°C) (Golla et al., 2011a). The crude hydro-alcoholic extract of Desmostachya bipinnata was subjected to preliminary qualitative phytochemical screening for the presence of major functional groups and various phytochemical constituents (Kokate et al., 2004; Khandelwal, 2006). The dried concentrated extract was suspended in water before administering to animals for study.

Animals: Wistar male albino rats (180-220 g) were used in this study. They were maintained at institutional animal
house, kept in standard polypropylene cages with 12 h of light and dark cycle in a room with controlled temperature (22±3°C). The animals were fed with standard rodent’s chow diet and provided water ad libitum. After proper acclimatization, the animals were used for study. Approval for the usage of animals in the experiments was obtained as per the Indian CPCSEA guidelines outlined by the Institutional Animal Ethical Committee (IAEC) of the faculty (Bharat Institute of Technology) and approval number of committee was 1015/e/06/CPCSEA. The study was approved and was conducted in accordance with the Institutional Ethical Committee (Golla et al., 2011b).

**Acute oral toxicity studies:** Wistar albino rats (180-220 g) of either sex were used for acute toxicity studies to determine a safe dose as per acute oral toxic class method of Organization of Economic Co-operation and Development (OECID) 423 guidelines (Ecobichon, 1997). Animals were fasted 3 h prior to the experiment and were observed for next 48 h and up to 14 day of oral administration of extract.

**Induction of hypo- and hyperglycemia:** The method for altering glycemic status was followed as described previously (Senthivel et al., 2007). Hypoglycemia was induced in rats either by allowing to swim in water at room temperature (29-30°C) for 3 min in a polypropylene container (40×35×25 cm) filled with water up to 15 cm height or by food deprivation for 24 h before the experimentation. Whereas, the hyperglycemia was induced by exogenous administration of dextrose (2 g kg⁻¹ p.o.) 20 min prior to conduct experiment.

**Experimental method:** The method described by Senthivel et al. (2007) was followed. The hydro-alcoholic extract of *Desmostachya bipinnata* was administered at a dose of 250 and 500 mg kg⁻¹ (p.o.) just 1 h prior to estimation of glucose. At the end of 60 min, the animals were permitted either to swim or received dextrose. Another set of animals were deprived of food for 24 h. The blood glucose was measured prior to food deprivation, swim exercise or dextrose administration and at 15 min after these maneuvers. The doses of *Desmostachya bipinnata* were selected based on pilot studies. Appropriate vehicle treated animals were served as control. The results were represented as the actual blood glucose value and also as the percentage change considering the initial value as 100%.

**Analytical procedure:** The blood glucose levels were estimated by using one touch horizon glucometer (Johnson and Johnson Medical, with appropriate glucostix). For this, a drop (1.5 μL) of blood was collected by vein puncture of tail under mild ether anesthesia. This one touch horizon glucometer has been validated and evaluated for its accuracy in earlier study (Mohan et al., 2004) against laboratory blood glucose assessment.

**Statistical analysis:** The data values were expressed as Mean±SEM, statistically analyzed by employing one way ANOVA followed by Dunnett’s test. The values of p<0.05 in comparison to initial values and control were considered as statistically significant (Duncan et al., 1977).

## RESULTS AND DISCUSSION

Treatment of vehicle in free fed rats showed an insignificant elevation of only +1.4% alterations in blood glucose level. *Desmostachya bipinnata* extract in both the tested doses produced insignificant and inconsistent alterations in the glycemic state of both the animals as shown Table 1. This result shows that the administration of extract itself don’t affect the euglycemic status, which supports the use of this extract for other treatments without affecting the normal glycemic levels.

In case of animals subjected to food deprivation for 24 h resulted in significant hypoglycemic levels (-27.6%) change. Notably, the supplementation of *Desmostachya bipinnata* extract in animals showed significant attenuation of glycemic levels toward maintaining of euglycemic status. However, the hypoglycemic state induced by deprivation of food was still maintained by rats administered with the extract. The results were shown in Table 2.

### Table 1: Effect of hydro-alcoholic extract of *Desmostachya bipinnata* on postprandial blood glucose levels in normal rats

<table>
<thead>
<tr>
<th>Status</th>
<th>Treatment</th>
<th>Initial</th>
<th>Final</th>
<th>Change in blood glucose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rats</td>
<td>Vehicle</td>
<td>124.5±3.6</td>
<td>126.3±5.3</td>
<td>1.44</td>
</tr>
<tr>
<td></td>
<td>DBPS 250</td>
<td>132.4±2.8</td>
<td>129.6±6.7</td>
<td>-2.11</td>
</tr>
<tr>
<td></td>
<td>DBPS 500</td>
<td>128.8±4.2</td>
<td>130.4±7.2</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Values are expressed as the Mean±SEM, n = 6, *p<0.05 vs. vehicle control (one-way ANOVA and Dunnett’s t-test)

### Table 2: Effect of hydro-alcoholic extract of *Desmostachya bipinnata* on postprandial blood glucose levels in normal and hypoglycemic food deprived rats

<table>
<thead>
<tr>
<th>Status</th>
<th>Treatment</th>
<th>Initial</th>
<th>Final</th>
<th>Change in blood glucose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rats</td>
<td>Vehicle</td>
<td>142.5±6.9</td>
<td>104.6±5.2</td>
<td>-27.60</td>
</tr>
<tr>
<td></td>
<td>DBPS 250</td>
<td>143.8±5.9</td>
<td>109.5±4.4</td>
<td>-23.87</td>
</tr>
<tr>
<td></td>
<td>DBPS 500</td>
<td>138.3±4.9</td>
<td>115.3±4.8</td>
<td>-16.90</td>
</tr>
</tbody>
</table>

Values are expressed as the Mean±SEM, n = 6, *p<0.05 vs. vehicle control (one-way ANOVA and Dunnett’s t-test)
<table>
<thead>
<tr>
<th>Status</th>
<th>Treatment</th>
<th>Blood glucose (mg dl⁻¹)</th>
<th>Change in blood glucose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Final</td>
<td></td>
</tr>
<tr>
<td>Rats</td>
<td>Vehicle</td>
<td>142.5±4.6</td>
<td>147.8±3.4</td>
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<tr>
<td></td>
<td>Swim alone</td>
<td>139.7±7.2</td>
<td>104.6±5.2</td>
</tr>
<tr>
<td></td>
<td>DBPS 250</td>
<td>144.8±3.9</td>
<td>110.3±4.4</td>
</tr>
<tr>
<td></td>
<td>DBPS 500</td>
<td>142.3±3.9</td>
<td>115.5±4.8</td>
</tr>
</tbody>
</table>

Values are expressed as the Mean±SEM, n = 6, *p<0.05 vs. vehicle control (one-way ANOVA and Dunnett's t test)

Whereas, the animals allowed to swim exhibited significant hypoglycemia (-25.2%) in comparison to vehicle treated group. Interestingly, the supplementation of Desmostachya bipinnata extract reduced the extent of hypoglycemia in rats when compared to vehicle treated group and at 500 mg kg⁻¹ dose supplementation suppressed hypoglycemia significantly (p<0.01) compared to initial value and to that of vehicle treated rats were shown in Table 3. Taken together the attenuation of hypoglycemic states induced by either food deprivation or swim toward euglycemic state by Desmostachya bipinnata extract revealed and supported the folkloric use of this plant for the cure of diabetes.

In case of animals administered with a dose of dextrose showed significant elevation of blood glucose level (+59.1 %) in rats. In Desmostachya bipinnata extract pretreated group of animals, the extent of hyperglycemia induced by dextrose dosage was significantly reduced in the dose dependent manner as shown in Table 4. This observation revealed that this Desmostachya bipinnata extract has hypoglycemic effect and helps in maintaining euglycemic levels. Altogether, the above results of the current study showed that the supplementation of Desmostachya bipinnata extract leads to dose dependent attenuation of hypo- or hyperglycemic states induced by different physiological situations, revealed a role in maintaining euglycemic levels in case of altered glycemic status.

This restoration of euglycemic status by Desmostachya bipinnata suggests that supplementation of extract with current anti-diabetic therapies, most of which have a tendency to result in hypoglycemia will be beneficial in management of Diabetes Mellitus and other situations where glycemic status is altered. The extract failed to induce significant alterations in glycemic levels and is favorable for counter-effecting the adverse hypoglycemic situation seen with conventional anti-diabetic agents. So, this study supported its folkloric anti-diabetic use and lends pharmacological credence to the ethno-medical use of this plant in traditional system of medicine.

The earlier studies on this plant revealed the presence of various therapeutically active terpenes, interpenoids, flavones, sterols, coumarins and many more (Medha et al., 2010). Even the current results revealed the role of Desmostachya bipinnata in attenuating euglycemic status in transient phase, but further detailed studies to chronic diseased situations, to identify the key constituents in order to unravel the mode of action are demanded.

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REFERENCES


