HYPOGLYCAEMIC EFFECTS OF ACACIA ALBIDA DEL. (MIMOSACEAE) METHANOL ROOT BARK EXTRACT

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ABSTRACT

Acacia albida root bark (family: Mimosaceae) have been used in Nigeria traditional medicine for the treatment of a plethora of diseases including diabetes mellitus, and its efficacy is widely acclaimed among the Hausa communities of northern Nigeria. The root bark is prescribed for diabetes mellitus. The hypoglycaemic property of methanol root bark extract of the plant was evaluated in normal and alloxan induced diabetic rats. Methanolic extract at 200mg/kg body weight significantly (P< 0.05) lowered glucose levels of diabetic rats by 34.5% within 7 hours but showed no similar effect in normoglycaemic rats. The LD₅₀ was found to be >5000mg/kg body weight. Phytochemical screening of the extract revealed the presence of carbohydrates, tannins, alkaloids, flavonoids and glycosides. The results provided evidence that Acacia albida root bark possessed hypoglycaemic activity, which may justify its traditional use in diabetes mellitus.

Keywords: Acacia albida, hypoglycaemic activity, alloxan induced diabetes, acute toxicity.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterised by hyperglycaemia expressed as abnormal glucose value, and altered lipid and protein metabolism (Pontiroli et al., 1994). Diabetes is the most common disease associated with carbohydrate metabolism and is a major cause of disability and hospitalization (Foster, 1996). Based on current estimates, at least 150 million people world-wide have diabetes, of which two-thirds live in developing countries. The total number of people with diabetes is predicted to rise to about 300 million by 2025, with one-third of affected individuals living in India and China alone (WHO, 2000). This disease is on the increase all over the world, especially in Africa where it was formerly regarded as the disease of the affluent (Amos et al, 1997). The American Diabetes Association classified diabetes into two: type I (insulin dependent diabetes Mellitus) and type II (non insulin dependent diabetes mellitus), with the former having its onset from infancy and manageable only with insulin products. The type II diabetes mostly has its onset in adulthood and is managed with several classes of drugs such as sulfonylureas, biguanides, and herbs. (Bailey and Mezitis, 1990). A third type, malnutrition-related diabetes mellitus, which affects young people in poor tropical countries and is associated with a history of nutritional deficiency is recognised (Evans, 2000). Type II diabetes is by far the commonest form of the disease globally, with rapidly developing countries being at the forefront of this epidemic (Narayan et al., 2003). The use of ethnobotanicals has a long folkloric history for the treatment of blood sugar abnormalities (Evans, 2005).
The World Health Organization has estimated that 80% of the world's population use botanical medicine for their primary healthcare needs (WHO, 2002). Therefore, the search for antidiabetic remedies is an ongoing process and includes phytotherapy. Many plants with antidiabetic activity are reported to contain many chemical compounds which appear to be the active hypoglycaemic principles and include steroids, glycosides and few number of alkaloid-containing plants (Evans, 2000). This study aimed at evaluating the hypoglycaemic effect of methanol root bark of Apple-ring acacia (Acacia albida) extract in normoglycaemic and alloxan-induced diabetic rats.

**MATERIALS AND METHOD**

**Collection and Preparation of Plant Materials**

Fresh roots of *Acacia albida* were collected within the main Campus of Ahmadu Bello University (ABU), Zaria. The plant was identified at the herbarium unit of Biological Sciences Department, A. B. U. Zaria where a voucher specimen (No. 900334) has been deposited.

The fresh roots were dried in open air and grounded into powder using pestle and mortar. The powder was first macerated in petroleum ether, then followed by maceration in methanol and allowed to stand for 48 hours. It was then filtered, and evaporated to dryness on water bath (Brain and Turner, 1975).

**Experimental Animals**

Male Wistar rats of body weight 130 – 230g obtained from the Faculty of Veterinary Medicine, A.B.U. Zaria, Nigeria was used divided into the following groups, with five animals in each. Group A: control; fed 5 ml of normal saline

Group B: Diabetic rats; treated with methanolic root bark extract 100 mgkg⁻¹

Group C: Diabetic rats; treated with methanolic root bark extract 200 mgkg⁻¹

Group D: Diabetic rats; treated with methanolic root bark extract 300 mgkg⁻¹

Group E: Diabetic rats; treated with Chlorpropamide 250 mgkg⁻¹.

**Antidiabetic Design**

The study was carried out on non-diabetic and alloxan-induced diabetic rats. The rats were fasted for 24 hours before the experiment, and blood samples were collected from the tail of the rats using a glucometer. The model used was that of fasted rats to induce hyperglycaemia (Mukherjee *et al.*, 1988, Venkatatesh *et al.*, 1988).

In the experiment the rats are randomly injected intraperitoneally (IP) with alloxan monohydrate dissolved in normal saline at a dose of 150 mg/kg body weight (Katsumata *et al.*, 1995). After 5 days, rats with moderate diabetes and having hyperglycaemia that is with blood glucose of 200 – 400 mg/dL were used for this experiment. Using alloxan to evoke diabetes, animals were examined after proper period of time to minimize side effects of alloxan

The study was conducted in order to determine the safety of the drug with regards to its traditional usage. The LD50 determination was conducted using the method of Lorke (1983). In the first phase male rats were divided into three groups of three rats each. After overnight fasting, they were treated with aqueous methanolic extract as follows 10, 100 and 1000 mgkg⁻¹ orally. In the second phase rats were group into three one per group and treated with doses of extract at 1600, 2900 and 5000 mgkg⁻¹. Animals were observed for 24hrs after treatment and the final LD50 value was calculated as the geometric mean of the lowest dose that kill and the highest dose that kill.

Acute Toxicity Testing

This study was conducted in order to determine the safety of the drug with regards to its traditional usage. The LD50 determination was conducted using the method of Lorke (1983). In the first phase male rats were divided into three groups of three rats each. After overnight fasting, they were treated with aqueous methanolic extract as follows 10, 100 and 1000 mgkg⁻¹ orally. In the second phase rats were group into three one per group and treated with doses of extract at 1600, 2900 and 5000 mgkg⁻¹. Animals were observed for 24hrs after treatment and the final LD50 value was calculated as the geometric mean of the lowest dose that kill and the highest dose that kill.

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action. It should also be emphasized that the range of the diabetogenic dose of alloxan is quite narrow and even light overdosing may be generally toxic causing the loss of many animals. This loss is most likely due to kidney tubular cell necrotic toxicity, in particular when too high doses of alloxan are administered (Lenzen et al., 1996 and Szkudelski et al., 1998).

glycosides (sodium picrate paper test) Flavonoids (Shinoda’s test, Conc. H$_2$SO$_4$, 10% NaOH and Dil, Hcl) Brain, 1975.

**Statistical Analysis**
Experimental data obtained from ‘test’ rats treated with *Acacia albida* root bark extract, chlorpropamide, and those obtained from distilled water treated control’ rats were pooled and expressed as means (± SEM). The difference between the plant extract and the chlorpropamide treated ‘test’ was analysed statistically using a Student t-test. These data were subjected to one-way design analysis of variance (ANOVA), Comparisons between groups under degree of freedom 7 and 8, probability level of p < 0.05 were considered significant, using Graph pad Prism Version 4.0 by jerry R. Miller t-test for multiple comparisons.

**RESULTS**
The maximal reductions in the blood glucose concentration occurred at the dose of 200 mg/kg, using the plant’s extract at the 7th hour after the oral administration. The reference antidiabetic agent (chlorpropamide 250 mg/kg p.o) produced significant reductions (P<0.05) in the blood concentration of the animals at 3 hours following oral administration, reaching the peak of its hypoglycaemic effect at 7th hour and still significant 9 hours after oral administration. Thereafter, the blood glucose concentrations of the animals gradually returned to base-line levels at the end of the 24th hour. Therefore, administration of methanol root bark extract at 200 mg/kg significantly lowered the blood glucose levels of Alloxan induced –diabetic rats (P< 0.05) when compared with control rats. The maximal reduction of 34.53% was observed at 7h after administering the extract. The experiment also revealed the antidiabetic activity of standard drug, chlorpropamide as summarised in Table 1. The phytochemical screening of the extract revealed the presence of flavonoids, tannins, alkaloids, saponins and carbohydrates. The LD$_{50}$ was calculated from the doses administered at the first and the second phases according to (Lorkes, 1983). The preliminary acute toxicity established the oral LD$_{50}$ of the extract to be above 5000mgkg$^{-1}$. This finding probably suggests that the plant extract is relatively safe. The difference between the plant extract and the chlorpropamide treated ‘test’ was analysed statistically and showed a significant difference of P ≤ 0.05.
Table 1: Effect of Methanolic Root Extract of *Acacia albida* and Chlorpropamide (250mg/kg p.o.) on blood glucose concentration (mg/dL)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Before treatment</th>
<th>After treatment</th>
<th>24 Hours</th>
<th>Reduction</th>
<th>Reduction</th>
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<tbody>
<tr>
<td></td>
<td>0 Hour</td>
<td>2 Hours</td>
<td>3 Hours</td>
<td>5 Hours</td>
<td>7 Hours</td>
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<tr>
<td>Normal (normoglycaemic)</td>
<td>590.4 ± 4.02</td>
<td>569.25 ± 19.6</td>
<td>576.45±14.72</td>
<td>562.5 (**)</td>
<td>573.3 (**)</td>
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<td>rats control (2ml/kg p.o.)</td>
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<tr>
<td>Normal Saline</td>
<td>556.56±25.27</td>
<td>471.6 * ± 27.83</td>
<td>489.96± 34.08</td>
<td>501.84*</td>
<td>451.08* (**)</td>
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<tr>
<td>Root extract 100 mg/kg</td>
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<td></td>
<td>500.4 ± 51.17</td>
<td>472.32 ± 79.12</td>
<td>456.2 ± 92.94</td>
<td>384.12±</td>
<td>327.6 *</td>
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<tr>
<td>Root extract 200 mg/kg</td>
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<td></td>
<td>484.65±52.05</td>
<td>402.3 ± 109.24</td>
<td>531.0 *(**)</td>
<td>466.65±</td>
<td>405.9 *</td>
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<tr>
<td>Root extract 300 mg/kg</td>
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<td></td>
<td>559.8 ± 23.89</td>
<td>539.28 ± 27.45</td>
<td>500.4 ± 33.91</td>
<td>400.32 *</td>
<td>332.6 *</td>
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<tr>
<td>Chlorpropamide (250mg/kg)</td>
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<td>standard drug by Pfizer</td>
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</table>

Values given represent the mean (± S. E. M) of 5 observations (n = 5, *P <0.05 vs control; (**) P <0.05 vs standard drug)
Figure 1: Effect of methanolic root bark extract of *Acacia albida* on Chlorpropamide (250 mg/kg p.o) on blood glucose concentration (mg/dL)

Figure 2: Percentage of Blood Glucose concentration on alloxan induced diabetic rats using different treatments
DISCUSSION
Diabetes arises from a deficient production of insulin by the β cells of the pancreatic islets. The endocrine hormone operates at various sites throughout the body regulating carbohydrate, triglyceride, protein metabolism and controlling entry of glucose into the blood. Insufficient insulin results in hyperglycemia (Condition characterized by an abnormally high level of sugar in the body). It is important however to appreciate that there are also many plants and plant extracts which possess marked hypoglycaemic activity. From ancient times such materials have been used for the treatment of diabetes mellitus and still find extensive use in traditional medicine worldwide (Evans, 2005).

The main classes of synthetic oral hypoglycaemic agents currently available for the management or control of adult-onset, type II, non insulin dependent diabetes mellitus include the sulphonylureas, biguanides, thiazolidinediones, e.t.c. Chlorpropamide, used as the reference hypoglycaemic agent in this study, is a member of the first generation sulphonylureas. As a class, sulphonylureas stimulate and increase the release of endogenous insulin from pancreatic β-cells. They also promote and facilitate peripheral tissue uptake and utilisation of glucose (Jackson, 1981).

Most drugs derived for their medicinal value on the presence of one or more compounds (Brain and Turner, 1975). The wide range of structures of those plant constituents which appear to be the active hypoglycaemic principles suggests different sites of action within the body. Polysaccharides feature prominently in antidiabetic plants (Evans, 2000). A previous report on phytochemical screening of Acacia albida revealed the presence of tannins 2 – 28% in the root bark (Irvine, 1961) which are associated with the beneficial effects of various herbs and infusions. Also, some flavonoids and related compounds have been shown to have hypoglycaemic activity, comparatively the number of alkaloid containing plants reported to have antidiabetic properties appears to be small (Evans, 2000). In addition, steroid – containing plants are known to exhibit antidiabetic activity (Evans, 2000). Therefore, the presence of above mentioned constituents might justify the use of the plant’s root bark as antidiabetic.

Table 1, shows the effect of root extract of Acacia albida on alloxan –induced diabetes mellitus in rats using 100, 200 and 300 mgkg⁻¹ body weights and chlorpropamide 250 mgkg⁻¹ on blood glucose concentrations. The maximal reductions in the blood glucose concentration occurred at the dose of 200mgkg⁻¹, using the plant’s extract at the 7th hour after the oral administration. While the reference antidiabetic (hypoglycaemic) agent chlorpropamide 250 mgkg⁻¹ produced significant reductions P<0.05 in the blood concentration of the animals at 3rd hours following oral administration, reaching the peak of its hypoglycaemic effect at 7th hours and still significant 9 hours after oral administration. Thereafter, the blood glucose concentrations of the animals gradually returned to baseline levels at the end of the 24th hour. The LD₅₀ greater than 5,000 mgkg⁻¹ (LD₅₀ > 5000 mgkg⁻¹) obtained for Acacia albida methanol root bark extract in this study probably suggests that the plant extract is relatively safe and / or non toxic to rats (Lorke, 1983). Hence, administration of this extract orally in the management of diabetes may be harmless and safe.

Repeated dose treatment of diabetic rats with a root extract provides an effective control in restoring the elevated blood glucose to normal level. This study showed that there was a need of certain prescription of medication, if a complete cure is to be achieved. Hence, a rise in blood glucose level to a higher level after 24 hours of the drug administration. Therefore a 24 hourly dosage will be required if an effective control is to be achieved.

In conclusion, our result revealed that the crude methanolic extract of Acacia albida may contain biologically active substances with hypoglycaemic activity. These support
the isolation and development of the active principle of this important medicinal plant as hypoglycaemic agent.

REFERENCES


