Preliminary Study of Hypoglycaemic and Hypolipidemic Activity of Aqueous Root Extract of Ricinus Communis in Alloxan-Induced Diabetic Rats

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Preliminary Study of Hypoglycaemic and Hypolipidemic Activity of Aqueous Root Extract of Ricinus Communis in Alloxan-Induced Diabetic Rats

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Abstract

Since diabetes mellitus is a major risk factor that leads to secondary conditions like cardiovascular disease, management of the condition include controlling other risk factors that may lead to secondary conditions in addition to managing diabetes, the primary condition. This work aimed at investigating the hypoglycaemic potential, lipid profile effects and phytochemistry of Ricinus communis L (root).

Powdered root of Ricinus communis was subjected to phytochemical analysis. A dose of 500mg/kg crude aqueous root extract was administered orally to alloxan-induced diabetic rats. Diabetic rats administered Glibenclamide orally served as the positive controls. Fasting blood glucose was monitored daily. Serum lipid profile was analyzed on the last day of the experiment. Coronary Risk Index (CRI) was calculated from the lipid profile parameters. The extract reduced fasting blood glucose by 61.9% and glibenclamide by 69.8%. The root extract caused a significant reduction in CRI of the rats under study. Tannin, saponin, cardenolide and alkaloid were detected in the plant. The detected bioactive principles were probably responsible for the hypoglycaemic effect observed. The reduced CRI observed also showed the potential of the extract in reducing artherosclerosis, a complication of diabetes.

Key words: Ricinus communis, diabetes, coronary risk index, hypoglycaemia, hypolipidaemia

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Introduction

Diabetes mellitus is a generalised metabolic disturbance that is classically considered to be an endocrinopathy of the pancreas (Jimez et al., 1986). At the early stage, there is reduced insulin sensitivity, characterised by elevated levels of insulin in the body. It progresses to worsened impairment of insulin secretion. Because insulin is deficient, entry of glucose into the cell is impaired and the principal early symptoms and signs are usually related to metabolic defects (Floyd, 1990). Severe long-term complications can result from unnoticed Type 2 diabetes, including renal failure due to nephropathy, vascular disease (including coronary artery disease), vision damage due to diabetic retinopathy, loss of sensation or pain due to neuropathy, liver damage from non-alcoholic steatohepatitis and heart failure from cardiomyopathy. The current treatment of the disease includes the use of hypoglycemics (sulfonamides, biguanides; and for Type 1 diabetes, insulin), hypolipidemics, antihypertensives, hygieno-diet measures and exercises (Menut et al., 1993; CDC, 2004). This management strategy is a long life. Because it is constraining, cumbersome and expensive therapy many people in developing countries, opt for medicinal properties of commonly available plants to fight the disease. Many of such plants lack proper scientific verification of the efficacy.

This study aimed at determining the hypoglycaemic and hypolipidemic potential of the root of castor oil plant, Ricinus communis L on alloxan-induced diabetic wistar rats. This plant is best known for its seed which is the source of castor oil, which is extensively used as a laxative, purgative, cathartic and demulcent (Greiling & Gressner, 1995).

Materials and Methods

Plant collection and extract preparation

The fresh root of Ricinus communis L was obtained locally from the Faculty of Agriculture, University of Ibadan, Nigeria. Authentication and herbarium deposit was done at the Forestry Research Institute of Nigeria (voucher number FHI 108864).

Aqueous extract was prepared by pulverizing 10g of the fresh root and extracting it with 100ml of distilled water (for crude aqueous extracts) at room temperature. This was left to stand for two hours, filtered with whatman filter paper and stored in the refrigerator in amber coloured bottle until use. The filtrate was used within two days before preparing fresh extract.

Experimental Animals

The animals used in this study were male Wistar rats (100-250g) procured from the Animal House, University of Ibadan, Ibadan, Nigeria. Animals were handled in compliance with the recommendations of the Institution’s Ethics and internationally accepted principles for laboratory animal use and care. The animals were acclimatised for 14 days prior to the onset of this study. They were allowed free access to rat chow (Guinea Feed, Nigeria) ad libitum and water throughout the study, unless where otherwise stated. All treatment was carried out between 7.00-9.00 a.m.

Induction of diabetes in experimental rats and extracts/drug administration

A set of rats which was not administered alloxan served as control animals and were allotted to group 1. This group received distilled water throughout the study.

Diabetes was induced in the rats by a single intraperitoneal injection of 150mg/kg body weight alloxan monohydrate dissolved in normal saline after animals were fasted for 12 hrs. 120 hrs thereafter, glucose was measured from the blood collected by the tail prick and using electronic glucometer, Roche Diagnostic. Animals with stable fasting blood glucose of 200mg/dl or over were included in the study. The first fasting blood glucose obtained was considered as the baseline (Day 0) and such animals allotted into groups. Five animals were allotted to each group. Alloxan-induced diabetic rats in Group 2 (Diabetic untreated) received distilled water throughout the study. Rats in group 3 received 500mg/kg body weight extract once daily after measurement of fasting glucose. Rats in Group 4 received 10mg/kg glibenclamide (reference hypoglycaemic agent)
once daily administration. Distilled water, extract and glibenclamide were administered orally.

The fasting blood glucose was measured daily throughout the experiment. At the end of the experiment (Day 7), blood samples were collected from the rats under anaesthesia into plain tubes. The tubes were then placed in a slanting position to produce serum for full lipid profile analysis. For each rats, percentage difference in fasting blood glucose was calculated thus: Fasting blood glucose measurement obtained on first day of experiment minus that obtained on the last day of experiment divided by the measurement of the first day multiplied by 100.

\[ \text{Percentage difference} = \frac{\text{fasting glucose day 0} - \text{day 7}}{\text{fasting glucose day 0}} \times 100 \]

**Determination of lipid profile**

The total cholesterol was determined by the Pap-method as described Fredrickson et al., (1967). Low Density Lipoprotein (LDL) was determined based on the Polyvinysulphate method (Demacker et al., 1984). High Density Lipoprotein (HDL) estimation was based on Dextran sulphate-Mg2+ method (Albers et al., 1978) while the serum triglyceride content was determined using the procedure of glycerol-phosphate oxidase (Fossati and Prencipe , 1982). Coronary risk index was calculated from the ratio of Total Cholesterol (TC) to High Density Lipoprotein (HDL) (Ishiguro et al., 1995; Seki et al., 1998).

**Phytochemistry**

Fresh sample of root of *Ricinus communis* was air-dried, powdered and subjected to phytochemical analysis for the presence of alkaloids, saponins, anthraquinones, cardenolides and tannins. The phytochemical screening was carried out using standard procedures (Trease & Evans, 1996; Ajaiyeoba et al., 2003).

**Statistical Analysis**

Results were expressed as mean ± standard error of mean (S.E.M). Where applicable, the data were subjected to one-way analysis of variance (ANOVA). Significant difference was set at P<0.05.

**Results and Discussion**

Blood glucose concentration of rats administered *Ricinus communis* reduced from 390.0 to 148.5 or 61.9%. Rats administered glibenclamide showed a steady reduction in mean value of blood glucose during the seven days of the study 316.3 to 95.3 or 69.8% (Table 1).

In the rats administered the aqueous extract, the Total cholesterol (TC), Triglyceride (TG), Low density lipoprotein (LDL), LDL/HDL and CRI were statistically reduced compared with the diabetic untreated rats (Table 2).

Alkaloid, saponin, tannin and Cardenolide were detected in *Ricinus communis* root. A trace of anthraquinone was detected in the same sample (Table 3).

Results obtained from the alloxan–induced diabetic rats (Table 1) showed that in the diabetic untreated group, the blood glucose concentration remained very high confirming the total destruction of beta cells and non stimulation of insulin secretion. Alloxan monohydrate has been shown to destroy the beta cells thus inducing diabetes type 1 or IDDM (Nimenibo, 2003; Gidado et al., 2004).

The increase in blood glucose concentration was proposed by Bansal et al. (1980) to be due to the toxic effect of alloxan on the beta cells of the pancreas. The report further stated that alloxan and the product of its reduction, dialuric acid, establishes a redox cycle with the formation of superoxide radicals. These radicals undergo dismutation to hydrogen peroxide and the action of the reactive oxygen species with a simultaneously massive increase in cytosolic calcium concentration causes rapid destruction of the beta cells. This destruction results in the inability of the pancreas to synthesize and secrete adequate amounts of insulin necessary for the metabolism of carbohydrate.

*Ricinus communis* caused 61.97% reduction in blood glucose, reduction over a period of 7 days. This is similar to that of the reference drug, glibenclamide. Probable mechanisms of action include inhibitory effect on glucose absorption, stimulation of glycolysis in peripheral tissues, reduced gluconeogenesis and reduced plasma glucagon levels.
Table 1: Effect of 500mg/kg dose of aqueous extract of Ricinus communis (root) on fasting blood glucose concentration of rats

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Blood glucose concentration (mg/dl)</th>
<th>Day 7 % difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 0</td>
<td>Day 1</td>
</tr>
<tr>
<td>Non diabetic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetic</td>
<td>548.3±57.5</td>
<td>474.3±22.3</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glibenclamide</td>
<td>316.3±79.9</td>
<td>242.0±100.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ricinus communis</td>
<td>390.0±77.9</td>
<td>290.3±9.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Superscripted items indicate statistically significant difference (p<0.05) exist between mean values of each group compared with diabetic untreated (1) and glibenclamide (2) groups.

Table 2: effect of 500mg/kg dose of aqueous extract of ricinus communis (root) on lipid profile of rats

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total cholesterol(TC) mg/dl</th>
<th>Triglyceride mg/dl</th>
<th>High density lipoprotein (HDL) (mg/dl)</th>
<th>Low density lipoprotein (LDL)(mg/dl)</th>
<th>LDL/HDL</th>
<th>Coronary risk index(CRI) TC/HDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>non diabetic</td>
<td>84.60±0.56</td>
<td>69.20±4.50</td>
<td>30.00±0.00</td>
<td>16.00±0.50</td>
<td>0.53±0.00</td>
<td>2.82±0.13</td>
</tr>
<tr>
<td>untreated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>diabetic</td>
<td>95.67±2.85</td>
<td>166.00±54.37</td>
<td>26.67±3.33</td>
<td>43.33±7.69</td>
<td>1.62±0.17</td>
<td>3.69±0.41</td>
</tr>
<tr>
<td>untreated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>glibenclamide</td>
<td>73.33±1.761</td>
<td>64.33±1.201</td>
<td>27.33±4.06</td>
<td>17.67±5.611</td>
<td>0.41±0.26</td>
<td>2.80±0.38</td>
</tr>
<tr>
<td>ricinus communis</td>
<td>77.33±1.451</td>
<td>76.00±4.621</td>
<td>32.00±1.15</td>
<td>30.00±1.151</td>
<td>0.93±0.00</td>
<td>2.42±0.041</td>
</tr>
</tbody>
</table>

Superscripted items indicate statistically significant difference (p<0.05) exist between mean values of each group compared with diabetic untreated (1) and glibenclamide (2) groups.
The detection of active principles in medicinal plants plays a strategic role in the phytochemical investigation of crude plant extracts and is very important with regards to their potential pharmacological effects (Pascual et al., 2002). The effects of medicinal plants on body systems, therefore, depend on the composition of chemical constituents. Anthraquinones derivatives have been found to play an important role in the treatment of tumours, diabetes, ulcer and cancer (Rajendran & Gnanarel, 2007). The hypoglycaemic effect observed in diabetic rats administered Ricinus communis extract could be as a result of the anthraquinone.

Flavonoids and tannins are phenolic compounds and plant phenolics are a major group of compounds that act as primary antioxidants or free radical scavengers (Polterait, 1997). Since diabetes and oxidative stress are interrelated, the presence of phenolics (e.g. tannin) in Ricinus communis could be factors that enhanced its hypoglycaemic effect in diabetic rats.

Alkaloid rich fraction isolated from the fruits of Capparis decidua remarkably improved the hepatic and muscle glycogen content in diabetic rats [Bhavna et al., 2010]; this could be a contributive and likely mechanism of action of the hypoglycaemic effect of Ricinus communis in diabetic rats. Saponin has been shown to have antidiabetic effect (Zhong et al., 2008) and this was detected in Ricinus communis which showed hypoglycaemic effects on diabetic rats.

A significant reduction in the ratio of High density lipoprotein to Low density lipoprotein compared with the diabetic untreated rats is suggestive of the ability of the extract to reduce atherosclerosis, a complication of diabetes.

The biochemistry of the movement of lipids in the blood stream and the factors that increase lipid deposition in arteries is extremely complex. As far as cholesterol is concerned, the two lipoproteins most concerned with its transport are the high density lipoproteins (HDL) and the low density lipoproteins (LDL). LDL transports cholesterol to the cells where it is deposited even though it may not be required and is therefore associated with atherosclerosis. HDL, on the other hand, transports cholesterol to the liver where it can be removed from the body (Allan et al., 2007). Normally, it is found that high cholesterol levels are associated with high LDL levels, but having a high HDL may compensate for this.

Thomas (Thomas, 2003) showed a strong relationship between high level of total cholesterol concentration in the blood and cardiovascular disorder. Furthermore diabetics have an increased risk of coronary disorder (Stratton et al., 2000; Davis et al., 2001). This may offer an explanation for the high coronary index (tendency to cause cardiovascular disorder) observed in the diabetic rats administered the extract. The lipid profile of rats administered the extract showed relatively

### Table 3: Phytochemical analysis of Ricinus communis (root)

<table>
<thead>
<tr>
<th>Test/Plant</th>
<th>Method/Reagent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>Dragendorff’s</td>
</tr>
<tr>
<td>Cardenolides</td>
<td>Keller-Killiani</td>
</tr>
<tr>
<td>Anthraquinones</td>
<td>±</td>
</tr>
<tr>
<td>Saponins</td>
<td>+</td>
</tr>
<tr>
<td>Tannins</td>
<td>+</td>
</tr>
</tbody>
</table>

+ ------ present  
= ------ absent  
± ------ trace
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cholesterol and low density lipoprotein which are factors that may lowers development of atherosclerosis.

Conclusion

Results from this study have confirmed the hypoglycaemic and hypolipidemic efficacy of root extract of Ricinus communis in rats. Further studies will be necessary for characterisation and structural elucidation.

References


Davis TM, Cull CA, Holman RR (2001). Relationship between ethnicity and glycaemia control, lipid profiles, and blood pressure during the first 9 years of type 2 diabetes: UK Prospective Diabetes Study (UKPDS 55). Diabetes Care; 24:1167–74.


