**Evaluation of the Hypoglycemic, Hypolipidemic and Antioxidant Effects of Methanolic Extract of “Ata-Ofa” Polyherbal Tea (A-Polyherbal) in Alloxan-Induced Diabetic Rats**

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Methanolic extract of “Ata-Ofa Polyherbal tea” (A-Polyherbal) was evaluated for hypoglycemic, hypolipidemic and antioxidant effects in alloxan-induced diabetic rats. Compared to the untreated diabetic rats, administration of methanolic extract of A-Polyherbal at 50mg/kg dose for 7 days caused a statistically significant (P < 0.05) percentage reduction in fasting blood glucose level (55.43±3.50%), significantly boosted the activities of superoxide dismutases and catalases, HDL-cholesterol, packed cell volume and hemoglobin, and significantly (P < 0.05) reduced the levels of thiobarbituric reactive substances (TBARS), total cholesterol, total bilirubin, conjugated bilirubin, in alloxan-induced diabetic rats. These results strongly demonstrate that “Ata-Ofa Polyherbal tea” (A-Polyherbal) has strong potential in the alleviation and management of diabetes and related complications, including hyperglycemia, oxidative stress, development of micro and macro vascular diabetic complications arising from elevated plasma lipids and decreased levels of antioxidant defense systems, as well as reduced erythrocyte survival rate.

**Keywords:** Ata-Ofa Polyherbal tea; A-Polyherbal; Hypoglycemic effect; Antioxidant effect, Hypolipidemic effect; alloxan-diabetes; anti-diabetic effect

**INTRODUCTION**

Diabetes mellitus is a metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion or insulin action, or both [1]. As a metabolic disorder, it is life threatening and it is estimated that worldwide, its annual incidence rate will continue to increase in the future. It is well documented that chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction and eventually the failure of organs especially the eyes, kidneys, nerves, heart and blood vessels [2, 3].

Synthetic oral hypoglycemic agents can produce a series of side effects including hematological, gastro-intestinal reactions, hypoglycemic coma and disturbances in liver and kidney metabolism. In addition, these preparations are not ideal for use during pregnancy [4, 5]. These reasons together with poor access to health facilities in developing countries have encouraged the popularity of ethnomedical solutions, including the use of herbs for management of diabetes [6, 7].

In recent decades, interest has increased on research of natural plant products all over the world, and a large number of substantiation and validation have shown the immense potential of medicinal plants used traditionally [7]. This is primarily because plant drugs are frequently considered cheap, affordable and freer from side effects than synthetic ones [8, 9]. Thus, many herbs have been investigated and shown to have anti-diabetic action in both human and animals [10]. Among plants products recently reported to have curative effects against diabetes and complications arising thereof are natural products and polyherbal formulations [11 – 16].

Polyherbal formulations evaluated for anti-diabetic property include “Diabet” which is a combination of six medicinal plants namely Curcuma longa, Coscinium fenestratum, Strychnos potatorum, Tamarindus indica, Tribulus terrestris and Phyllanthus reticulatus [12], and a host of others [13 – 16]. Recently, Atawodi [17] reported a new formulation, “Ata-Ofa” Polyherbal tea (also called A-Polyherbal), which contains twenty one (21) plants, including Tamarindus indica, Ginger officinale, Khaya senegalensis, Nauclea latifolia, Moringa olefera, Phyllanthus amarus, Camellia sinensis, Anicardium occidentale, Mangifera indica, Aframomum melegueta and Morinda lucida which was compounded to combat many oxidative stress related diseases. In that report, it was demonstrated that A-Polyherbal showed antioxidant, organ protective and lipid lowering effects in rats acutely and chronically intoxicated with carbon tetrachloride. As a follow up to that investigation, this study examines in alloxan-induced diabetic rats the effects of methanol extract of A-Polyherbal on diabetes and indices of complications associated with diabetes, including oxidative stress, hyperlipidemia, hyperglycemia, decreased levels of antioxidant defense systems, reduced erythrocyte survival rate, etc.

**MATERIALS AND METHODS**

**Chemicals:**

Thiobarbituric acid was from Sigma Chemicals (St Louis. M.O., USA), while other chemicals were acquired from the following sources: α – tocopherol (Teva pharmaceutical industries Ltd Petach Tikva), carbon tetrachloride (Fisher Scientific Company, Chemical Manufacturing Division (Fawlain, New jersey 07410, USA), alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase reagent kits (Randex Laboratories Ltd (Crumilin Co. Antrim, United Kingdom BT 29 4QY).

**Sample collection and identification:**

The leaves of the plants were collected from Kogi State, Nigeria. They were identified at the Herbarium of Biological Science Department of Ahmadu Bello University, Zaria. The rhizomes of Zingiber officinale, seeds of alligator pepper

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polyherbal tea is composed of nineteen (19) plant products, described [17]. The polyherbal formulation, “Ata-ofa” depressed immune responses, etc) was formulated as earlier antidote against many diseases, especially those with “Ata-ofa” a polyherbal tea intended as a multipurpose and stored in the refrigerator at 4°C desiccators at room temperature until brittle, then weighed were dried under reduced pressure, and later kept in same procedure. The combined methanolic extracts obtained from the leaf were extracted with 300 ml methanol for three hours using the same procedure as above to obtain the methanolic extract. The methanol extraction was performed three times using the same procedure. The petroleum ether extraction was air-dried and further thimble and defatted with 300ml of petroleum ether for 6 days before sampling and evaluation of relevant parameters. Animals were divided into five groups of six animals each as Animal grouping and treatment with A-Polyherbal methanolic extract: Animals were divided into five groups of six animals each as follows: normal control which consisted of non-diabetic rats administered saline, diabetic control which received only normal saline, standard drug group which consisted of diabetic group that received 1mg/kg glibenclamide, non-diabetic animals administered methanol extract of the polyherbal tea, and alloxan-diabetic rats treated with A-polypolyherbal tea extract (50 mg/kg). All groups had uncontrolled access to feed and drinking water, and were treated for seven days before sampling and evaluation of relevant parameters. Blood Collection and Fasting Blood Sugar (FBS) Determination: After overnight fast, animals were weighed before sacrifice on the 8th day. Fasting blood sugar was immediately measured (after collection of blood from the tail tip or from retro-orbital plexus under mild chloroform anesthesia) using one touch electronic glucometer utilizing glucose test strips. Animals were sacrificed, blood was collected for separation of serum used in biochemical analysis, and organs were immediately collected into ice for analysis of thiobarbituric reactive substances. Organs and Homogenization: The various organs were carefully collected using forceps, immediately washed in ice cold physiological saline and weighed. Homogenization was done using pre-cooled laboratory pestle and mortar and pestle and the powdered samples were measured and mixed together. Preparation of A-Polyherbal extracts: Exactly 35 g of the well mixed pulverized “Ata-Ofa” polyherbal mixture was carefully added to the extraction thimble and defatted with 300ml of petroleum ether for 6 hours in a Soshlex apparatus. The plant residue left after petroleum ether extraction was air-dried and further extracted with 300 ml methanol for three hours using the same procedure as above to obtain the methanolic extract. The methanol extraction was performed three times using the same procedure. The combined methanolic extracts obtained were dried under reduced pressure, and later kept in desiccators at room temperature until brittle, then weighed and stored in the refrigerator at 4°C until required. Animal and animal husbandry: Male albino rats weighing 150 to 200g were obtained from the Department of Pharmacology, Ahmadu Bello University, Zaria, Nigeria. They were acclimatized for two weeks at room temperature in our laboratory, and had free access to food and water before the experiment was started. Food, but not water was withdrawn, 18 hrs before commencement of experiments. The animal experiment was approved by the Ethical Committee of Biological Science Sub-Complex of Ahmadu Bello University, Zaria, Nigeria. Induction of Diabetes in Animals: Experimental diabetes was induced in rats by administration of an intraperitoneal injection of alloxan monohydrate (120mg/kg) dose of alloxan, which was boosted by an additional dose of 80 mg/kg 24 hrs later. Two days after the last alloxan injection, rats with plasma glucose levels of 140 mg/dl and above were included in the study. Treatment with plant extracts was started 48 h after last alloxan injection. Animal grouping and treatment with A-Polyherbal methanolic extract: Animals were divided into five groups of six animals each as follows: normal control which consisted of non-diabetic rats administered saline, diabetic control which received only normal saline, standard drug group which consisted of diabetic group that received 1mg/kg glibenclamide, non-diabetic animals administered methanol extract of the polyherbal tea, and alloxan-diabetic rats treated with A-
RESULTS

and absence of the sample. The method can be summarized thus; exactly 920 µL of assay buffer was added into clean test tube containing 40µL of sample, mixed and incubated for 2 min. at 25°C. 40 µL of hematoxylin solution was added, mixed quickly and the absorbance was measured at 560nm.

**Determination of liver function parameters:**
The serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were determined spectrophotometrically at 546nm as described by Reitman and Frankel [22] using assay kits, while total and direct bilirubin were measured spectrophotometrically using Randox kits. Total protein concentration of the serum and homogenates was determined using Biuret method, and utilizing bovine serum albumin as standard.

**Determination of cholesterol:**
Cholesterol determinations were made spectrophotometrically using Randox reagent kits. Briefly, serum total cholesterol was analyzed according to the method of Roschlau and Gruber [23], while serum HDL was analyzed based on the principle outlined by Allain and Chan [24].

**Determination of packed cell volume (PCV) and hemoglobin concentration:**
Whole blood samples were collected into heparinized capillary tubes, filled up to 2/3 the length during animal sacrifice, sealed with plasticine and centrifuged at 3,000rpm for 10 minutes. Packed cell volume was determined using hematocrit reader, and hemoglobin concentration was calculated as PCV/3 [25].

**Statistical analysis:**
The results obtained were statistically analyzed using analysis of variance (ANOVA) and students t-test for significant difference between the grouped means at 95% confidence level (P<0.05).

**RESULTS**

Alloxan-induced diabetes resulted in a significant elevation in blood glucose level in comparison with the untreated diabetic control. However, administration of methanolic extract of A-Polyherbal for 7 days caused a statistically significant reduction (P < 0.05) in fasting blood glucose level, bringing the level close to that of the normal control group, but significantly different (P < 0.05) from that of the untreated diabetic control. The percentage reduction in fasting blood sugar (FBS) caused by the extract (55.43±3.50%) was not statistically different (P>0.05) from that caused by glibenclamide (55.83±4.68%), the standard drug (Table 1).

**Table 1.** Percentage change in fasting blood sugar (FBS) levels and percentage organ/body weight ratio in alloxan-diabetic rats treated intraperitoneally with methanolic extract of A-Polyherbal at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Percentage Organ/Body Weight Ratio</th>
<th>Percentage Organ/Body Weight Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Change in FBS</td>
<td>Liver</td>
</tr>
<tr>
<td>Normal control</td>
<td>0.21±0.26</td>
<td>4.13±1.52</td>
</tr>
<tr>
<td>Diabetic control</td>
<td>0.53±0.03</td>
<td>4.34±0.55</td>
</tr>
<tr>
<td>Diabetic + glibenclamide</td>
<td>55.83±4.68</td>
<td>4.46±0.70</td>
</tr>
<tr>
<td>Normal + A-Polyherbal</td>
<td>1.75±0.05</td>
<td>3.84±0.33</td>
</tr>
<tr>
<td>Diabetic + A-Polyherbal</td>
<td>55.43±3.50</td>
<td>3.81±0.31</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05); Percentage change in FBS levels were calculated with respect to day 0.

Similarly, percentage change in organ/body weight revealed that there was a nominal increase in the ratio of organs to body weight in the diabetic control group compared to that of the normal control group. Treatment with A-Polyherbal methanolic extract restored liver and heart weight back to normal but kidneys showed slow response to treatment (Table 1).

**Effects of A-Polyherbal extract on levels of TBARS and endogenous antioxidant enzyme activity in alloxan-induced diabetic rats:**

Tables 2, 3 and 4 respectively, show the activity of thiobarbituric acid reactive substances (TBARS), superoxide dismutase (SOD) and catalase (CAT) in the liver, kidney and heart of rats in all groups. Levels of TBARS which were significantly increased in the untreated diabetic control were significantly reduced in diabetic rats treated with either A-polyherbal extract (50mg/kg) or the standard drug, glibenclamide (1mg/kg) for seven days, bringing their levels to within the range of the normal control (Table 2).

**Table 2.** Thiobarbituric Acid Reactive Substances (TBARS) levels in the organs of alloxan-diabetic rats treated intraperitoneally with methanolic extract of A-Polyherbal at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TBARS (nmol/mg Protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LIVER</td>
</tr>
<tr>
<td>Normal control</td>
<td>0.19±0.01</td>
</tr>
<tr>
<td>Diabetic control</td>
<td>0.18±0.03</td>
</tr>
<tr>
<td>Diabetic + glibenclamide</td>
<td>0.12±0.01</td>
</tr>
<tr>
<td>Normal + A-Polyherbal</td>
<td>0.10±0.03</td>
</tr>
<tr>
<td>Diabetic + A-Polyherbal</td>
<td>0.13±0.05</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05).
Table 3. Superoxide Dismutase (SOD) activities in the organs of alloxan-diabetic rats treated intraperitoneally with methanolic extract of *A-Polyherbal* at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>SOD Activity (u/mg Protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal control</td>
<td>16.16±4.35</td>
</tr>
<tr>
<td>Diabetic control</td>
<td>11.72±6.20</td>
</tr>
<tr>
<td>Diabetic + glibenclamide</td>
<td>16.74±3.93</td>
</tr>
<tr>
<td>Normal + <em>A-Polyherbal</em></td>
<td>24.71±3.85</td>
</tr>
<tr>
<td>Diabetic + <em>A-Polyherbal</em></td>
<td>16.58±4.21</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05).

Table 4. Catalase activities in serum organs of alloxan-diabetic rats treated intraperitoneally with methanolic extract of *A-Polyherbal* at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>CAT Activity (u/mg protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal control</td>
<td>47.4±1.70</td>
</tr>
<tr>
<td>Diabetic control</td>
<td>37.9±6.21</td>
</tr>
<tr>
<td>Diabetic + glibenclamide</td>
<td>46.2±1.11</td>
</tr>
<tr>
<td>Normal + <em>A-Polyherbal</em></td>
<td>44.0±5.03</td>
</tr>
<tr>
<td>Diabetic + <em>A-Polyherbal</em></td>
<td>30.3±3.30</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05).

Similarly, alloxan-diabetic rats not treated with *A-Polyherbal* extract showed a statistically significant decrease in the activity of SOD and CAT compared to the normal control, but treatment of diabetic rats for seven days with *A-Polyherbal* extract, just like those treated with the standard drug significantly reversed the trend, with these groups showing a significantly boosted activities (P < 0.05) of the antioxidant enzymes (Tables 3 and 4).

*A-Polyherbal* extract administration, liver function and some hematological parameters in alloxan-induced diabetic rats:

Induction of diabetes by alloxan caused a statistically significant elevation in the levels of the activities of liver enzymes, AST and ALT above the normal control group. However, treatment with *A-Polyherbal* methanolic extract caused a significant difference between the diabetic group treated with the extract and the untreated diabetic group (P < 0.05), but no such difference was observed between the diabetic group treated with the *A-Polyherbal* extract and the group treated with the standard drug (Table 5). Similarly, total bilirubin and direct bilirubin levels were significantly elevated in the alloxan-induced diabetic group compared to the normal control. Treatment with *A-Polyherbal* methanolic extract alleviated the pathological condition as indicated by the normalization of the bilirubin levels when compared with the normal control as well as glibenclamide-treated group. This effect was however, better observed with direct bilirubin levels than in total bilirubin levels. The effect of the extract was also more apparent on packed cell volume than on hemoglobin levels (Table 6).

Table 5. Some liver function parameters in alloxan-diabetic rats treated intraperitoneally with methanolic extract of *A-Polyherbal* at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>AST (u/l)</th>
<th>ALT (u/l)</th>
<th>D. Bilirubin (mg/dl)</th>
<th>T. Bilirubin (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Control</td>
<td>13.0±2.13</td>
<td>7.6±1.32</td>
<td>1.5±0.54</td>
<td>10.7±2.54</td>
</tr>
<tr>
<td>Diabetic Control</td>
<td>20.3±1.56</td>
<td>11.3±1.52</td>
<td>2.0±0.61</td>
<td>12.0±2.42</td>
</tr>
<tr>
<td>Normal + <em>A-Polyherbal</em></td>
<td>12.0±1.03</td>
<td>4.6±1.15</td>
<td>1.0±0.18</td>
<td>4.9±0.04</td>
</tr>
<tr>
<td>Diabetic + <em>A-Polyherbal</em></td>
<td>14.5±0.01</td>
<td>7.6±2.88</td>
<td>1.4±0.06</td>
<td>7.0±1.42</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05).

Table 6. Packed Cell Volume and Hemoglobin concentration in alloxan-diabetic rats treated intraperitoneally with methanolic extract of *A-Polyherbal* at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Packed Cell Volume (PCV)</th>
<th>Hemoglobin Concentration (g/100ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Control</td>
<td>45.5±8.66</td>
<td>15.1±6.28</td>
</tr>
<tr>
<td>Diabetic Control</td>
<td>32.3±2.84</td>
<td>10.7±2.54</td>
</tr>
<tr>
<td>Normal + <em>A-Polyherbal</em></td>
<td>42.6±6.70</td>
<td>14.2±0.94</td>
</tr>
<tr>
<td>Diabetic + <em>A-Polyherbal</em></td>
<td>40±1.00</td>
<td>13.3±0.33</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05).

Administration of *A-Polyherbal* extract and cholesterol levels in alloxan-induced diabetic rats:

Serum total cholesterol level increased significantly in alloxan-induced diabetic group when compared to the normal control (P < 0.05). But whereas, a significant difference (P < 0.05) existed between the diabetic rats treated with the *A-Polyherbal* extract and the untreated diabetic rats, no such difference existed between the diabetic rats treated with the extract and those treated with the standard drug, with the two groups maintaining no statistically significant difference with the normal control (P > 0.05). Administration of the extract or the standard drug, produced opposite effect with respect to the HDL-cholesterol levels (Table 7).

Table 7. Levels of total cholesterol and HDL-cholesterol in alloxan-diabetic rats treated intraperitoneally with methanolic extract of *A-Polyherbal* at 50mg/kg dose for seven days.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>HDL-Cholesterol (mg/dl)</th>
<th>Total Cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal control</td>
<td>7.6±1.29</td>
<td>5.7±1.29</td>
</tr>
<tr>
<td>Diabetic Control</td>
<td>5.3±1.25</td>
<td>8.6±1.17</td>
</tr>
<tr>
<td>Normal + <em>A-Polyherbal</em></td>
<td>6.8±1.29</td>
<td>5.3±1.25</td>
</tr>
<tr>
<td>Diabetic + <em>A-Polyherbal</em></td>
<td>6.5±1.52</td>
<td>5.1±1.52</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± SEM, n=6; Vertical data with different superscripts differ significantly from each other (p<0.05).

**DISCUSSION**

According to Govindarajan and coworkers [26], the etiology of the complications of diabetes involves oxidative stress perhaps as a result of hypoglycemia, because glucose itself and hyperglycemia-related increased protein glycosylation are important sources of free radicals. Elevated glucose causes slow but significant non-enzymatic glycosylation of proteins in diabetes. Glucose auto-oxidise in the presence of transition metal ions, generating oxygen free radicals which make the membrane vulnerable to oxidative damage. Thus, that the *A-Polyherbal* extract caused comparable amelioration in the
Occurrence of anemia is due to the increased non-enzymatic pathology of diabetes mellitus, it has been suggested that erythrocyte survival, and lipid fluidity [43]. Thus, in the rigidity, decreased cellular deformability, reduced membrane lipid peroxidation include increased membrane [44]. The major pathological consequences of free radical induced metabolic complications arising from it.

Possess potent capacity to ameliorate diabetes and the standard drug, and at the same time significantly (P < 0.05) alleviated oxidative stress in the same pattern (Tables 2, 3 and 4) suggest that A-polyherbal possess anti-diabetic effect, and this effect is related to the antioxidant property of the extract. This assertion is based on two grounds: Firstly, alloxan, as a diabetogenic agent is widely used to induce type II diabetes in animals [27], because alloxan and its reduction product, dialuric acid establish a redox cycle with the formation of superoxide radicals. These radicals undergo dismutation and consequently form the highly reactive hydroxyl radicals by the Fenton reaction. The action of reactive oxygen species, presumably with the DNA of pancreatic islets as one of its primary targets, together with a simultaneous massive increase in cytosolic calcium concentration causes rapid destruction of beta cells [28]. This, is what qualifies alloxan-induced diabetes mellitus as a pathological biological model for testing a substance with supposed antioxidant activities in vivo [29].

Secondly, the different plant components used in the formulation of A-Polyherbal are known to contain a variety of antioxidant compounds including caffeine and catechins like epicatechin-3-gallate (ECG), epigallocatechin (EGC), epigallocatechin-3-gallate(EGCG), and epicatechin (EC), quercetin, myricitrin and kaempferol which are present in Camellia sinensis leaves [30], and 4-O-methylgallic acid and (α)-epicatechin which are present in Tamarindus indica [31]. The presence of the antioxidants, mangiferin, penta- O-galloyl-glucoside gallic acid and methyl gallate have been demonstrated in Mangifera indica [32], just as the presence of anacardic acids, cardanol and cardols and catechin, rutin and quercitin rhamnose have been reported in Anacardium occidentale [33], and Klanya senegalensis [34] respectively. Similarly, Morinda oleifera is reportedly rich in chlorogenic acid, rutin, quercetin glucoside, and kaempferol rhamnoside [35], while [6]-Gingerol, a very potent antioxidant [36], is a major pungent principle constituent of Ginger officinalis and Aphanomerum melegueta [37], two other components of A-Polyherbal. Some of the plant constituents of A-Polyherbal have been demonstrated to have anti-diabetic action [38] and earlier workers have indeed, established the relationship between antioxidant activity and anti-diabetic properties of plants and other natural products [39, 40].

In addition to the roles of oxidative stress and hyperglycemia in the pathology of diabetes mellitus, another factor frequently proposed to be associated with the development of micro and macro vascular diabetic complications include elevated plasma lipids leading to increased lipid oxidation and decreased levels of antioxidant defense systems [41, 42]. Thus, the significantly reduced levels of total cholesterol and significantly elevated levels of HDL-cholesterol in diabetic rats treated with the A-polyherbal extract (Table 7) coupled with the significantly boosted levels of activities of superoxide dismutases and catalases in the extract treated animals (Tables 3 and 4) strongly suggest that A-polyherbal possess potent capacity to ameliorate diabetes and the metabolic complications arising from it.

The major pathological consequences of free radical induced membrane lipid peroxidation include increased membrane rigidity, decreased cellular deformability, reduced erythrocyte survival, and lipid fluidity [43]. Thus, in the pathology of diabetes mellitus, it has been suggested that occurrence of anemia is due to the increased non-enzymatic glycosylation of membrane proteins of the red blood cells, which correlates with hyperglycemia [44, 45]. Oxidation of these glycosylated membrane proteins and hyperglycemia in diabetes mellitus cause an increase in the production of lipid peroxides leading to hemolysis of red blood cells, and resulting in many pathological consequences [44, 45]. Thus, the levels of hemoglobin and packed cell volume which were significantly reduced in untreated diabetic rats, were largely corrected in the groups treated with either A-Polyphenol extract or the standard drug glibenclamide, strongly suggests that the extract and the drug lowered lipid peroxidation level in the red blood cell membrane leading to an enhanced membrane integrity and a decreased susceptibility of the RBCs to hemolysis. The significantly boosted enzymatic antioxidant defense system including superoxide dismutases (SODs) and catalases (CATs) by administration of the A-Polyherbal extract can decompose superoxide and hydrogen peroxide in the cells, and hence A-Polyherbal boosts the main defense against oxidative injuries. Besides, the role of SOD in blocking pathways of hyperglycemic damage is well established [46].

Assessment of liver function can be made by estimating the activities of serum AST and ALT (which are some of the enzymes originally present in higher concentrations in the cytoplasm), as well as levels of total and conjugated bilirubin. When there is hepatopathy, these enzymes leak into the blood stream corresponding with the extent of liver damage [47]. The elevated level of these marker enzymes observed in the diabetic rats in this present study correlated with the extensive liver damage induced by alloxan and the subsequent generation of oxidative radicals and stress. However, the reduced concentrations of ALT and AST, as well as total and conjugated bilirubin following A-Polyherbal extract administration might be due, at least, in part to the presence of some antioxidant polyphenolic components in the extract [39, 40, 48]. Thus, the tendency of these marker enzymes and biochemicals to return to a near- normal level when administered the methanolic extract of A-Polyherbal, comparable to the group administered glibenclamide (Table 5) strongly suggests a clear manifestation of the anti-hepatotoxic effect of the formulation. Hence, these results demonstrate that A-Polyherbal extract possess strong capacity for the alleviation and management of diabetes and related complications, including, oxidative stress, hyperglycemia, development of micro and macro vascular diabetic complications arising from elevated plasma lipids and decreased levels of antioxidant defense systems, as well as reduced erythrocyte survival.

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REFERENCES


Sunday E Atawodi: Evaluation of the Hypoglycemic, Hypolipidemic and Antioxidant Effects of Methanolic Extract of “Ata-Ofa” Polyherbal Tea (A-Polyherbal) in Alloxan-Induced Diabetic Rats


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