Toxicological Effects of Oral Consumption of Aqueous Leaves Extract of *Senna occidentalis* on Experimental Animals (Albino Rats)

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**Abstract**

*Senna occidentalis* is among the shrubs that are widely distributed in the temperate or warm regions across the globe. The leaves of this plant were reported to exhibit abroad pharmacological effects including; antibacterial, antimalarial, antifungal as well as anticancer activities. This study accounts for the toxicological effects of oral administration of the aqueous *Senna occidentalis* leaves extract on organ body weight ratio, some biochemical, hematological as well as histopathological parameters in male albino rats. The results indicate a significant decrease in organ body weight ratio for liver, kidney, spleen, pancreas, lungs and heart in the test groups. The result also revealed a significant increase in the hematological...
parameters, indicating that, the extract burst the hematopoietic capacity of the animals. The administration of low dosage of the extracts does not remarkably alter the liver as well as the renal function parameters studied as compared to control group, indicate that the extract does not pose any liver and renal damage. Therefore, the aqueous leaves extract of Senna occidentals can be considered as hematopoietic stimulator and does not have effect on vital organs.

Key words: Senna occidentalis, aqueous extract, toxicity, liver function, renal function

Introduction
The plant *Senna occidentalis* (Fabaceaeasalpiniaceae) known commonly as coffee senna is widely grown in warm areas of the world, with exception of Australasia. The plant is a shrub in nature and was reported to be a native of America and mainly used for landscape flowering purposes (Hussein, 2003). Coffee senna is also reported to be used as a substitute to coffee. The seeds of the shrub are brewed into the coffee-like beverage and used for the treatment of asthma. The pharmacological effect of the leaf extracts were previously reported to have a broad spectrum of antibacterial, antimalarial and antifungal activities (Caceves et al., 1991; Perez and Suarez, 1997; Tona et al., 1999). The leaves extract were also reported to possess antimutagenic (Sharma et al., 2000), antiplasmodial (Tona et al., 2004), anticarcinogenic (Vashishtha et al., 2009), and hepatoprotective activity. It was also been used for the treatment of stomach disorders, rheumatism, and some liver diseases (Sara et al., 1994; Jafri et al., 1999). The leaves are commonly used as a leaf vegetable and are eaten either raw or in a mixture with coconut, chilli, and onion (Selvam, 2007; Vashi et al., 2009). Currently, in Kano, Nigeria the leaves of *Senna occidentalis* are sold in market for its medicinal values. The leaves were either soaked and boiled in water and taken for the treatment of typhoid fever, malaria and some form of cancers or the fresh leaves are rubbed on the tumor. In view of the above, there is an urgent need to assess the toxicological effect of the aqueous extract of the leaves in order to validate its traditional uses.

Materials and Methods
Collection of Plant Materials and Extraction
The leaves of *Senna occidentalis* (Fabaceaeasalpiniaceae) were obtained from a farm in Wudil town, Kano state, Nigeria, in the Month of January, 2016. The leaves of the plant were identified and the identity of the leaves was authenticated in the Department of Botany, Ahmadu Bello University Zaria, Kaduna State, Nigeria, by Mr. Namadi Sunusi. The leaves were given a voucher number of 1047 and was deposited in their Herbarium for future reference. The leaves were dried under shade in the absence of sunlight for a period of two weeks and were grinded to powder using mortar and pestle. The dried powdered leaves (400g) was homogenized with hot (70°C) distilled water (200 cm³) and kept for two days with regular stirring. The aqueous mixture formed was filtered using Whatman no. 1 filter paper and then, the filtrate was
evaporated or concentrated using rotary evaporator. The concentrated extract was then freeze-dried and the dried powder of aqueous leaves extract was obtained. The dried powdered extract was kept in refrigerator at -20°C for until use.

**Phytochemical Analysis**
The total alkaloid, saponin, flavonoid, tannin and phytate of the dried powdered aqueous leaves extract of *Senna occidentalis* were determined using standard methods (Sofowora, 1993).

**Experimental Animals**
The experimental animals used in this work are albino rats and were purchased from animal house of the Department of Zoology, Bayero University Kano, Nigeria. A total of 25 adult male rats aged 6-8 weeks and weighing 100-160g, were housed under a standard laboratory living conditions with 12 hours dark/light, with full access to standard animal feed (Pelletised growers feed, Zawan roundaboute Josa Plateau State, Nigeria) and water ad libitum was also provided. The albino rats were divided into five groups of five rats each based on weight and concentration of extract to be taken and were used after one week of acclimatization. The albino rats used were fasted for a period of 15 hours (5.00pm- 8.00 am) before the beginning of the experiments but were all allowed free access to water. These animals were handled with strict compliance to international guidelines as reported by the Canadian council on the care and uses of experimental animals (1993).

**Toxicological Studies**
The rats were divided into five groups of five animals each, a concentration of 25mg/kg body weight was received by group one, 50mg/kg/day received by group two, 100mg/kg/day received by group three and group four received 200mg/kg/day. The fifth group serves as control and received only 1ml of physiological saline daily.

**Administration of Plant Extract and Collection of Blood Samples**
The aqueous leaves extract of *S. occidentalis* was found to be completely soluble in water and corresponding daily dose of each group was orally administered to the rats for a period of six weeks. At the end of the experimental period, under a mild chloroform anesthesia, all the rats were sacrificed and 5cm³ blood samples were collected from each rat with aid of cervical decapitation. One cm³ of the blood was immediately taken out and mixed with anticoagulant (EDTA) for hematological analysis. The remaining 4 cm³ of the blood were allowed to clot and then centrifuged at 3000 rpm for 10 minutes. The serum was separated from the cells and was used to determine the liver and renal function’s parameters (Biochemical analysis). The liver, kidney, pancreas, spleen, lungs and heart of each rat were carefully dissected (Mikel, 1994) from the animal and the remnant’s blood was wiped out with filter paper and weighed. At the end of
dissection the liver and kidneys after weighing were immediately immersed in 10% neutral buffered formalin for histopathological studies.

**Determination of Relative organ weight**
The organ weight in relation to body weight of the rats is the percentage of the ratio of absolute organ weight to the body weight of animal on sacrifice day (Yakuba et al., 2008).

**Determination of Hematological Parameters**
The percentage hematocrits (HCT%) was determined according to method described by Sanderson (1981), while the RBC, Total WBC and platelet counts were determined according to standard methods.

**Determination of Biochemical Parameters**
The liver function indices such as Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), and Alkaline phosphatase (ALP) were determined using Randox kits as described by the manufacturer, while the total and direct bilirubin were determined by the method described by Jendrassik and Grof (1938).
The renal function parameters determined include the serum concentration of chloride (Schoenfeld and Lowellen, 1964), Bicarbonate (Van Slyke method), urea (Veniamin and Vakirtzi, 1970), Creatinine (Jaffe, 1886), uric acid (caraway method) while the sodium and potassium ion concentrations were determined by flame photometry.

**Histopathology Test**
The biopsies of the liver and kidney of the albino rats were fixed in 10% formal saline, dehydrated with ascending grades of alcohol, cleared with toluene, infiltrated with molten paraffin wax. The microtome sections (approx. 5mm) were stained with hematoxylin and eosin (H and E) technique and structure was examined under electron microscope (Auwioro, 2010).

**Statistical Analysis of Data**
The results of this work were all expressed as Mean values ±SD and the statistical variations among the groups were evaluated by one way analysis of variance (ANOVA) at p value of less than 0.05.

**Results**
The result of the phytochemical screening, hematological test parameters, organ body weight ratio and liver and renal function test parameters are presented in the form of mean and standard deviation of three determinations as shown in Table 4. The histopathological analysis is in the form of stained picture of the respective test tissue section and are shown in Figure 6.
Phytochemical Screening
The aqueous leaves extract of *Senna occidentalis* was tested for some common phytochemical constituents, the result revealed the presence of saponins, flavonoids, tannins, alkaloids and phytate as shown in Table 1.

Hematological Indices
The result for the hematological test revealed that, there were significant differences in the values for WBC, RBC, HCT% and PLT% for all groups when compared to their corresponding values in control group (p<0.05)

Liver Function Test
The result in the form of mean and standard deviation of the liver function indices (Aspartate aminotransferase, Alanine aminotransferase, alkaline phosphatase and bilirubin (total and direct)) were shown in Table 4. There was significant difference in AST of group II, III and IV when compared with control group (p<0.05) but no significant difference exist between group I and control group (p>0.05).

The result of this work also shows a significant difference in values of AST and ALT for all the test groups when compared with their corresponding values in the control group (p<0.05) with exception in AST values for group I in which no significant difference exist when compared to corresponding values in control group (p>0.05).

The values for ALP in group I, II and IV were found to be significantly different when compare to the corresponding values in control group (p<0.05) but those from group III were found to be significantly similar to those of control group as depicted in Table 4 respectively.

The values for total and direct bilirubin across the test groups found indicate a significant variation when compared to the corresponding values in control group (p<0.05) with exception for the values of total bilirubin in group II and IV (p>0.05) in which no significant difference exist when compared to their corresponding values in control group as shown in Table 4.

Renal Function Indices
The result for the renal function indices shows that, there were significant differences in the values of Na, K and chloride for all the test groups when compared to the corresponding value in control group (p<0.05) with exception for the values of Na and chloride from group IV and K from group I as shown in Table 5 respectively.

Histopathology of Liver and Kidney
The result for liver and kidney histology revealed that, there were no remarkable liver and renal damage for the liver and renal section from the group I, II and III that received mild doses of the extract but mild hepatocyte degeneration and renal tubule dilatation were detected in group IV that received the highest extract concentration.
Table 1: The quantitative phytochemical constituents of aqueous leaves extract of *Senna occidentalis*

<table>
<thead>
<tr>
<th>Phytochemicals (%)</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytate (%)</td>
<td>0.18±0.01</td>
</tr>
<tr>
<td>Alkaloids (%)</td>
<td>3.99±0.13</td>
</tr>
<tr>
<td>Tannins (%)</td>
<td>1.05±0.07</td>
</tr>
<tr>
<td>Flavonoids (%)</td>
<td>76.92±0.44</td>
</tr>
<tr>
<td>Saponins (mg/L)</td>
<td>13.17±0.04</td>
</tr>
</tbody>
</table>

Table 2: Effect of aqueous leaves extract of *Senna occidentalis* on organ body weight ratio in albino rats

<table>
<thead>
<tr>
<th>Organ</th>
<th>Control group (Normal saline)</th>
<th>Group I (25mg/kg)</th>
<th>Group II (50mg/kg)</th>
<th>Group III (100mg/kg)</th>
<th>Group IV (200mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>4.01</td>
<td>3.29*</td>
<td>3.30*</td>
<td>3.29*</td>
<td>2.96*</td>
</tr>
<tr>
<td>Kidney</td>
<td>0.74</td>
<td>0.67*</td>
<td>0.65*</td>
<td>0.70</td>
<td>0.67*</td>
</tr>
<tr>
<td>Spleen</td>
<td>0.46</td>
<td>0.41*</td>
<td>0.49*</td>
<td>0.36*</td>
<td>0.35*</td>
</tr>
<tr>
<td>Pancreas</td>
<td>0.38</td>
<td>0.32*</td>
<td>0.30*</td>
<td>0.32*</td>
<td>0.30*</td>
</tr>
<tr>
<td>Lungs</td>
<td>2.06</td>
<td>1.13*</td>
<td>1.15*</td>
<td>1.04*</td>
<td>1.21*</td>
</tr>
<tr>
<td>Heart</td>
<td>0.48</td>
<td>0.41*</td>
<td>0.46</td>
<td>0.47</td>
<td>0.41*</td>
</tr>
</tbody>
</table>

Note: Values are expressed as mean of three determinations ±SD, * stance for significant difference from the control (p<0.05)

Table 3: Effect of aqueous leaves extract of *Senna occidentalis* on some Hematological parameters in albino rats

<table>
<thead>
<tr>
<th>Conc. of extract (mg/kg)</th>
<th>WBC x10^9/L</th>
<th>RBC x10^12/L</th>
<th>HCT %</th>
<th>PLT x10^9/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (25)</td>
<td>9.2±0.21*</td>
<td>4.6±0.04*</td>
<td>32.5±1.41*</td>
<td>374.5±4.95*</td>
</tr>
<tr>
<td>Group II (50)</td>
<td>9.7±0.74*</td>
<td>6.2±0.03*</td>
<td>42.7±0.64*</td>
<td>1214.5±0.70*</td>
</tr>
<tr>
<td>Group II (100)</td>
<td>10.9±0.54*</td>
<td>11.3±0.69*</td>
<td>66.2±1.69*</td>
<td>866.0±5.65*</td>
</tr>
<tr>
<td>Group IV (200)</td>
<td>11.9±0.08*</td>
<td>15.2±1.23*</td>
<td>93.0±0.14*</td>
<td>1350.0±7.07*</td>
</tr>
<tr>
<td>Control</td>
<td>3.2±0.21</td>
<td>8.4±0.03</td>
<td>63.6±0.78</td>
<td>942.5±0.71</td>
</tr>
</tbody>
</table>

Note: Values are expressed as mean of three determinations ±SD, * stance for significant difference from the control (p<0.05)
Table 4: Liver function indices for albino Rats administered with aqueous leave extract of *Senna occidentalis*

<table>
<thead>
<tr>
<th>Conc. Extract (mg/kg)</th>
<th>AST (U/L)</th>
<th>ALT (U/L)</th>
<th>ALP (IU/L)</th>
<th>Bilirubin Total (mg/dl)</th>
<th>Bilirubin Direct (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (25)</td>
<td>22.0±2.83</td>
<td>27.5±0.71*</td>
<td>34.0±1.41*</td>
<td>7.5±0.71*</td>
<td>2.75±0.35*</td>
</tr>
<tr>
<td>Group II (50)</td>
<td>25.0±0.07*</td>
<td>30.5±0.78*</td>
<td>34.5±0.71*</td>
<td>8.5±2.12*</td>
<td>3.02±0.24*</td>
</tr>
<tr>
<td>Group III (100)</td>
<td>29.5±3.54*</td>
<td>41.0±0.55*</td>
<td>46.0±1.41</td>
<td>10.5±0.71</td>
<td>3.5±0.71*</td>
</tr>
<tr>
<td>Group IV (200)</td>
<td>36.5±2.12*</td>
<td>43.0±0.71*</td>
<td>50.0±4.24*</td>
<td>12.0±0.99</td>
<td>3.5±2.12*</td>
</tr>
<tr>
<td>Control</td>
<td>22.9±0.14</td>
<td>69.5±3.54</td>
<td>46.0±5.66</td>
<td>10.5±2.12</td>
<td>1.2±0.28</td>
</tr>
</tbody>
</table>

Note: Values are expressed as mean of three determinations ±SD, * stance for significant difference from the control (p<0.05)

Table 5: Renal function indices for albino Rats administered with aqueous leave extract of *Senna occidentalis*

<table>
<thead>
<tr>
<th>Conc. Extract (mg/kg)</th>
<th>Sodium (mEq/L)</th>
<th>Potassium (mEq/L)</th>
<th>Chloride (mEq/L)</th>
<th>Bicarbonate (mEq/L)</th>
<th>Urea (mg/dl)</th>
<th>Creatinine (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (25)</td>
<td>156.5±3.53*</td>
<td>9.8±1.20</td>
<td>70.5±3.53*</td>
<td>8.55±0.071*</td>
<td>5.9±0.28*</td>
<td>25.8±2.12*</td>
</tr>
<tr>
<td>Group II (50)</td>
<td>160.5±0.71*</td>
<td>10.1±1.13*</td>
<td>69.0±1.41*</td>
<td>11.1±1.20*</td>
<td>5.25±0.071*</td>
<td>34.0±4.24*</td>
</tr>
<tr>
<td>Group III (100)</td>
<td>161.5±0.71*</td>
<td>10.6±2.40*</td>
<td>64.5±2.83*</td>
<td>10.65±4.9*</td>
<td>6.2±0.64*</td>
<td>30.3±0.71*</td>
</tr>
<tr>
<td>Group IV (200)</td>
<td>162±1.41</td>
<td>13.2±2.89*</td>
<td>65.5±0.71</td>
<td>8.1±1.06*</td>
<td>5.9±0.28*</td>
<td>42.5±7.07*</td>
</tr>
<tr>
<td>Control</td>
<td>164.5±0.71</td>
<td>9.7±0.21</td>
<td>65.5±2.12</td>
<td>12.5±0.71</td>
<td>5.5±0.50</td>
<td>25.1±0.07</td>
</tr>
</tbody>
</table>

Note: Values are expressed as mean of three determinations ±SD, * stance for significant difference from the control (p<0.05)
Discussion
The results of the phytochemical screening, organ body weight ratio, hematology, biochemical and histopathological analysis of the aqueous leave extract of *Senna occidentalis* are described. The result of the phytochemical analysis of aqueous leave extract of *Senna occidentalis* revealed the presence of the following constituents; alkaloids (4%), tannins (1.1%), flavonoids (76.9%), saponins (13.2%) and phytate (0.2%). In primary healthcare system, the use of traditional medicine especially in rural and developing states for the curing of disease plays an important role because of the general belief that, herbs are natural and are always safe (Seyyed et al., 2015). The oral consumption of any herbal preparation for the sake of curing any aliment without any proper prescription coupled with limited scientific studies on the safety of the traditional medicine raises a strong concern on their possible toxicity (Saad et al., 2006).

The leaves extract is rich in some phytochemicals which may be responsible for its used in treating diseases and that, at low concentration, the aqueous leave extract does not cause any toxic effect on the organs and tissues of the albino rats used. These phytochemicals; alkaloids, tannins, flavonoids, saponins and phytate couldaccount for the traditional use of the extract in managing some diseases. This finding is supported by the fact that, alkaloids and their synthetic derivatives are used as anti-analgesic, antimalarial, antiseptic as well as anti-bacteria (Evans, 2002). The finding is also in line with the fact that, saponins are used as antifungal and antibacterial (Okwu and Emenika, 2006). Therefore, the presence of alkaloids, saponins, flavonoids and tannins in the

![Liver and Kidney histology](image)

Figure 1: Effect of aqueous leaves extract of *Senna occidentalis* on the histology of liver and kidney of the albino rats
aqueous extract of *Senna occidentalis* can qualify the extract to have natural antibiotic (Dimaro *et al*., 2007), as well as anti-inflammatory properties (Quiroga *et al*., 2001).

The organ body weight ratio is defined as the ratio of the organ weight to that of the body weight of the organism. This ratio gives an idea of whether the extract administered interact with the various organs favorably or unfavorably. The result of the organ body ratio revealed a gradual decrease in the ratio with increase in extract concentration. This may be as a result of unfavorable interaction (cellular constriction and inflammation) of the extract or its component with the respective organs. This result is not in agreement with the fact that, aqueous leave extract of *Passiflora edulis* posed no any effect on the ratio in experimental animals (Devaki *et al*., 2012; Schmidst *et al*., 2007)

The effect of aqueous leaves extract of *Senna occidentalis* on WBC, RBC, HCT% and PLT counts of albino rats were studied. The result reveals a significant increase in all the parameters determined with increase in the concentration of the extract administered as compared to the control group. These clearly indicate that, the aqueous leave extract may possess component that stimulates the hemopoiesis in the albino rats. The rate of stimulation increases in dose-dependent manner. The result is not in line with that reported by Appidi *et al.* (2009) that, oral administration of aqueous leave extract of *Hermania incana* results in mild decrease in some hematological index in rats. Some aqueous leave extract of such as *Passiflora edulis* produce no any change in hematological parameters of rats (Devaki *et al*., 2012).

The results of the effect of various concentrations of the extract on liver function parameters indicated no significant difference in the value of AST in group I that received 25mg/kg extract as compared to the control group. However, there was significant decrease in the values of ALT, ALP and bilirubin as compared to these values from the control group. The values for all the liver parameters studied were found to increase in a dose-dependent manner. Therefore, at low concentration, the extract posed no any toxicity to liver. The increases in these values correspond to the increase in membrane permeability of the liver caused by the toxicant. These result are in line with the fact that, liver toxicity may lead to a compromised membrane integrity (Yakubu *et al*., 2003). The compromised membrane integrity may also have negative effect on the metabolism and regulation of amino acid by liver. The elevated levels of ALP with extract concentration may also be due to the fact that the extract may possess component that can stimulate the enzyme synthesis in the liver (Emelike and Dapper, 2013). The significant increase in total and direct bilirubin in comparison with control is due to reduction of its uptake by the liver arising from the toxicity of the extract at high doses. This is in line with the fact that liver damage may impaired its function (Ashafa *et al*., 2010). The result of liver function test is generally in conformity with the fact that, the liver markers may tend to increase due to toxic effect of high dose of aqueous *Hibiscus sabdariffa* extract (Yakubu *et al*., 2001).
The kidneys play a vital role in body homeostasis and are primary to the excretion of waste products of metabolism. The regulation of intracellular volume, electrolyte and acid-base balance depend solely on kidneys (Orisakwe et al., 2003), therefore, toxic insult of the kidneys could affect the total body metabolism (Goldstein et al., 1999). The result of the possible effect of oral administration of aqueous leave extract of Senna occidentalis was shown on Table 5, which reveals that, there was significant change in serum levels of sodium, potassium, bicarbonate and chloride as well as creatinine and urea as compared to that of control group. The assessment of the effect of the oral administration on the level of the excretory metabolites such as the electrolytes, urea and creatinine can aid in evaluating the integrity of the kidney functions (Adebayo et al., 2003; Yakubu et al., 2003). Creatinine is a hydrolysed product of creatine phosphate and its serum level is widely used to assess renal function while urea is a nitrogenous waste product of protein and amino acid metabolism which can also be used as marker for renal function test (Adedapo et al., 2009). The significant increase in the serum levels of creatinine and urea at high concentration of the extract indicate a significant change as compared to the control group. These suggest that, the integrity of the kidney is compromised by administering high dose of the extract and the result is in line with the result reported by Orisakwe et al. (2004) and Abubakar et al. (2010).

The result of the present stud reveals a significant decrease in the level of serum sodium in the groups that receives the various doses of the extract as compared to that for the control group. These suggest that, the extract may possess component that stimulate the function of the sodium pump and the extract do not contribute to the serum sodium level. This result did not agree with the report by Adigun et al. (2006) that, aqueous extract of Hibiscus sabdariffa is rich in sodium ion, implying that, rats consuming the Hibiscus sabdariffa may be increasing their oral sodium load and hence the plasma level.

The serum potassium level increases significantly with increase extract concentration administered as compared to that from the control group. This is in contrast with report on aqueous Hibiscus sabdariffa by Ukoha et al. (2015), the serum potassium in rat decreases following the oral administration.

The significant increase in serum level of chloride and bicarbonate following the administration of aqueous leave extract of Senna occidentalis at various high doses may be a sign of tubular and glomerular dysfunction. This observation is in line with the report of Ukoha et al. (2015) that, serum chloride and bicarbonate increase with increase in doses of Hibiscus sabdariffa in rats.

The result of the effect of oral administration of various doses of aqueous leaves extract of Senna occidentalis for a period of four weeks on liver and kidney tissues was assessed using the general tissue structure studies (H and E) and the result was shown on Figure 6. It revealed that, there was no much changes in the features of the liver and the kidney at low concentration of the extract, little changes were detected at high extract concentration. The result is in conformity with
the report of Seyyed et al. (2015) that, aqueous extract of *Asafarida* caused little degenerative changes in hepatocyte but no prominent effect on the kidneys tissues of the rats. This is also in agreeeth with Ukaho et al. (2015), that chronic consumption of aqueous *Hibiscussabdariffa* calyx might be toxic to kidneys of the rats.

**Conclusion**
The study of the toxicological effect of oral administration of aqueous leaves extract of *Senna occidentalis* on organ body weight ratio, some hematological, biochemical and histopathological parameters of male albino rats for a period of four weeks reveals that, at low concentration no pronounced toxic effect was detected on the rats. Administration of high concentration of the extract may cause some toxicity to the animals and that; the extract seems to stimulate the rate of blood formation by the rats.

**Competing interests**
The author hereby declared that, no competing interest exists.
References


