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Effects of Aqueous Extract of *Khaya senegalensis* Stem Bark on Biochemical and Hematological Parameters in Rats

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ABSTRACT

In this study, the effects of aqueous extract of *Khaya senegalensis* stem bark on hematological and biochemical parameters were investigated in rats. The rats were randomly divided into four groups of 5 rats per group. Group I (control) received normal saline while Groups II, III and IV were fed 50, 100 and 200 mg kg^{-1} of *Khaya senegalensis* stem bark extract orally for 21 days. Repeated administration of the extract resulted in a dose-dependent increase in total protein, globulin, urea and creatinine. The extract also produced an increase in the plasma levels of some liver enzymes namely Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and Alkaline Phosphatase (ALP). These changes were significant ($p<0.05$) with 100 and 200 mg kg^{-1} of the extract. At this same dose range, the extract caused a significant decrease in Red Blood Cells (RBC), Packed Cell Volume (PCV) and Hemoglobin level (Hb). In contrast, serum sodium ion (Na^+) and potassium (K^+) ion concentrations were elevated following the administration of the extract but there were no significant changes in the serum chloride (Cl^-) and bicarbonate ions (HCO_3^-) concentrations. The results of this study suggest that prolonged use of aqueous extract of *Khaya senegalensis* stem bark extract may adversely affect vital organs in the body.

Key words: *Khaya senegalensis*, assay, electrolytes, hemolytic, toxicity, creatinine

INTRODUCTION

The use of medicinal herbs in traditional system of medicine is a common practice in many cultures around the world, especially in African society. This practice has gained widespread acceptance in developing as well as in developed nations. Researchers are also beginning to appreciate the role of medicinal plants in health care delivery. This is as a result of the effectiveness, low cost and the availability of these herbal medicines (Tiwari *et al*., 2004). It is noteworthy that some orthodox medicines in use today were developed from the biochemical templates obtained from medicinal plants (Falodun, 2010). However, the widespread use and popularity of herbal medicines do not guarantee their efficacy and safety (Shafaei *et al*., 2011). Therefore, there is the need for detailed scientific analyses of and adequate information on the toxicity of commonly used herbal drugs (Nevin and Vijayammal, 2005). The way to determine the safe or unsafe use of a medicinal plant is the assessment of how it affects hematological and biochemical parameters (Akpanabiatu *et al*., 2005; Aboderin and Oyetayo, 2006). Changes from

normal physiological levels of these parameters after administration of a chemical agent to experimental animals is an indication of adverse effects of such agent on living organisms (Cheesborough, 1991). For example, an increase in the levels of liver enzymes such as Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and Alkaline Phosphatase (ALP) suggests liver injury. In general, the extent of damage to the organ is directly proportional to the degree of activities of the enzymes (Aliyu *et al*., 2007a). In the same vein, effects of drugs on the kidney can be assessed by determining serum levels of creatinine and urea.

Khaya senegalensis (Desr.) is a medicinal plant that is widely used to treat various diseases in Nigeria and other West Africa countries. It belongs to the family Meliaceae (mahogany family). The Nupes of Niger state of Nigeria especially value the tree for its medicinal uses. The stem bark extract is used for treating jaundice, malaria, dermatoses and hookworm infections (Gill, 1992). The ethanolic crude extract of the stem bark of *Khaya senegalensis* has been reported to possess free radical scavenging activity (Lompo *et al*., 2007). The seeds and leaves are also used to treat fever and headache while the root extract is used to treat mental illness, leprosy and syphilis (Maydell, 1986). Although *Khaya senegalensis* is of such great medicinal value, information on its effects on hematology and biochemical parameters is very scanty. In this study, we investigated the effects of *Khaya senegalensis* stem bark aqueous extract on these parameters in rats.

MATERIALS AND METHODS

Plant materials: Dry stem bark of *Khaya senegalensis* was purchased in the month of September from Bodija market, Ibadan, Nigeria. It was identified and authenticated at the Department of Botany, University of Ibadan, Nigeria and voucher specimen was deposited in the herbarium of the Department. The study was conducted between September and November, 2010.

Experimental animals: Healthy wistar rats weighing between 150 and 200 g were obtained from the Laboratory Animal House, College of Health Sciences, Ladoke Akintola University of Technology, Osogbo, Nigeria. They were kept in rat cages in a well ventilated and hygienic laboratory environment. The rats were allowed access to standard feed pellets and clean water *ad libitum*. All experimental protocols were in compliance with Ladoke Akintola University of Technology Ethics on Research in Animals as well as internationally accepted principle for laboratory animal use and care.

Extraction procedure: The dry stem bark of *Khaya senegalensis* were cut into small pieces and pulverized into fine powder using a grinding machine. 300 g of the powder sample was soaked in 750 mL of distilled water for 48 h. Thereafter the solution was filtered and the filtrate was evaporated in an oven at 40°C to produce a dark brown residue. With reference to the powdered sample, the yield of the extract was 10.0%.

Experimental procedure: Twenty albino rats were used for the study. They were randomly divided into 4 groups of 5 rats each. Group I served as the control and received normal saline (5 mL kg^{-1}). Groups II, III and IV were treated with 50, 100 and 200 mg kg^{-1} of the extract, respectively for 21 days. All drugs were administered orally.

Blood sample collection: Rats were anaesthetized in a glass chamber containing cotton wool soaked in diethyl ether and blood samples collected by cervical decapitation into clean lithium

heparin bottles. The blood samples were centrifuged for 5 min and the supernatant plasma was subsequently used for the assay of biochemical parameters. Whole blood was used for hematological assays.

Biochemical and hematological assays: Total protein was estimated by Randox kit formulated for Biuret reaction while hemoglobin concentration was measured using cyanomethemoglobin method (Ramnik, 1999). Albumin was measured by colorimetric estimation using the Sigma Diagnostic albumin reagents (Sigma® Diagnostic, U.K). Packed Cell Volume (PCV) of each sample was determined using Hawskley microhematocrit centrifuge at 12000 g for 5 min (Dacie and Lewis, 1984). Globulin was calculated as the difference between total protein and albumin. Red blood cell and white blood cell counts were estimated using the improved Nuebauer hemocytometer (Dacie and Lewis, 1984). Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and Alkaline Phosphatase (ALP) were determined using spectrophotometric method as described by Toro and Ackermann (1975). Plasma potassium ion (K^+) was measured using sodium tetraphenylboron-formulated reagent (Tietz, 1976). The precipitation method described by Henry (1974) was used to determine sodium ion (Na^+) concentration. Chloride ion (Cl^-) was measured by titration method of Ramnik (1999) and bicarbonate ion (HCO_3^-) was measured by the method of Ochei and Kolhatkar (2003). Serum urea and creatinine levels were determined as described earlier (Toro and Ackermann, 1975). Serum bilirubin was estimated colorimetrically using assay kit obtained from BioAssay Systems, USA (Garber, 1981).

Statistical analysis: All data were expressed as Mean±SEM and statistically analyzed with the Student's t-test at 95% confidence limit.

RESULTS

The effects of administration of various doses of aqueous extract of *Khaya senegalensis* on biochemical parameters, hematological parameters and electrolyte levels are presented in Table 1-3. Administration of the extract for 21 days resulted in a dose-dependent increase in total protein, globulin, creatinine, urea and the liver enzymes (ALT, AST and ALP). 100 and 200 mg kg^{-1} of the extract produced statistically significant increase ($p<0.05$) in these parameters (Table 1). Creatinine level significantly increased from 88.30±6.82 to 109.27±3.81 (mmo L^{-1}) while

Table 1: Effect of *Khaya senegalensis* on biochemical parameters

	Dosage groups (mg kg^{-1} body weight)			
Parameters	Control	50	100	200
Total protein (mg dL^{-1})	6.24±0.86	8.40±1.05	9.16±1.20*	9.29±1.16*
Albumin (mg dL^{-1})	4.22±0.19	3.87±0.45	3.63±0.49	1.75±1.03*
Globulin (mg dL^{-1})	2.02±0.69	4.53±0.60*	5.53±0.71*	7.54±0.13*
Total bilirubin (mmol L^{-1})	0.46±0.39	0.48±0.26	0.72±0.74	0.95±0.66
Creatinine (mmol L^{-1})	88.30±6.82	89.55±1.62	92.34±2.21	109.27±3.81*
Urea (mmol L^{-1})	5.32±0.49	7.21±1.06	10.11±1.27*	14.90±1.09*
AST (IU L^{-1})	128.44±3.85	151.19±5.23	187.06±4.11*	198.50±4.73*
ALT (IU L^{-1})	63.04±1.12	66.21±2.82	79.33±4.50*	94.58±3.74*
ALP (IU L^{-1})	5.32±0.49	7.21±1.06	10.11±1.27*	14.91±1.09*

n = 5; *$p<0.05$ compared with the control

Table 2: Effect of *Khaya senegalensis* on hematological parameters

	Dosage groups (mg kg^{-1} body weight)			
Parameters	Control	50	100	200
RBC (×1012 L^{-1})	8.71±0.33	7.25±0.84	7.06±0.40	4.24±1.07*
WBC (×109 L^{-1})	14.24±0.82	14.68±0.79	14.83±1.20	15.87±1.38
PCV (%)	40.34±1.38	35.20±2.25	33.03±1.18*	28.79±1.51*
Hb (g dL^{-1})	14.96±1.16	11.28±1.20	8.13±1.61*	6.33±2.13*

n = 5; *p<0.05 compared with the control

Table 3: Effect of *Khaya senegalensis* on electrolyte levels

	Dosage groups (mg kg^{-1} body weight)			
Parameters	Control	50	100	200
Na^+ (mmol L^{-1})	135.51±1.60	137.21±1.42	142.33±1.46*	142.85±1.48*
K^+ (mmol L^{-1})	4.25±0.02	4.72±0.11	18.29±1.30*	21.31±2.85*
Cl^- (mmol L^{-1})	94.22±2.41	95.82±1.82	93.40±2.10	98.29±1.64
HCO_3^- (mmol L^{-1})	24.54±0.21	24.88±0.44	26.13±1.20	25.72±1.42

n = 5; *p<0.05 compared with the control

urea increased from 5.32±0.49 to 14.90±1.09 (m mol L^{-1}). Aspartate Aminotransferase (AST) significantly increased from 128.4±3.85 to 198.5±4.73 and Alkaline Phosphatase (ALP) increased from 5.32±0.49 to 14.91±1.09. Also, the extract caused a dose-dependent significant decrease ($p<0.05$) in Red Blood Cells (RBC), Hemoglobin (Hb) and Packed Cell Volume (PCV). The reduction in PCV was from 40 to 28%. There was no significant change ($p>0.05$) in the value of white blood cells (Table 2). Extract administration also caused significant changes in the levels of sodium and potassium ions but no significant change was observed in the levels of chloride and bicarbonate ions (Table 3). Sodium ion (Na^+) increased from 135.5±1.6 to 142.8±1.48 while potassium ion (K^+) significantly increased from 4.25±0.02 to 21.31±2.85 (m mol L^{-1}).

DISCUSSION

Alterations in the plasma total protein (Table 1) is usually due to a decrease in the quantity of albumin which may be accompanied by an increase in the level of globulin as observed in this study (Adedapo *et al.*, 2009). The rise in globulin level in this case may suggest that the extract has the potential to boost the immune system by promoting the production of immunoglobulins (Puri *et al.*, 1993). However, increase in total protein in blood may be the result of tissue damage. This is consistent with the results observed in other parameters investigated. Increase in creatinine and urea levels could be an indication of renal dysfunction (Aliyu *et al.*, 2007b). These results confirmed an earlier report on the effect of *Khaya senegalensis* on biochemical parameters (Adebayo *et al.*, 2003). There were also significant increase in the levels of AST, ALT, ALP and total bilirubin following the administration of the plant extract. AST and ALT are non-plasma specific enzymes involved in the deamination of aspartic acid and alanine respectively in the liver. The activity of aminotransferases in blood is generally low but there is usually a surge in their activity following trauma or necrosis of muscles. Elevation of these enzymes in blood is used as an indicator of tissue damage and altered membrane permeability (Satpal *et al.*, 2010). Therefore the significant increase observed in the levels of AST, ALT and ALP in this study suggests tissue damage in the experimental animals. Alkaline Phosphatase (ALP) is a marker enzyme for the plasma membrane

and endoplasmic reticulum. It is used to determine the integrity of plasma membrane (Akanji *et al*., 1993). Damage to liver, kidney, small intestine and bone may increase the level of ALP in blood (Adedapo *et al*., 2007). Marked elevation of ALP in this study suggests that the aqueous extract of *Khaya senegalensis* stem bark most likely caused tissue damage in the rats. The damage caused by the extract was also reflected in its effect on hematological parameters. Significant reduction was observed in red blood cells, packed cell volume and hemoglobin following the administration of 100 and 200 mg kg^{-1} body weight. This also confirmed the observation made by Sanni *et al*. (2005). In their study, they reported that the active principles of *Khaya senegalensis* could cause toxic effects. This is especially so when it is administered repeatedly as in the present study. Since an increase in plasma ALP indicates an increase in membrane permeability, this may explain the observed destruction of red cells. It also suggests that the plant extract could be hemolytic with prolonged use. The effects of aqueous extract of *Khaya senegalensis* on serum electrolytes showed that 100 and 200 mg kg^{-1} caused significant increase in the levels of sodium and potassium ions but there was no significant difference in the levels of chloride and bicarbonate ions when compared with the control. The observed increase in the levels of serum sodium and potassium ions in this work suggests the inability of the kidney to properly regulate these electrolytes as a result of renal dysfunction (Oboh and Olumese, 2008).

CONCLUSION

This study showed that repeated administration of aqueous extract of *Khaya senegalensis* stem bark may cause damage to vital organs like kidney, liver, heart and blood and adversely affect their functions. Therefore, it is suggested that further work should be carried out on the plant to isolate the pharmacologically active component.

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