

# Effects of *Sterculia setigera* Del. Stem Bark Extract on Hematological and Biochemical Parameters of Wistar Rats

Moses Z. Zaruwa<sup>1</sup>, Nne. I. Ibok<sup>2</sup>, Ibokabasi U. Ibok<sup>2</sup>, Emmanuel C. Onyenonachi<sup>2</sup>, C. Danchal<sup>3</sup>, Aisha G. Ahmed<sup>2</sup>, Maryam U. Ahmed<sup>1</sup> and Ismaila Y. Sudi<sup>1</sup>

<sup>1</sup>Department of Chemistry, Faculty of Science, Adamawa State University, Mubi, Nigeria. <sup>2</sup>Department of Science Laboratory Technology, Federal Polytechnic, Mubi, Nigeria. <sup>3</sup>Department of Laboratory Services, Federal Polytechnic, Mubi, Nigeria.

**ABSTRACT:** Africa is rich in a wide range of flora that are exploited as herbal medicines and remedies. Several diseases such as diabetes, diarrhea, dysentery and jaundice have been successfully managed using herbal medicines. Herbal decoctions or concoctions have been used as pain killers, antibiotics, and hematinics. This study evaluated the hematopoietic and biochemical properties of the stem bark of *Sterculia setigera* Del. in Wistar rats. Results showed that *S. setigera* decoction has copiously high tannin and cardiac glycoside levels. Ingestion of the decoction by rats over a 16-day period significantly ( $P < 0.05$ ) increased the body weights of rats by 22.4% in the *S. setigera*-treated group. Hematological profiles showed raised levels of red blood cells, hemoglobin, packed cell volume, mean corpuscular volume, mean cell hemoglobin, mean cell hemoglobin concentration, and platelets, while biochemical parameters showed lower levels of alanine aminotransferase and aspartate aminotransferase, and slight increase in albumin and TP levels. We posit that the results justify the use of the stem bark of *S. setigera* as a hematinic by traditional medical practitioners and show its relative safety. Further experiments are needed to evaluate its safety.

**KEYWORDS:** hematinic, tannin, *S. setigera*, stem bark, decoctions

**CITATION:** Zaruwa et al. Effects of *Sterculia setigera* Del. Stem Bark Extract on Hematological and Biochemical Parameters of Wistar Rats. *Biochemistry Insights* 2016;9 19–22 doi:10.4137/BCI.S36143.

**TYPE:** Original Research

**RECEIVED:** October 18, 2015. **RESUBMITTED:** August 17, 2016. **ACCEPTED FOR PUBLICATION:** August 19, 2016.

**ACADEMIC EDITOR:** Gabor Mocz, Editor in Chief

**PEER REVIEW:** Five peer reviewers contributed to the peer review report. Reviewers' reports totaled 805 words, excluding any confidential comments to the academic editor.

**FUNDING:** Authors disclose no external funding sources.

**COMPETING INTERESTS:** Authors disclose no potential conflicts of interest.

**COPYRIGHT:** © the authors, publisher and licensee Libertas Academica Limited. This is an open-access article distributed under the terms of the Creative Commons CC-BY-NC 3.0 License.

**CORRESPONDENCE:** moseszira@gmail.com

Paper subject to independent expert single-blind peer review. All editorial decisions made by independent academic editor. Upon submission manuscript was subject to anti-plagiarism scanning. Prior to publication all authors have given signed confirmation of agreement to article publication and compliance with all applicable ethical and legal requirements, including the accuracy of author and contributor information, disclosure of competing interests and funding sources, compliance with ethical requirements relating to human and animal study participants, and compliance with any copyright requirements of third parties. This journal is a member of the Committee on Publication Ethics (COPE).

Published by Libertas Academica. Learn more about this journal.

## Introduction

The rich floral biodiversity of Africa has provided herbal health practitioners with an impressive pool of natural pharmacy, which led to the prescription of herbal medicines for treatment, management, and/or control of several array of human ailments. The World Health Organization consultative group defined a medicinal plant as one which in single or more of its parts contains substances that can be used for therapeutic purposes, or which are precursors of useful drugs.<sup>1</sup>

In traditional African communities, majority of the population still use medicinal plants for observing primary health care.<sup>2</sup> Natural products derived from plants contain physiologically active principles that have been exploited in traditional medical practice over the years for the treatment of various ailments.<sup>3</sup> The use of *Sterculia setigera* Del. in the treatment of severe diarrhea,<sup>4,5</sup> dysentery,<sup>6</sup> and jaundice<sup>7</sup> has been reported by several researchers over the years. Replacement for already existing pain killers, hematinics and antibiotics are soughted for globally due to the cost of already existing drugs and its associated side effects.<sup>8</sup>

*S. setigera* is one of the plants used in traditional medicine. It is a member of the family Sterculiaceae, a multipurpose savannah tree with a wide ecological spread in tropical Africa. It is found mostly in the wild.<sup>9</sup> It is a deciduous plant that grows up to 40 feet high, with a smooth bark, and it peels off thin

scales to expose yellowish patches.<sup>10</sup> The plant *S. setigera* has been used in traditional medical practice by various communities in Africa.<sup>11</sup> The gum is used in the treatment of snake bites, leprosy, syphilis, coughs, bronchitis, and rickets and to manage insanity.<sup>12</sup> Previous reports indicated that *S. setigera* is used in the treatment of jaundice.<sup>5,7</sup> The plant is also used as a hematinic (blood booster) by traditional medical practitioners for postpartum women, people with symptoms of anemia, or those recuperating from one form of ailment or another.<sup>13</sup> Hamidu<sup>10</sup> reported that it contains active metabolites such as tannins, flavonoids, saponins, phenolics, and glycosides. Analyses of several parts of *S. setigera* for their nutritional composition revealed that the plant has high crude protein, fiber, amino acids, minerals, carbohydrate, and fat contents. It is rich in sodium, iron, zinc, and manganese and contains different types of essential vitamins (vitamins A, B1, B2, B6, B12, and E).<sup>14–16</sup> The aim of this research, therefore, is to study the effect of *S. setigera* aqueous extract on hematological parameters of Wistar rats.

## Materials and Methods

**Collection of *S. setigera* Del.** Stem bark of *S. setigera* Del. was collected at the Mubi Farm of Adamawa State University located along Mubi-Sahuda road. The specimen was identified by Prof. Mohammed Saquib of the Department of Biological



Science, Adamawa State University, Mubi, Nigeria. The stem bark was cut into small pieces and dried in an oven at 65°C. The dried sample was pulverized into a fine powder using an electric grinder and stored in air tight bottles until required.

**Preparation of plant extract.** From the dried powdered sample of *S. setigera* Del., 100 g was weighed and dissolved in 500 mL distilled water in a 1000-mL beaker by mixing using a hot magnetic stirrer at a temperature between 50°C and 60°C. The mixture was cooled to room temperature and filtered using muslin cloth. The filtrate was centrifuged at 2500 rpm for 10 minutes. The supernatant was collected and refiltered through Whatman No. 1 filter paper.

**Phytochemical screening of *S. setigera* Del.** Qualitative phytochemical screening of *S. setigera* Del. was carried out using standard methods.<sup>17,18</sup>

**Experimental animals.** Fifteen male adult Wistar rats weighing between 150 and 180 g were obtained from the animal house of Biochemistry Department, University of Maiduguri, Nigeria. The rats were acclimatized for two weeks to laboratory conditions and were fed food and water ad libitum. The rats were randomly distributed into three groups containing five rats per group.

#### Treatment of animals.

Group 1: The control group was fed with normal feed and drinking water.

Group 2: The B complex-treated group was fed with normal feed and administered B complex in solution (Emzor Pharmaceutical Industries Limited).

Group 3: This group was fed normal feed and drinking water, and 50 mg/kg body weight of aqueous stem bark extract of *S. setigera* was orally administered.<sup>19</sup> The administration of plant extract was done once daily between the hours of 8:00 and 9:00 am.

This research was conducted in accordance with Adamawa State University's guidelines on the use of animals for research.

**Animal weights and blood sample collection.** Each group was weighed after every 4-day interval for a period of 16 days. The mean weight was computed and recorded for each group. The rats were subjected to an overnight fast after which blood samples (1.0–2.0 mL) were collected from the animal tails into EDTA-containing bottles and were used for analysis.

**Hematological analysis.** Hematological analysis was carried out using an Automatic Haematology Analyser (Coulter®) as described by the manufacturer.

**Biochemical enzyme assay.** Enzymes such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST), total protein, albumin (ALB), and bilirubin were analyzed using VITROS DT 60, DTSC 11, DTE 11 device, model 2004 manufactured by Orthodox—Clinical Diagnostics.

**Statistical analysis.** All values are reported as mean ± SD and compared using one-way analysis of variance and further by Duncan multiple range test. Values were considered significant when  $P < 0.05$ .

## Results

The results of phytochemical screening of aqueous stem bark extract of *S. setigera* showed that the plant contained tannins copiously; cardiac glycosides were in moderate amount, while saponins and anthraquinones were in low concentration (Table 1).

The results showed significant ( $P < 0.05$ ) increase in body weight of Wistar rats after 16 days administration of aqueous stem bark extract of *S. setigera* compared to the control and B complex-treated group (Table 2). The body weights of rats treated with B complex increased by 22.56%, while the body weight of rats treated with aqueous *S. setigera* stem bark extract increased by 33.85% compared to the control group that increased by 13% only (Table 2).

The hematological profile of rats treated with aqueous stem bark extract of *S. setigera* showed that levels of hemoglobin (HGB), packed cell volume (PCV), mean corpuscular volume (MCV), mean cell hemoglobin concentration (MCHC), platelets (PLT), and NEUT were significantly higher ( $P < 0.05$ ) than those in both the control and B complex-treated rats. The B complex-treated group showed increase in the levels of red blood cells (RBCs), mean cell hemoglobin (MCH), and MCHC. White blood cell (WBC) count of the rats administered with the extract was not significantly different from that of the control. There was a significant decrease in the levels of neutrophils in both B complex and extract-treated groups when compared with the control (Table 3).

Table 4 shows the effect of aqueous stem bark extract of *S. setigera* in rat liver biomarkers (ALB, total bilirubin [TB], ALT, and AST) after 16 days of administration. There was negligible increase in ALT level (0.03%), while AST level decreased by 8.88%. The levels of serum ALB and TB for both vitamin B complex and aqueous stem bark *S. setigera*-treated group of rats increased slightly compared to the control groups.

## Discussion

*S. setigera* Del. stem bark aqueous extract revealed that the plant contained copious levels of tannins and saponins and

**Table 1.** Phytochemical analysis of stem extract of *S. setigera*.

PHYTOCHEMICALS	INFERENCE
Tannin	+++
Phlobatanin	–
Steroid	–
Saponin	+
Terpenoid	–
Flavonoid	–
Cardiac glycosides	++
Anthraquinone	+
Alkaloid	–

**Notes:** +++, highest concentration; ++, high concentration; +, low concentration; –, absent.

**Table 2.** Body weights of Wistar rats treated with *S. setigera* bark extract.

TREATMENT GROUP(S)	WEIGHTS (G)				
	DAY 1	DAY 4	DAY 8	DAY 12	DAY 16
No treatment (control)	192 ± 0.23 <sup>a</sup>	203 ± 1.23 <sup>a</sup>	207 ± 1.41 <sup>a</sup>	214 ± 1.03 <sup>a</sup>	217 ± 1.28 <sup>a</sup>
B complex	210 ± 0.51 <sup>b</sup>	223 ± 0.93 <sup>b</sup>	230 ± 0.99 <sup>b</sup>	214 ± 1.59 <sup>a</sup>	236 ± 1.27 <sup>b</sup>
<i>Sterculia setigera</i> aq. extract	210 ± 0.45 <sup>b</sup>	223 ± 0.33 <sup>b</sup>	248 ± 0.67 <sup>c</sup>	248 ± 1.97 <sup>b</sup>	257 ± 1.63 <sup>c</sup>

**Note:** Values with different superscript down the row are significantly ( $P < 0.05$ ) different.

moderate levels of anthraquinones and cardiac glycosides, which is in agreement with previous studies,<sup>10,11</sup> except for the absence of phenols and flavonoids observed in the present study. The presence of saponin (although in low concentration) is an important indicator and justifies the use of *S. setigera* in traditional medicine. This is due to the fact that saponin serves mainly as an important adjuvant in vaccines<sup>20</sup> and was previously reported to have shown hematopoietic properties.<sup>21</sup> Previous studies showed that the bactericidal properties of plants are attributed to the presence of active secondary metabolites such as alkaloids, flavonoids, and saponins.<sup>22–24</sup> The absence of phenols and flavonoids in the present study could be attributed to the fact that aqueous stem bark extract of *S. setigera* Del. was used as against methanolic leaf extracts used in the previous work by Hamidu.<sup>10</sup> The variations in bioactive metabolites of the same plant could also be attributed to the difference in their habitat.<sup>25</sup> The absence of flavonoids in the stem bark extract of *S. setigera* Del. was also reported by Tor-Anyiin et al.<sup>11</sup> However, the use of organic solvents such as acetone, ethanol, methanol, and petroleum ether could be investigated further to confirm the presence of these phytochemicals for possible development of novel drugs.

The B complex group showed an increase of 98.7% in weight than the untreated group of rats (86.0%). There was an unexplained decrease in weight on day 8, but the rats quickly

regained their body weight by the 12th day. *S. setigera*-treated animals consistently gained weight all through the experiment.

Tor-Anyiin et al.<sup>11</sup> opined that these constituents may be responsible for the biological properties observed. Increase in body weight is an indication that the extract contains nutrients that are properly digested and utilized by the body.

The study showed that both *S. setigera* aqueous stem bark extract and B complex elicit an increase in the level of hematological profiles in white Wistar rats with *S. setigera*, showing a higher hematological effect. B complex has been previously reported to have hematopoietic-stimulating factor.<sup>26</sup> *S. setigera* aqueous stem bark exhibited a better hematological effect than B complex. The increase in PCV and its related indices by the extract is an indication that the extract contains phytochemicals that can stimulate the secretion of erythropoietin—a glycoprotein hormone that stimulates stem cells in the bone marrow to produce RBCs.<sup>27</sup> This may be attributed to the presence of saponin<sup>21</sup> and its richness in iron and vitamins.<sup>14–16,28</sup> Platelet is implicated in blood clotting and plays a crucial role in reducing blood loss and repair of vascular injury.<sup>29</sup> The significant increase in platelet concentration by the plant extract indicates that it contains principles capable of stimulating the biosynthesis of blood clotting factors.<sup>30</sup> The major functions of WBCs and its differential are to fight infections, defend the body by phagocytosis against invasion by foreign bodies or toxins, and produce or at least transport/distribute antibody in immune response. Insignificant difference in WBC count of the control group and *S. setigera* bark extract-treated group suggests that the plant does not possess toxins.

The results of 16 days' evaluation of liver enzymes function showed negligible changes in both B complex and *S. setigera* groups, indicating that it has no observable adverse

**Table 3.** The hematological profile of rats after administration of the aqueous bark extract of *S. setigera*.

	1	2	3
RBC ( $\times 10^6/\mu\text{L}$ )	7.1 ± 0.51 <sup>b</sup>	6.5 ± 0.72 <sup>a</sup>	7.5 ± 0.56 <sup>b</sup>
HGB (g/dl)	5.6 ± 0.07 <sup>a</sup>	5.9 ± 0.09 <sup>a</sup>	6.6 ± 0.11 <sup>b</sup>
PCV (%)	36.0 ± 0.78 <sup>a</sup>	38.7 ± 1.89 <sup>b</sup>	48.8 ± 1.51 <sup>c</sup>
MCV (fl)	56.3 ± 2.51 <sup>a</sup>	71.8 ± 3.13 <sup>b</sup>	74.7 ± 3.59 <sup>b</sup>
MCH (pg)	14.0 ± 1.81 <sup>a</sup>	16.1 ± 2.55 <sup>b</sup>	15.1 ± 1.54 <sup>b</sup>
MCHC (g/dl)	41.1 ± 2.34 <sup>a</sup>	46.6 ± 2.66 <sup>b</sup>	61.8 ± 3.01 <sup>c</sup>
PLT ( $\times 1000$ )	1203 ± 3.82 <sup>a</sup>	1491 ± 4.34 <sup>b</sup>	1629 ± 4.45 <sup>c</sup>
WBC ( $\times 10^9/\text{L}$ )	5.4 ± 0.01 <sup>a</sup>	6.3 ± 0.05 <sup>c</sup>	5.6 ± 0.08 <sup>a</sup>
LYM (%)	64.4 ± 3.07 <sup>a</sup>	67.3 ± 3.52 <sup>b</sup>	66.9 ± 2.61 <sup>b</sup>
NEUT $\times 10^3/\text{UI}$	10.3 ± 2.11 <sup>c</sup>	5.1 ± 2.64 <sup>a</sup>	6.5 ± 1.91 <sup>b</sup>

**Notes:** Values with different superscript across the column are significantly ( $P < 0.05$ ) different. Group(s) 1: control, 2: B complex, 3: *S. setigera* aq. extract treated, respectively.

**Table 4.** Biochemical parameters of rats' liver after the administration of the aqueous extract of *S. setigera*.

GROUP(S)	ALT (U/L)	AST (U/L)	ALB (g/dl)	TB (g/dl)
1.	70.8 ± 3.71 <sup>a</sup>	74.2 ± 3.71 <sup>b</sup>	4.1 ± 0.01 <sup>a</sup>	0.8 ± 0.03 <sup>a</sup>
2.	71.4 ± 2.96 <sup>a</sup>	73.4 ± 3.40 <sup>b</sup>	4.4 ± 0.02 <sup>a</sup>	1.0 ± 0.01 <sup>b</sup>
3.	68.3 ± 4.48 <sup>a</sup>	71.8 ± 2.56 <sup>a</sup>	4.4 ± 0.02 <sup>a</sup>	0.9 ± 0.01 <sup>b</sup>

**Notes:** Values with different superscript down the row are significantly ( $P < 0.05$ ) different. Group 1: control, 2: B complex, 3: *S. setigera* aq. extract treated, respectively.



effect on the liver function when taken at a controlled dosage. The effect of the extract on the levels of both serum ALB and bilirubin was insignificant. This is indicative that the extract poses no damage to the rat's liver and its use in traditional medical practice may pose no serious threat to the liver. However, 16 days only provide short-term safety evidence.

## Conclusion

This study showed that the aqueous stem bark extract of *S. setigera* elevated hematological parameters in rats and also showed insignificant change in the level of disease biomarkers tested. The dose effect of *S. setigera* stem bark extracts on both hematological and biochemical parameters may be further studied for possible therapeutic applications in the management of hematological-related disorders because its use by tradomedical practitioners is justified.

## Abbreviations

WBC, white blood cell; RBC, red blood cell; HGB, hemoglobin; PCV, packed cell volume; MCV, mean corpuscular volume; MCH, mean cell hemoglobin; MCHC, mean cell hemoglobin concentration; PLT, platelets; LYM, lymphocytes; NEUT, neutrophils; ALT, alanine aminotransferases; AST, aspartate aminotransferases; ALB, albumin; TB, total bilirubin.

## Acknowledgments

Our gratitude goes to the traditional medical practitioners who assisted us by way of information and good will during the research.

## Author Contributions

Conceived and designed the experiments: MZZ. Analyzed the data: All. Wrote the first draft of manuscript: ECO. Contributed to the writing of the manuscript: NII, IUI, ECO, CD, AGA, and MUA. Agreed with manuscript results and conclusions: All. Jointly developed the structure and arguments for the paper: IYS and MUA. Made critical revisions and approved the final version: MZZ. All the authors reviewed and approved the final manuscript.

## REFERENCES

- Sofowora A. *Medicinal Plants and Traditional Medicine in Africa*. 1st ed. Chichester, New York: John Wiley and Sons Ltd; 1982:142–146.
- Farnsworth NR, Akerele O, Birgel AS, Soejarto DD, Guo Z. Medicinal plants in therapy. *Bull World Health Organ*. 1985;63(6):965–981.
- Adebajo AO, Adewumi CO, Esseini EE. Anti-infective agent of higher plants. *International Symposium of Medicinal Plants*. 5th ed. Nigeria: University of Ife; 1983:152–158.
- Daziell JM. *The Useful Plants of Tropical West Africa*. London: The Crown Agents for the Colonies; 1948:611.
- Almagboul AZ, Bashir AK, Farank A, Salihu AKM. Antimicrobial activity of certain sudanese plant used in folkloric medicine: screening of antibacterial activity. *Fitoterapia*. 1995;56(6):331–337.
- Igoli JO, Ogaji OG, Tor-Anyiin TA, Igoli NP. Traditional medicine practice amongst the Igede people of Nigeria. Part II. *Afr J Tradit Complement Altern Med*. 2005;2(2):134–152.
- El-Kamali HH, El-Khalifa KF. Folk medicinal plants of riverside forest of the Southern Blue Nile District, Sudan. *Fitoterapia*. 1999;70:493–497.
- Lathan SP, Kannabiran K. Antimicrobial activity and phytochemicals of *Solanum trinobatum* linn. *Afr J Biotechnol*. 2006;5(23):2402–2404.
- El-Bassir AHA, Mohamed OM, Hamdin NI. *Sterculia setigera* seeds as food for tilapia fish (*Oreochromis niloticus*) finger lings. *Eur Acad Res*. 2015;3(2):1571–1586.
- Hamidu AA. Phytochemical constituents of the leaves of *Sterculia setigera*. *J Pharm*. 2012;2(1):062–064.
- Tor-Anyiin TA, Akpuaka MU, Oluma HOA. Phytochemical and antimicrobial studies on stem bark of *Sterculia setigera*, Del. *Afr J Biotechnol*. 2011;10(53):11011–11015.
- El-Khalifa AA. *Domestication of Sterculia setigera (L.) in Sudan* [Ph.D. Thesis]. University of Khartoum; 2007.
- Personal Contact. Made between Researcher and Tradomedical Practitioners; 2013.
- Adelakun KM, Mustapha MK, Ogundiwin DI, Ihidero AA. Nutritional and anti-nutrient composition of karaya gum tree (*Sterculia setigera* seed): a potential fish feed ingredient. *J Fish*. 2014;2(3):151–156.
- Ayodele JT, Alao OA, Olagbemi TO. The chemical composition of *Sterculia setigera*. *Niger J Anim Sci*. 2000;4(5).
- Idu M, Uzoekwe S, Onyigbe HI. Nutritional evaluation of *Sterculia setigera* seeds and pod. *Pak J Biol Sci*. 2008;11(1):139–141.
- Edeoga HO, Okwu DE, Mbaebie BO. Phytochemical constituents of some Nigerian medicinal plants. *Afr J Biotechnol*. 2005;4:685–688.
- Khan AM, Qureshi RA, Ullah F, et al. Phytochemical analysis of selected medicinal plants of Margalla hills and surroundings. *J Med Plant Res*. 2011;5(25):6017–6023.
- Prakash O. Antifertility investigation on embelin in rats from oral contraceptives of plant origin. part 1. Biological properties. *Plants*. 1981;41:259–266.
- Toma I, Karumi Y, Geidman MA. Phytochemical screening and toxicity studies of aqueous extract of the pop pulp of *Cassia sieberiana*. *Afr J Appl Chem*. 2001;3(2):026–030.
- Ufelle S, Neboh E, Ghasi S. Potential haematopoietic properties of crude methanolic seed extract of *Pentaclethra macrophylla* in Wistar rats. *Biokemistri*. 2015;27(27):22–25.
- Scher-Banvaskii JC. Rat rhesus Nikitskii. *Bot Sad USSR*. 1971;17:133–141.
- Leven M, Vanden Berghe DA, Marten I, Vilientnick A, Lomweas EC. Screening of higher plants for biological activity. *Planta Med*. 1979;36:311–312.
- Ebana RUB, Madunagu BE, Ekpe ED, Otung IN. Microbiological exploitation of cardiac glycosides and alkaloids from *Garcinia Kola*, *Boreria ocymoides*, *Kola nitida* and *Citrus aurantifolia*. *J Appl Bacteriol*. 1991;71:398–401.
- Elujoba A. Chemical and biological analysis of Nigeria *Cassia* species for laxative activity. *J Pharm Biomed Anal*. 1989;7(12):1457–1467.
- Ezeilo AC. *Text Book of Physiology*. New Delhi: Oxford University Press; 2002.
- Ohlsson A, Aher SH. Early erythropoietin for preventing red blood cell transfusion in preterm and/or low birth weight infants. *Cochrane Database Syst Rev*. 2006;3:CD004863. doi:10.1002/14651858.
- Lohar PS, Lohar MS, Roychoudhury S. Erythropoietic effect of some medicinal plants of India on experimental rat model. *Slovak J Anim Sci*. 2009;42:95–98.
- Oyedemi SO, Yakubu MT, Griesson DS, Afolayan AJ. Toxicological effects of the aqueous extract of *Strychnos henningsii* gilg in Wistar rats. *J Nat Pharm*. 2010;1:1.
- Adebayo OJ, Adesokan AA, Olatunji LA, Buoro DO, Soladoye AO. Effects of ethanolic extract of *Bouainvillea spectabilis* leaves on haematological and serum lipids variables in rats. *Biokemistri*. 2005;17:45–50.