Safety Evaluation of *Sphenocentrum jollyanum* on Heamatological Indices, Antioxidant Status and Organs in Normal Sprague Dawley Rats

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Abstract

Background: The high dosage of plant extracts has the potential to cause serious toxic effects, though they are of natural origin, it cannot necessarily be safe. **Objective:** To assess the safety of *Sphenocentrum jollyanum* stem consumption in the treatment of diseases. **Materials and Methods:** *Sphenocentrum jollyanum* was extracted with absolute ethanol, freeze dried and administered orally at 10mg, 100mg and 1000mg/kg (Acute: phase I) and 1600mg, 2900mg and 5000mg/kg body weight (Acute: phase II). The extract was administered through gastric gavage. In sub-chronic toxicity the extract was administered orally at doses ranging from 200 to 5000mg/kg. The survived animals (100 %), were euthanized, and blood collected for biochemical and haematological assessment, while the heart, liver, kidney and pancreas, were harvested for histopathological evaluation. **Results:** The acute toxicity show no sign of toxicity at 5000mg/kg body weight. In the sub-chronic toxicity, there were no significant ($p > 0.05$) changes in the red cell indices and white blood cell (WBC) count. There was a significant ($p < 0.05$) increase in platelets at the tested doses of extract. The total antioxidant capacity (TAC) in the treated animals was elevated when compared to control. At 200mg and 5000mg of extract there was significant ($p<0.05$) decrease in blood glucose. Histopathologically, the Kuffer cells of the liver were activated, while the kidney, heart and pancreas show normal microarchitecture. **Conclusion:** This study showed that the consumption of extract may not be harmful in this animal model.

Keywords: *Sphenocentrum jollyanum* extract, Rats, Antioxidants, Blood Glucose, Erythrocyte.

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Introduction

Sphenocentrum jollyanum Pierre (family *Menispermaceae*) popularly known as obanabe (Edo) or agbo akerejupo (Yoruba) in Nigeria, is a shrub native to the tropical forest zones of West Africa and thrives in deep shade. It is widely cultivated in Cameroun, Sierra Leone, Nigeria, Ghana, and Côte d'Ivoire (1). They are famous for a plethora of important biological functions. *Sphenocentrum jollyanum* is employed in folk medicine as a cure for wounds, fever, coughs, high blood pressure, breast tumor, rheumatism, constipation, and as an aphrodisiac. In Nigeria a decoction of the root is applied to dress tropical ulcers. A decoction of the leafy twigs is used as a wash to stop bleeding of wounds, sores and cuts; the wounds are also covered with the powdered bark. Ingestion of crushed leaves curbs spitting of blood (2). The fruit is consumed by the natives and used to treat tiredness. It is sometimes taken with lemon or the fruits of *Piper guineense* to cure

cough (3). Its pharmacological activities include anti-diabetic, anti-inflammatory, anti-bacterial, anti-viral, anti-malarial, angiogenic, and anxiogenic (4). There is paucity of information on the safety of the plant stem that is widely used by the natives , hence the need to evaluate possible adverse effects in normal rats

Materials and Methods

Plant material and extraction

Fresh root pieces of wild *Sphenocentrum jollyanum* were harvested from Usen forest, Edo State of Nigeria. Root pieces of the plant were identified and authenticated by a taxonomist, at the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria with a voucher number UBH-S449, and deposited at the Herbarium. Ethical approval for the study was obtained from the Ethical Board of the College of Medical Sciences, University of Benin, Benin City with REC Approval No: CMS/REC/2021/179. The roots were thoroughly washed, cut into small pieces and air dried. The plant roots were grinded into a uniform powder using a mechanical grinder (pulverization) and then soaked in absolute ethanol for 72 hours with intermittent stirring to allow for percolation and maceration (5). After 72 hours, the sample was filtered using two different sizes of filter. The filtrate was exposed to air in the laboratory for the solvent to evaporate. The slurred sample was freeze dried using (Coolsafe Superior Touch 95/55-80) freeze dryer. (The pulverized sample yielded 3200 g which was soaked in 12.5 litres of ethanol. The sample weighed 560 g after freeze drying). The freeze-dried sample was stored in the freezer at 4 ^{0}C ready for use.

Animals

Sprague Dawley rats were purchased from the Department of Anatomy, School of Basic Medical Sciences, University of Benin, Benin City, Nigeria. The rats [average body weight 190.49 ± 2.86 g] were housed in clean cages under standard laboratory conditions of temperature, humidity and light at the animal house, Department of Anatomy, School of Basic Medical Sciences, University of Benin, Benin City and had free access to standard laboratory diet and distilled water for a period of two weeks for acclimatization.

Pellet Ingredient Ingredient Commercially Available

Maize, Soybean meal, wheat offals, soy oil, salt, sodium bicarbonate, Limestone, dicalcium phosphate, bone meal, Di-methionine, c-lysine, L-threonine, choline chloride, vitamin/mineral premix, natural growth promoters, toxin binder, carbohydrases enzyme, and phytase enzyme.

Acute toxicity test

The evaluation of acute oral toxicity of *Sphenocentrum jollyanum* was carried out using Lorke's method (6). Fifteen (15) Sprague Dawley rats were used for this study and involved two phases; in phase I, there were three treatment groups with three rats per group as against control group that had distilled water. The extract was administered as follows: group I(normal rats that received distilled water),groups II, III, and IV were orally administered 10mg,100mg and 1000mg / kg body weight of ethanolic extract respectively in a single dose using gastric gavage. In phase II, there were three treatment groups of one animal each(group V,VI and VII), and were orally administered 1600 mg, 2900 mg and 5000 mg/kg body weight of extract respectively in a single dose using gastric gavage (6) .The animals were observed for mortality, signs of gross toxicity and behavioral changes one hour post dosing and at least once daily for 14 days. Body weights and feed intake were recorded before dosing and after the observation period.

Sub-chronic oral toxicity

Thirty (30) Sprague Dawley rats were used for this study and grouped according to sex and weight (average body weight 190.49 ± 2.86 g) into six groups as follows: group I (Normal rats + distilled water), group II (Normal rats + 200 mg/kg body weight of extract), group III (Normal rats + 500 mg/kg body weight of extract), group IV (Normal rats + 1000 mg/kg body weight of extract), group V (Normal rats + 3000 mg/kg body weight of extract), and group VI (Normal rats + 5000 mg/kg body weight of extract). Both control and test groups had five (5) rats per group. Test animals were administered doses of ethanolic extract of *Sphenocentrum jollyanum* ranging from 200 mg/kg body weight to 5000 mg/kg body weight. Control rats were given distilled water. Animals in all the groups were fasted overnight and observed for 10-20 min before the administration of extract. *Sphenocentrum jollyanum* extract was administered using an oral gastric gavage once a day (between 8.00 a.m. – 9.00 a.m.) for 28 days. The animals were observed for signs of toxicity and mortality daily throughout the experimental period. Daily oral administration of ethanolic *Sphenocentrum jollyanum* stem extract at 200 mg/kg body weight to 5000 mg/kg body weight, while the control rats had distilled water *ad libitum*. The animals were observed for signs of toxicity and mortality daily throughout the experimental period. Daily oral administration of ethanolic *Sphenocentrum jollyanum* stem extract at 200 mg/kg body weight to 5000 mg/kg body weight for 28 days did not induce any obvious symptoms of toxicity and mortality. On the 28th day, animals in control group and groups 1 –5 were fasted overnight, euthanized by decapitation and blood collected in appropriate tubes for biochemical and haematological assessments. Organs (pancreas, liver, heart and kidney) were collected and kept in containers containing 10% buffered formalin for histopathological evaluation.

Weekly Body Weight

The body weight of each rat in the groups were determined using a sensitive balance (EMS 3000-2-KERN) during the period of acclimatization. This enabled the animals to be grouped according to weight before commencing the dosing. The animals were weighed weekly, and on the day of sacrifice the weights were also determined.

Feed Consumption

The amount of feed consumed was measured daily by subtracting the feed remaining (left over) from the quantity supplied after a period of 24 hours using Grof technique (7).

Blood Glucose Test

Fasting blood glucose was determined in all groups using a glucometer (ACCU-Check, Roche, Germany) on day 0,7,14,21 and 28 using caudal vein blood samples. The glucometer was used according to the manufacturer's instructions

Haematological Parameters

White blood cell count, lymphocyte, monocytes, granulocytes, red blood cell (RBC), packed cell volume (PCV), haemoglobin (Hgb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and platelets were determined using an automatic blood analyzer (URIT-3010 Automated Haematology Analyzer, Gullin, Guangxi, China).

Histopathological examination

The organs (pancreas, liver, heart and kidney) were harvested and immediately submerged in 10 % buffered formalin for 72 hours. The tissues were subsequently processed, embedded in paraffin, sectioned (4 µm) and stained with haematoxylin and eosin (H &E) [8] prior to microscopic examination.

Statistical analysis

The biochemical and haematological data were expressed as mean ± standard error of the mean (SEM). The difference between

the groups was tested using ANOVA. Duncan's multiple range test was used to test for significant difference among the means ($p < 0.05$).

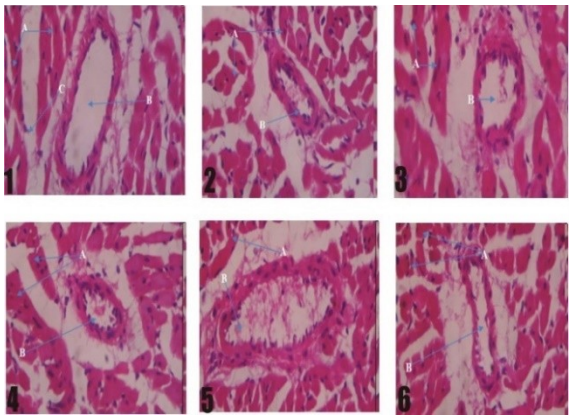
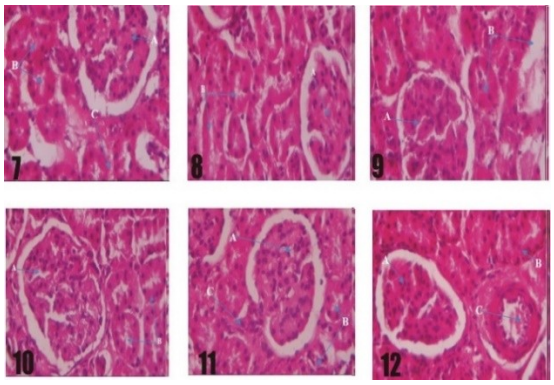
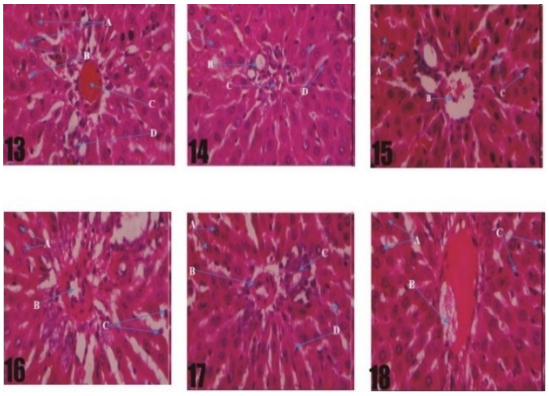


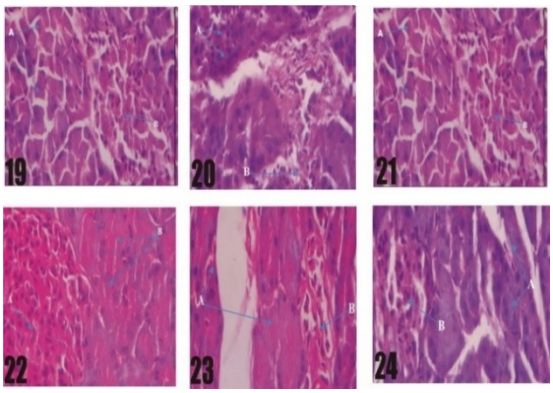
Figure 4. Photomicrograph of section of rat heart after 28 days of administration with the extract at doses of 200, 500, 1000, 3000, and 5000 mg/kg body weight (plates 1-6 respectively) as compared to the control (plate 1). There is normal myocardiac fibres (A), normal coronary vessel (B) and normal interstitial space (C). Sections were stained with H&E x 400 (plates 1-6).



Photomicrograph of section of rat kidney after 28 days of administration with the extract at doses of 200, 500, 1000, 3000, and 5000 mg/kg body weight (plates 7-12 respectively) as compared to the control (plate 7). There is normal glomerular (A), normal tubular microstructure (B), and normal vascular architecture (C). Sections were stained with H&E x 400 (plates 7-12).



Photomicrograph of section of rat liver after 28 days of administration with the extract at doses of 200, 500, 1000, 3000, and 5000 mg/kg body weight (plates 13-18 respectively) as compared to the control (plate 13). There is normal hepatocytes (A), normal portal vascular microarchitecture (B), and kuffer cell activation (C). Sections were stained with H&E x 400 (plates 13-18).



Photomicrograph of section of rat pancreas after 28 days of administration with the extract at doses of 200, 500, 1000, 3000, and 5000 mg/kg body weight (plates 19-24 respectively) as compared to the control (plate 19). There is normal acinar (A), and normal islets of Langerhans microarchitecture (B). Sections were stained with H&E x 400 (plates 19-24).

Results

In week one, there was a significant ($p<0.05$) increase in the body weight of animals in the groups administered 200 mg/kg, 500 mg/kg, 1000 mg/kg of extract when compared to control. Surprisingly, there were no significant ($p>0.05$) changes in the group of animals administered 3000

mg and 5000 mg of extract in weeks 2, 3 and 4 when compared to their respective controls (Table 1). There were no significant ($p > 0.05$) changes in the organ weights of animals treated with the different doses of extract when compared to the control (Table 2). Though there was no significant ($p > 0.05$) changes in the WBC of animals treated with the extract, however, its concentration increased steadily from 200 mg to 500 mg/kg body weight when compared to normal control. There was a significant ($p < 0.05$) increase in platelets count in all the tested doses when compared to the control animals (Table 3). There was a significant ($p < 0.05$) reduction in RDW-SD at 500 mg, 1000 mg and 5000 mg and MCV at 1000 mg when compared to the control group. While there was a significant ($p < 0.05$) decrease in MCH at 1000 mg of extract administered there was a corresponding significant ($p < 0.05$) increase at 3000 mg of extract (Table 4). There was no significant ($p > 0.05$) difference in Total antioxidant capacity (TAC) (Table 5). There was a significant ($p < 0.05$) decrease in glucose concentration at 200 mg, and 5000 mg of extract when compared to their respective controls (Table 6). There were no significant ($p > 0.05$) changes in the organ weights of animals treated with the different doses of extract when compared to the control (Figure 1). There is was a significant ($p < 0.05$) increase in the feed intake at 3000 and 5000 mg/kg body weight when compared to control. At 200 - 1000 mg/kg body weight there was significant ($p < 0.05$) decrease when compared to the control (Figure 2).

There was a significant ($p < 0.05$) increase in the body weight of animals in the groups administered 200 mg/kg, 500 mg/kg, 1000 mg/kg and 5000 mg/kg of extract when compared to control. Nevertheless, in we Herbal products traditionally have been used by the general public and traditional healers worldwide to treat various ailments and are considered non-toxic. Though Herbal extracts are of natural origin, however, they are not necessarily said to be safe. Plants contain chemicals that are active ingredients that perform the same function like those found in synthetic or orthodox drugs (9). They may be ineffective in low doses, highly beneficial in the right doses, but may be toxic or have adverse effects in high doses administered for a prolonged period. In this study, a comprehensive safety evaluation of ethanol extract of *Sphenocentrum jollyanum* was done by performing acute and sub-chronic toxicity studies in normal Sprague Dawley rats. The result obtained from the acute toxicity study showed that no animal died within 24 hours of the administration of the extract, the ethanol stem extract of *Sphenocentrum jollyanum* demonstrated high safety margin since the animals tolerated up to 5g/kg body weight of the extract orally. In toxicity rating by joint FAO/WHO Expert Committee on Food Additives (10), if at 2 g/kg oral dose no death occurred, it is sufficient to assume the substance to be non-toxic. The high safety margin through oral route justified its therapeutic use by the traditional healers.

In sub-chronic study, when the extract was administered daily to the animals for a period of 28 days, no mortality or morbidity was observed. There was significant weight gain in the treated animals when compared to control groups. This may be due to the animals ability to absorb, digest and assimilate the nutrients in the feed administered, hence the weight gain observed. The gross examination of internal organs revealed no detectable inflammation. According to reports, reduction in body and internal organ weights are considered sensitive indices of toxicity after exposure to toxic substance (11, 12)

Hematopoietic system has been reported to be one of the most sensitive targets for toxic substances (8). Hematological indices can be used to assess the degree of the deleterious effect of a plant extract on blood function of an animal (13). Moreover, significant changes in the hematological indices have been reported to have higher predictive value for human toxicity when data from animal investigations are extrapolated to human settings and situations (14).

In haematological evaluation of this study, There was an observed non-significant ($p<0.05$) increase in lymphocytes when compared with the control. Inflammatory process is characterized by the involvement of multiple inflammatory cells of the WBC (15). WBC and some of its indices such as lymphocytes usually show increase in activity in response to toxic environment (16). In this study, WBC was not significantly altered while lymphocytes, the main effectors cells of the immune system (17) showed marginal increase thus suggesting that the extract may have exerted minimal challenge on the immune system of the animals. The observed significant increase in platelets at 200 mg / kg to 5000 mg / kg of extract when compared to the control may be suggestive of the extract possessing hematopoietic potentials. There was significant ($p<0.05$) changes in mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) concentrations at 1000 mg and 3000 mg/kg body weight of extract respectively. Values of MCH typically mirror MCV results in the sense that small red blood cells have a lower MCH and large red blood cells have higher MCH. Interestingly, MCH most times increases and decreases with same conditions as MCV. The observed changes in this study may be as a result of any increase or decrease in the normal volume or size of a red blood cell, hence affecting oxygen transport. This study did not reveal any changes in HCT and Hb which implied the that the observed changes may be due to some physical or physiological changes in the group of animals administered 1000mg and 3000 mg of extract. RDW-SD is part of a standard complete blood count (CBC) in association with MCV it can be used to evaluate anaemia. The value of RDW-SD can be affected by the rat fragility and higher vulnerability to adverse outcomes. RDW-SD is a risk factor for cardiovascular diseases (18). The observed decrease in RDW at 1000 mg and 3000 mg of extract may be as a result of isolated physiological changes as the result was not consistent with the other concentrations administered to the animals.

This study showed that, there was no significant ($p>0.05$) difference in the Total Antioxidant capacity. However, it has been reported that the different parts of Sphenocentrum jollyanum have varied pharmacodynamics effect that include anti-inflammatory and antioxidant (19,1). The insignificant difference observed maybe as a result of shorter days of administration of the extract over a period of 28 days and may increase with extension of days. Nevertheless, there was a steady increase in the concentration of total antioxidant capacity which may have also confer some protection on the cells and tissues of the animals.

There was significant decrease ($p < 0.05$) at doses 200 mg / kg , 500 mg/kg, 1000 mg/kg and 5000 mg / kg of extract in blood glucose in the treated animals when compared to control ,the decrease in blood glucose levels in the treated animals demonstrated the presence of hypoglycaemic agents in the plant. This is in

agreement with reports from (20,21) of the plant to have anti-hyperglycaemic effect.

Histopathological examination of the pancreas of rats treated with ethanolic extract, showed well-formed islets and normal exocrine glands. The stained liver sections showed normal hepatocytes, normal ductal, portal vascular architecture and Kuffer cell activation across doses. A low dose of 200 mg activates kuffer cells more, boasting the immune system, at 500 mg dose of the extract dilates blood vessels more when compared with the control group. Kuffer cells represent an important component of innate immunity, the initial, rapid response to potentially dangerous stimuli (22). Localization of these components in the liver and the fact that Kuffer cells constitute 80–90% of tissue macrophages present in the body suggest a central role of the liver in systemic as well as regional defense. Hence, the consumption of the extract may boost the immunity of the people who use it to treat various illnesses. Histopathological examination of the kidney of rats treated with ethanolic extract, showed normal glomerular, normal tubular microstructure and vascular architecture, no toxic damage observed. Histopathological examination of the heart showed normal myocardiac fibres, coronary vessel and normal interstitial spaces. At 500 mg, doses of the extract showed more dilation, which implied that the tested dose may improve the patency of the blood vessels which could have health potential benefits.

Conclusion

The stem extract of *Sphenocentrum jollyanum* did not show any toxic potentials from our study. The extract demonstrated hypoglycaemic and luminal patency of the heart vessels hence, it probable benefits in health situations as revealed in an animal model.

Declarations

Acknowledgement

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Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. All authors read and approved the manuscript for publication.

Table 1: **Effect of ethanolic extract of *Sphenocentrum jollyanum* stem on weekly body weight of normal Sprague Dawley rats**.

Weeks	Control	200mg/kg	500mg/kg	1000mg/kg	3000mg/kg	5000mg/kg
1	117.22±10.35^{a}	165.46±6.55^{b}	157.98±6.48^{bc}	152.96±4.63^{bc}	126.98±4.98^{ad}	140.12±8.43^{cd}
2	151.82±12.66^{a}	201.36±8.73^{b}	194.10±6.10^{bc}	186.20±8.45^{bc}	145.72±8.79^{a}	167.28±14.06^{ac}
3	149.20±16.07^{a}	204.04±8.03^{b}	209.42±9.61^{b}	196.26±7.96^{b}	154.70±9.46^{a}	163.66±8.33^{a}
4	164.34±10.68^{a}	211.84±8.34^{b}	222.48±9.04^{b}	207.68±13.06^{b}	162.54±9.90^{a}	164.18±8.09^{a}

Values carrying superscripts different from the control are significantly different ($p< 0.05$; n=5 ± SEM of 5 replicates).

Table 2. **Effect of ethanolic extract of *Sphenocentrum jollyanum* stem on organ weight in normal Sprague Dawley rats.**

	Control	200mg/kg	500mg/kg	1000mg/kg	3000mg/kg	5000mg/kg
Heart	0.60±0.03[a]	0.64±0.02[a]	0.63±0.03[a]	0.72±0.02[a]	0.56±0.07[a]	0.58±0.04[a]
Pancreas	0.82±0.12[a]	0.84±0.04[a]	0.78±0.08[a]	0.80±0.05[a]	0.70±0.10[a]	0.62±0.11[a]
Liver	5.52±0.60[a]	6.06±0.22[a]	5.18±0.34[a]	6.16±0.56[a]	5.26±0.42[a]	4.84±0.37[a]
Kidney	1.14±0.16[a]	1.36±0.04[a]	1.43±0.09[a]	1.44±0.10[a]	1.42±0.17[a]	1.14±0.05[a]

Values carrying superscripts different from the control are significantly different ($p< 0.05$; n=5 ± SEM of 5 replicates).

Table 3. **Effect of oral administration of different doses of *Sphenocentrum jollyanum* stem extract on White blood cells, platelets and differentials in Sprague Dawley rats**

	Control (0 mg)	200mg/kg body wt.	500mg/kg body wt.	1000mg/kg body wt.	3000mg/kg body wt.	5000mg/kg body wt.
WBC (x10^6 U/L)	11.00±2.08[a]	16.34±3.82[a]	19.03±1.38[a]	14.78±1.30[a]	16.94±2.11[a]	19.02±1.88[a]
LYM (%)	72.34±1.44[a]	70.46±4.05[a]	73.63±1.67[a]	63.98±6.52[a]	77.40±2.26[a]	68.02±8.88[a]
MID (%)	7.06±0.69[a]	6.76±0.70[a]	7.80±0.69[a]	7.84±0.67[a]	6.66±0.36[a]	7.18±0.49[a]
GRAN (%)	20.60±1.14[a]	22.78±3.70[a]	18.58±1.14[a]	28.18±6.12[a]	15.94±1.94[a]	24.80±8.52[a]
LYM# (x10^9/L)	7.98±1.54[a]	10.96±2.41[a]	14.08±1.31[a]	9.54±1.45[a]	13.20±1.78[a]	13.42±2.43[a]
MID# (x10^9/L)	0.80±0.18[a]	1.22±0.35[a]	1.50±0.07[a]	1.16±0.14[a]	1.14±0.16[a]	1.34±0.11[a]
GRAN# (%)	2.22±0.41[a]	4.16±1.24[a]	3.45±0.17[a]	4.08±0.82[a]	2.60±0.29[a]	4.26±0.93[a]
PLT (x10^9/L)	291.00±56.56[a]	519.00±76.62[ab]	596.25±23.15[b]	569.80±37.61[b]	589.20±36.19[b]	619.60±56.67[b]
MPV(fL)	7.86±0.16[a]	7.58±0.59[a]	7.20±0.18[a]	7.22±0.05[a]	7.24±0.09[a]	7.06±0.16[a]
PDW (fL)	10.70±0.70[a]	8.88±1.28[a]	8.33±0.48[a]	8.10±0.14[a]	8.48±0.25[a]	8.02±0.18[a]
PCT (%)	0.22±0.04[a]	0.37±0.04[ab]	0.42±0.01[b]	0.41±0.03[b]	0.42±0.02[b]	0.43±0.04[b]
P-LCR (%)	0.50±0.37[a]	3.02±2.80[a]	0.20±0.20[a]	0.74±0.37[a]	1.58±0.79[a]	0.74±0.36[a]

Values carrying superscripts different from the control are significantly different ($p< 0.05$; n=5 ± SEM of 5 replicates).

Table 4. **Effect of oral administration of *Sphenocentrum jollyanum* stem extract on Red cell indices in Sprague Dawley rats.**

	Control	200mg/kg	500mg/kg	1000mg/kg	3000mg/kg	5000mg/kg
RBC (x10^12/L)	5.60±0.65^{a}	5.37±1.00^{a}	6.79±0.12^{a}	6.21±0.35^{a}	6.03±0.16^{a}	6.22±0.15^{a}
HGB (g/dL)	11.98±1.36^{a}	11.16±2.03^{a}	13.85±0.35^{a}	12.49±0.73^{a}	13.05±0.36^{a}	12.62±0.22^{a}
HCT (%)	35.94±4.07^{a}	33.48±6.09^{a}	41.55±1.06^{a}	37.46±2.19^{a}	39.16±1.06^{a}	37.86±0.65^{a}
MCV (fL)	64.46±1.36^{ab}	63.00±1.28^{abc}	61.15±0.70^{ac}	60.34±0.48^{c}	65.03±1.73^{b}	60.93±0.53^{ac}
MCH (Pg)	21.48±0.44^{a}	20.98±0.42^{abc}	20.38±0.23^{ac}	20.12±0.17^{c}	21.66±0.58^{b}	20.32±0.17^{ac}
MCHC (g/dL)	33.30±0.00^{a}	33.30±0.00^{a}	33.30±0.00^{a}	33.30±0.00^{a}	33.30±0.00^{a}	33.30±0.00^{a}
RDW-CV (%)	14.68±0.65^{a}	14.42±0.68^{a}	13.15±0.26^{a}	13.64±0.23^{a}	14.26±0.29^{a}	13.94±0.34^{a}
RDW-SD (fL)	42.84±0.96^{a}	40.74±1.15^{ab}	38.78±0.55^{b}	38.82±1.21^{b}	40.94±1.22^{ab}	37.90±0.54^{b}

Values carrying superscripts different from the control are significantly different ($p< 0.05$; n=5 ± SEM of 5 replicates).

Table 5: **Total Antioxidant Capacity (TAC) of ethanolic extract of *Sphenocentrum jollyanum* in the serum of Sprague Dawley rays.**

	Control	200mg/kg	500mg/kg	1000mg/kg	3000mg/kg	5000mg/kg
TAC	1.35±0.14^{a}	1.37±0.09^{a}	1.39±0.04^{a}	1.36±0.04^{a}	1.32±0.04^{a}	1.26±0.02^{a}

Values carrying superscripts different from the control are significantly different ($p< 0.05$; n=5 ± SEM of 5 replicates).

Table 6: Plasma glucose level of Sprague dawley rats treated with *Sphenocentrum jollyanum* ethanolic stem extract.

mg/dl	Control	200mg/kg	500mg/kg	1000mg/kg	3000mg/kg	5000mg/kg
Blood glucose (0)	53.60±2.29^{a}	63.20±3.15^{b}	52.20±1.50^{a}	47.40±1.60^{a}	54.80±3.40^{a}	77.20±2.78^{c}
Blood glucose (7)	54.20±2.82^{a}	50.80±2.08^{a}	52.40±2.38^{a}	52.20±3.89^{a}	57.40±3.17^{a}	53.20±3.15^{a}
Blood glucose (14)	46.20±2.75^{ab}	38.00±1.92^{a}	42.60±1.75^{a}	43.20±4.16^{a}	47.00±3.67^{ab}	56.60±6.65^{b}
Blood glucose (21)	55.20±2.08^{a}	67.80±1.62^{b}	59.60±0.75^{a}	54.40±3.04^{a}	57.80±3.65^{a}	53.80±1.32^{a}
Blood glucose (28)	52.20±2.27^{a}	54.80±3.76^{a}	52.00±3.65^{a}	60.20±6.02^{a}	60.40±1.72^{a}	52.40±1.25^{a}

Values carrying superscripts different from the control are significantly different ($p< 0.05$; n=5 ± SEM of 5 replicates).

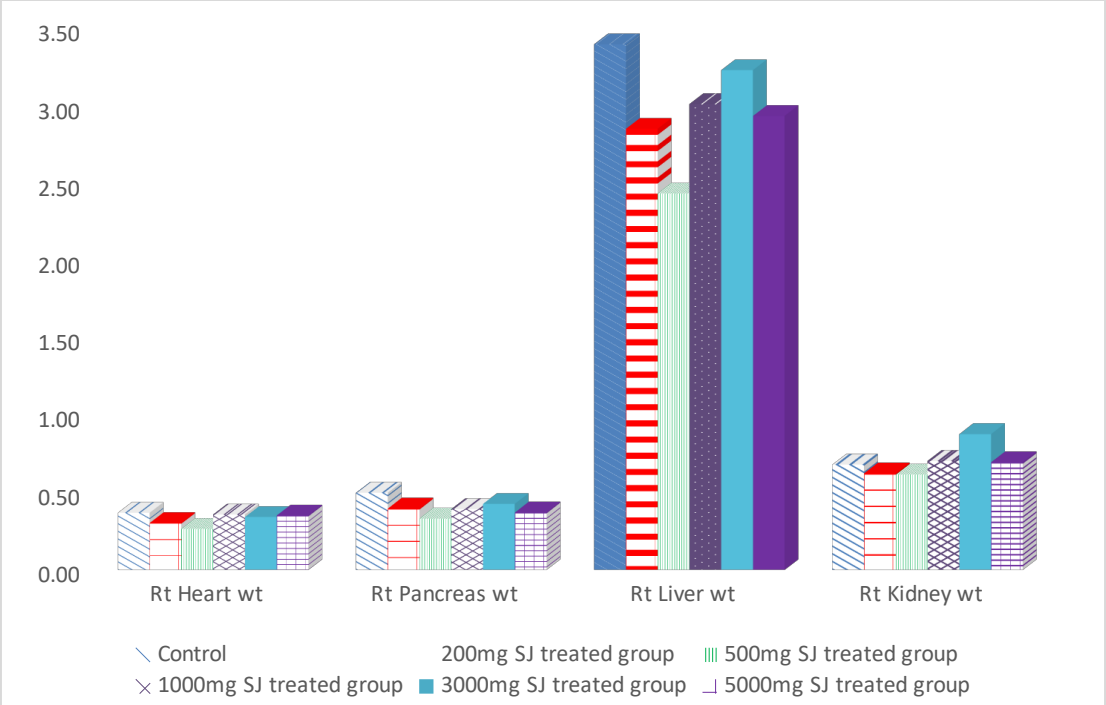

Figure 1: Relative organ weight following 28 days oral administrations of ethanolic extract of *Sphenocentrum jollyanum* were expressed as mean ± SEM. Values were not significantly different among the groups ($p > 0.05$).

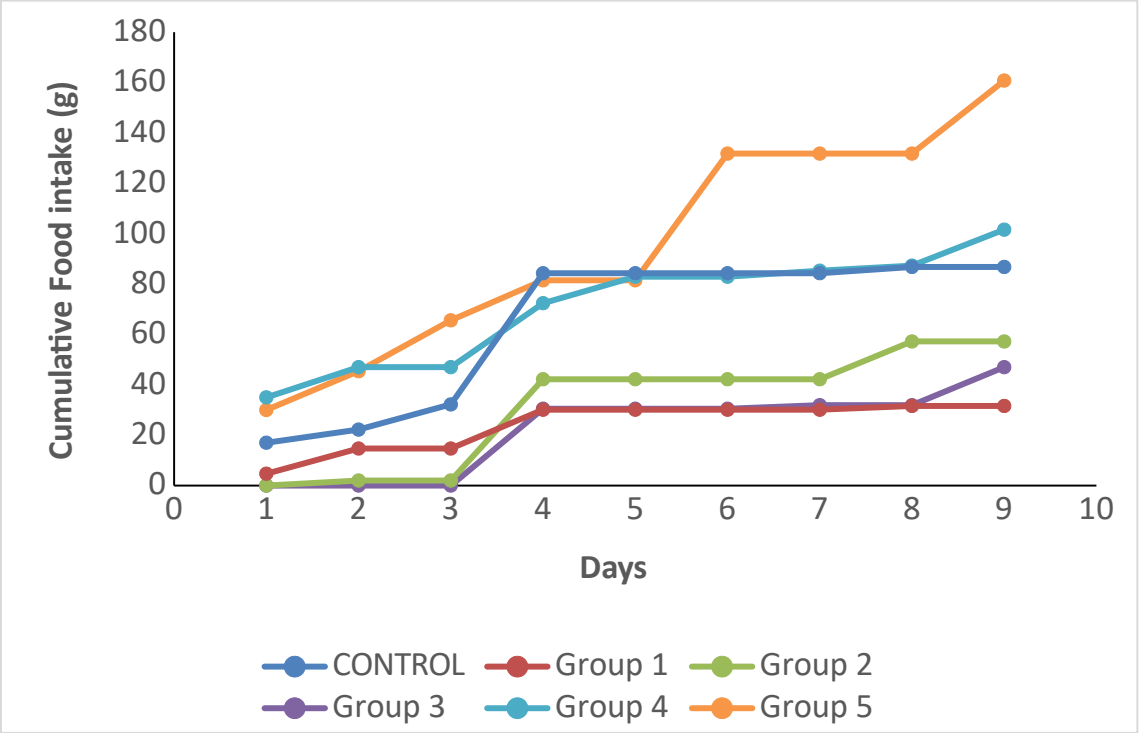

Figure 2: Effect of *Sphenocentrum jollyanum* ethanolic extract at 200, 500, 1000, 3000 and 5000mg/kg body weight on Feed intake were expressed as mean ± SEM; $p < 0.05$ is significant compared to control.

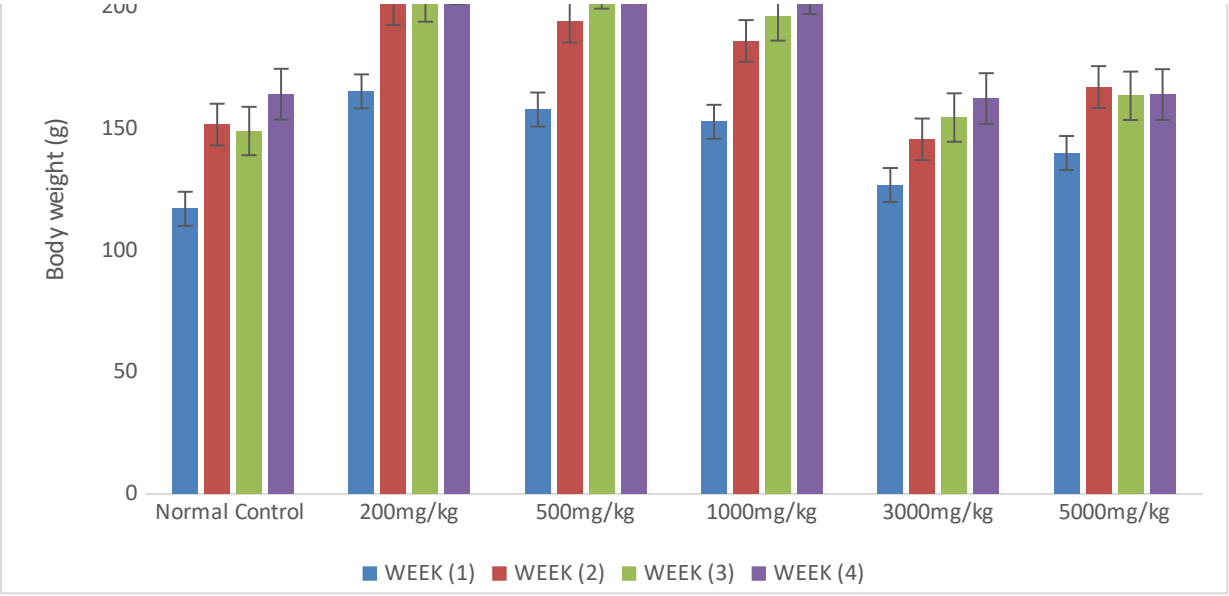

Figure 3: Effect of ethanolic extract of *Sphenocentrum Jollyanum* at doses of 200 mg/kg, 500 mg/kg, 1000 mg/kg, 3000 mg/kg and 5000 mg/kg on body weight of rats.

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