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Doxorubicin-Induced Heart and Kidney Toxicities in Female Wistar Rats: Effect of Aqueous Extract of the Sprout of *Phaseolus vulgaris* (L)

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ABSTRACT

Background: The use of doxorubicin in the treatment of cancer and concomitant toxic effects on some basic organs of the body has continued to limit its therapeutic potentials in many patients with cancer. Leguminous plants sprouts have been reported to be nutritionally and medicinal viable against some degenerative diseases.
Objectives: The study seeks to investigate the curative and protective potentials of *Phaseolus vulgaris* sprout extracts on the toxic effects of doxorubicin on heart and kidney using female albino rats.
Methods: *Phaseolus vulgaris* (belonging to the Family Fabaceae/Leguminosae) popularly called cowpea, common bean or ewa-funfun in South-Western Nigeria was obtained from Oba's market in Ado-Ekiti, Ekiti State, Nigeria. It was cultivated for sprouts production; the aqueous extract of the sprouts was investigated for anti-toxic effects on the kidney and heart of doxorubicin-induced female albino rats to utilize it to subdue the side effects of this drug on kidney and heart of the cancer patients using doxorubicin. Thirty-five female albino rats were divided into seven groups of Normal control group (group 1), different concentrations (20 mg/kg, 40 mg/kg and 60 mg/kg body weight) of doxorubicin-induced groups (groups 2, 3 and 4 respectively) and *Phaseolus vulgaris* sprouts aqueous extract treated groups (groups 5,6 and 7). The animals were sacrificed; plasma, kidney and heart of the rats were obtained after twenty-eight days of induction and treatment. The organs were harvested and homogenized while some biochemical evaluations of aspartate transaminase (AST), alkaline phosphatase (ALP), and alanine transaminase (ALT), triglyceride (TRG) total cholesterol (TCHOL), HDL-cholesterol (HDL-C), LDL-cholesterol (LDL-C), creatinine (CRT), malondialdehyde (MDA), catalase (CAT), superoxide dismutase (SOD) and reduced glutathione (GSH) were determined in the plasma and organs homogenates.
Results: The results obtained showed that the aqueous extract of the sprouts of the beans was able to reverse to normal activities of the marker enzymes, modifies to normal the lipid profiles, reduce lipid peroxidation, reduced kidney creatinine and enhanced the antioxidant enzymes against kidney and heart toxicities of the doxorubicin induced female Wistar rats.`
Conclusion: The aqueous extract of the sprouts of the beans seems to be of therapeutic importance to subdue the side effects of doxorubicin in cancer patients.

Keywords: Doxorubicin-induction, cardio-toxicity, nephron-toxicity *Phaseolus vulgaris*, sprout-extract

INTRODUCTION

Doxorubicin belongs to the anthracycline types of drug. In the first line, anti-cancer drugs are long recognized as strong cardiotoxic substances. Predominantly, anthracyclines are the best known and the most discussed drugs which hardly affect cardiac muscle (Cai *et al.,* 2019). They were isolated from *Streptomyces peucetius*, a species of actinobacteria and are well established as highly efficacious anti-neoplastic agents for various hemopoietic and solid tumors such as breast cancer, sarcoma, ovarian and bronchogenic carcinoma as well as lymphoma, and certain forms of leukemia (Alecsandru and Cornel, 2007). Over the centuries anticancer drugs evolved from natural products, discovered mainly from green plants and minerals to fully chemically synthesized chemotherapeutic agents. Plants have a long history of use in the treatment of cancer (Cragg and Newman, 2013). The cardiotoxicity of doxorubicin, which has been recognized shortly after their introduction in clinical practice, continues to limit their therapeutic potential and to threaten the cardiac function of many patients with cancer. There are several known risk factors for doxorubicin-associated cardiotoxicity. Consequently, modern adjuvant doxorubicin regimens typically contain

less than the cumulative dose associated with an increased risk of cardiomyopathy (Wu, 2008; Carver et al., 2008). Young females who were treated with high cumulative doses of doxorubicin or with regimens of high individual doses, as well as patients of both sexes who were relatively young at the time of treatment or have had long periods of follow-up since doxorubicin therapy, appear to be at the highest risk for late cardiotoxic effects (Lipshultz et al., 1995). Patients who are younger at the time of diagnosis have the greatest reductions in left ventricular mass and the most profound increases in afterload. It was suggested that this difference could be due to the inhibition of myocardial growth by doxorubicin, which would be accentuated in younger children, whose left ventricular mass is smaller (Lipshultz et al., 1999). Moreover, it was evidenced that limiting the cumulative dose of doxorubicin may not suffice to prevent late cardiotoxic effects in patients treated for cancer during childhood. Similarly, patients of advanced age over 65 years old may be at greater risk for congestive heart failure and may benefit from the early administration of a cardio-protectant (Swain et al., 2003). Interestingly enough, the female gender is associated with a higher risk of cardiotoxicity as compared to males. Other risk factors include combination cancer therapy, prior or concomitant mediastinal radiotherapy, previous cardiac disease, and hypertension (Singal and Iliskovic, 1998). Seed sprouting is a veritable processing method used to manipulate the nutritional composition of plant seeds, Seed and grain sprouts help in protecting man's body from some different diseases; sprouting of legume seeds is also not a new technology (Akpapunam et al., 1996, Mahando, 2004, Harper and Zandi, 2008). According to Srilakshmi (2008), seed sprouting of legumes improves the protein and other nutritional contents and also reduces the anti-nutritional composition. Sprouted seeds, grains, legumes or nuts help support cell regeneration as sprouts alkalize the body and protect it from disease including cancer. High levels of proteins, amino acids, oligosaccharides, and polyphenols in beans are thought to be the main contributors to the antioxidant, antimicrobial, anti-inflammatory, and antitumor activities of the sprouts and are involved in the regulation of lipid metabolism (Kanatt et al., 2011; Randhir et al., 2004; Vanamala et al., 2006; Anjum et al., 2011). This reported cardiotoxicity and other organs complications because of cancer treatment with doxorubicin can however be assuaged using other complementary therapy. Leguminous plants sprouts have been reported to reduce the risk of cancer in the junk foods in many countries.

Therefore, there is a need to investigate the curative and preventive effects of aqueous extract of the sprout of *Phaseolus vulgaris* on doxorubicin-induced heart and kidney toxicities using female Wistar albino rats.

MATERIALS AND METHODS

Plant material

Leguminous grains white beans (*Phaseolus vulgaris*) were bought in March 2014 at the Oba market in Ado-Ekiti, Ekiti State, Nigeria and were authenticated at the Department of Plant Science, Ekiti State, University, Ado-Ekiti with herbarium voucher no. UHAE 2020102. The bean seeds were planted between March and May 2014 at the research garden beside College of Medicine of Ekiti State University. The germinated bean seed growth shoot called sprouts were obtained at the expiration of 4 weeks (28 days) of planting.

Extract preparation

The sprouts were collected and air dried under shade and ground into powder with Marlex Excella laboratory blender. 10% aqueous extract of sprouts was prepared by weighing 100 g of the sprout powder into 1000 mL of distilled water, shaken overnight on laboratory mechanical shaker and filtered to remove the residue, the filtrate was administered to treat the doxorubicin induced rats.

Experimental protocol

The study was performed on Thirty-five female albino rats obtained from Animal House of College of Medicine, Ekiti State University, Ado-Ekiti, Nigeria; they were divided into seven main groups and housed in ventilated cages in the animal house where the research was conducted. The rats were acclimatized for two weeks before induction. Groups 2-4 animals were induced with 0.5 mL of 20 mg/kg body weight, 40 mg/kg body weight, 60 mg/kg body weight doxorubicin respectively every other day while groups 5-7 animals were given doxorubicin as above but treated with 0.5 mL of 10% aqueous extract of *Phaseolus vulgaris* sprouts in addition every other day respectively for the twenty-eight days duration of the administrations.

Group 1: Normal control group animals
Group 2: 20 mg/kg body weight doxorubicin-induced group animals
Group 3: 40 mg/kg body weight doxorubicin-induced group animals
Group 4: 60 mg/kg body weight doxorubicin-induced group animals

Group 5: 20 mg/kg body weight doxorubicin-induced group animals + 10% sprouts' aqueous extract of *Phaseolus vulgaris* group animals
Group 6: 40 mg/kg body weight doxorubicin-induced group animals + 10% sprouts' aqueous extract of *Phaseolus vulgaris* group animals
Group 7: 60 mg/kg body weight doxorubicin-induced group animals + 10% sprouts' aqueous extract of *Phaseolus vulgaris* group animals

Chemicals/Reagent kits

All chemicals and drugs used were obtained commercially and of analytical grade. The diagnostic kits used were obtained from Fortress Chemical Ltd. England.

Preparation of plasma and organs homogenates

After the expiration of the twenty-eight days induction and treatment, the animals were anesthetized with chloroform and quickly dissected to obtain the heart and kidney which were quickly placed on ice-bath while blood was collected from the heart with syringe and needle into anticoagulant bottle, shaken and centrifuged to obtain plasma. 10% of each organ homogenate was then prepared in 6.7mM potassium phosphate buffer, (pH 7.4) using a top driven electric homogenizer. The homogenate was centrifuged at 3,000rpm for 10 minutes at 4^0C to obtain a clear supernatant that was used for measurement of biochemical parameters.

Biochemical Assay

Fortress standard diagnostic kits from England were used in the determination of total cholesterol (TCHOL), HDL-cholesterol (HDL-C), LDL-Cholesterol (LDL-C), Triglyceride (TGR) Creatinine (CRT), Aspartate transaminase (AST), Alkaline phosphatase (ALP) and Alanine transaminase (ALT) while Malondialdehyde (MDA) was determined by Varshney and Kale, (1990) and Adam-Vizi and Seregi, (1982). Superoxide dismutase was assayed by Misra and Fridovich, (1972), Catalase by Sinha, (1972) and Von Euler and Josephson, (1972) and reduced glutathione was determined by Jollow et al., 1974

Statistical Analyses

The results of the study were obtained in triplicates and subjected to mean and standard deviation determinations with one-way ANOVA.

RESULTS AND DISCUSSION

Administration of doxorubicin significantly raised the plasma level of AST activity with significant reduction in the enzyme activity in the heart tissue of the rats as observed in Tables 1, which may indicate serious cardio-toxic effect of the drug in dose dependent manner, while the observed effect of the drug in the kidney did not show any significant difference. On treatment varying concentration of the sprout aqueous extracts, there was a significant reversal to normal control in plasma, kidney and heart tissues. Similarly, doxorubicin caused a significant increase in the level of ALT activity in the plasma with corresponding decreased activity in the heart and kidney tissues as observed in Table 2. The treatment of the effects of doxorubicin with the sprouts aqueous extract however restored the level of activity to the normal control in the study organs. There was a significant increase ($p < 0.05$) in the level of ALP activity with doxorubicin induction which was observed to show a concomitant reduction on treatment with the sprouts aqueous extract in the plasma as there is no clear-cut trend in the kidney and heart tissues as observed in Table 3.

Like ALT, AST is found in the cytoplasm of hepatocytes and other tissues, including skeletal muscle. Injury to hepatocytes causes leakage of AST into the extracellular compartment with subsequent elevation in serum. AST activity may also be elevated in times of skeletal muscle injury in preclinical species.

The magnitude of ALT elevation is usually greater than AST when both are elevated due to hepatocellular injury because of the longer half-life of ALT and the greater fraction of AST that is bound to the mitochondria (Aulbach and Amuzie, 2017). In liver and heart injury, the transport function is disturbed, resulting in the leakage of the plasma membrane (Zimmerman and Seeff, 1970), thereby causing an increased enzyme level in blood and a decrease in the affected organs. If the injury involves organelles such as mitochondria, soluble enzymes like AST normally located there, will also be similarly released. Administration of doxorubicin significantly raises the plasma level of enzymes like AST and ALT in rats as observed in this study, which indicate that apart from the cardiotoxic effect of the drug, it can also cause damage to other organs like kidney, where there is a reduced level of the enzyme due to the damage to their membrane and release of the enzymes

Table 1: Aspartate transaminase activity (AST) in (IU) of selected organs of doxorubicin-induced female Wistar rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	37.77±2.01^{a}	32.11±3.10^{a}	120.56±18.90^{a}
2	56.96±5.28^{b}	33.89±2.40^{a}	68.08±8.94^{b}
3	63.52±9.26^{b}	32.89±3.13^{a}	58.79±4.20^{c}
4	121.54±15.21^{c}	36.74±4.34^{b}	43.56±3.20^{d}
5	38.46±4.66^{a}	42.99±5.39^{c}	84.94±11.39^{e}
6	46.98±6.78^{d}	33.39±1.49^{a}	69.70±13.40^{b}
7	55.37±7.40^{b}	34.93±3.13^{a}	76.55±4.94^{f}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along the column are determined as significantly different ($p<0.05$)

Table 2: Alkaline Transaminase activity (ALT) in (IU) of selected organs of doxorubicin -induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	16.98±0.09^{a}	39.66±0.05^{a}	49.51±0.05^{a}
2	17.99±0.28^{a}	26.37±0.11^{b}	33.60±0.05^{b}
3	29.86±0.10^{c}	36.33±0.25^{c}	26.23±0.20^{c}
4	31.09±0.21^{d}	33.81±0.10^{c}	23.90±0.20^{d}
5	16.10±0.05^{a}	34.45±0.97^{c}	50.31±0.40^{a}
6	21.26±0.00^{e}	30.46±0.00^{b}	43.49±1.73^{e}
7	13.17±0.10^{a}	42.71±0.16^{d}	39.83±0.26^{f}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along the column is determined as significantly different ($p<0.05$).

Table 3: Alkaline Phosphatase activity (ALP) in (IU) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUPS	PLASMA	KIDNEY	HEART
1	6.46±0.07^{a}	10.13±0.10^{a}	12.16±0.07^{a}
2	15.86±0.36^{b}	17.06±0.08^{b}	17.95±0.14^{b}
3	25.24±0.07^{c}	16.84±0.14^{b}	16.61±0.07^{b}
4	25.24±0.07^{c}	17.87±0.07^{b}	9.38±0.07^{c}
5	9.79±0.07^{d}	16.81±0.40^{b}	16.77±0.07^{b}
6	9.93±0.00^{d}	15.23±0.58^{b}	15.82±0.06^{b}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along the column are determined as significantly different ($p<0.05$)

compared to the control. The treatment with the aqueous extract of the sample exhibited a significant restoration in the levels of ALT and AST in the tissues close to the control value. The observation here agrees with the earlier obtained by (Oseni et al., 2015a, 2015b) which recorded a similar trend in both AST and ALT levels when hypertension was induced with dexamethasone and treated with *Moringa oleifera*. The decreased activity of the plasma enzymes is often accompanied by a corresponding increase in enzyme activity of the affected organ. The pronounced rise in ALP activities of the kidney and heart relative to the plasma enzymes activities is to be attributed to the protective effect of the aqueous sprout extract as seen in Table 3.

Plasma alkaline phosphatase activity rises in many diseases especially in the liver, the highest levels occurring with obstruction to the flow of bile, either intrahepatic or extrahepatic, or with intrahepatic space-occupying lesions such as primary or metastatic tumours (*Mclntyre and Rosalki, 1994).*

The rats induced with doxorubicin developed hypercholesterolemia marked by significant ($P < 0.05$) increase in plasma triglyceride, total cholesterol (TC), low density lipoprotein cholesterol (LDL -C) in dose dependent fashion. However, treatment with the sprout aqueous extract produced a reversal towards the control values as seen in Tables 4-6. The high-density lipoprotein cholesterol (HDL-C) concentration in Table 7 showed a significant ($P < 0.05$) reduction in the plasma, kidney and heart with increased concentration of doxorubicin, while treatment with the extract of the sprout also caused a significant reversal to the control.

These results indicated that the extract of *Phaseolus vulgaris* performed effectively against tissues hypercholesterolemia and atherosclerosis. The observed hypolipidaemic effect of the extract may be due to decreased cholesterogenesis and fatty acid synthesis. Significant lowering of total cholesterol, LDL-cholesterol and triglycerides (TG) with increased HDL-cholesterol is a very desirable biochemical state for the prevention of atherosclerosis and ischemic conditions (*Jouad et al., 2003;* Daisy et al., 2009). As a result, the extract may prevent increased factors causing coronary heart diseases (CHD) and cardiovascular diseases (CVD) to prevent atherosclerosis.

The results of creatinine concentration in plasma was shown in Table 8 to be significantly increased ($p < 0.05$) after induction with various concentrations of doxorubicin in groups 2 to 4 and subsequent decreased in concentrations in the kidney in dose related manner. However, treatment with 0.5 mL of 10% sprout aqueous extract caused significant reduction to the control, this observation was similar to that obtained by Nagai et al., (2018). Creatinine is a waste product of creatine, which the muscles use to make energy, however it is excreted by kidney without been accumulated in the plasma. Hence, a high creatinine level in the plasma means that the kidney is malfunctioning.

The lipid peroxidation index as seen in Table 9 showed that doxorubicin significantly ($p<0.05$) increased the malondialdehyde concentration in dose-dependent fashion in both plasma, kidney and heart tissues which was significantly reduced on the treatment with 10% aqueous extract of the sprout of *Phaseolus vulgaris*. This observation was similar to what was observed by Tatlidede *et al*., (2009) and Al-Harthi *et al*., (2014) in their earlier studies.

Table 10 presented the percentage (%) inhibition of superoxide radicals of superoxide dismutase results in selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of sprouts. The induction with doxorubicin caused a significantly ($p<0.05$) reduction in the power of the enzyme to scavenge superoxide radical in-vivo both in the plasma, kidney and heart while treatment with the 10 percent sprout aqueous extract conversely produced increased % inhibition of the superoxide radical in dose-dependent fashion

The catalase enzyme activity of doxorubicin-induction in female Wistar rats was observed to reduce significantly in both plasma and studied tissues while treatment with aqueous extract of sprouts of *Phaseolus vulgaris* also manifested significant ($p<0.05$) increase in the enzyme activity which was also displayed in dose dependent manner as observed in Table 11, this results however corroborated that observed by Kang et al., (2002). Doxorubicin also caused significant ($p<0.05$) decrease in the concentration of reduced glutathione in both plasma and studied organs as shown in Table 12, this observation was in agreement with the works of QuanJun et al., (2017) and Tetlidede et al., (2009). However, treatment with the aqueous extract of the sprouts of the beans also caused significant increase in the concentration of GSH in both plasma and studied organs.

CONCLUSION

In this study, doxorubicin caused tissues toxicities in the female Wistar albino rats in dose related mode while the 0.5 mL 10% aqueous extract of sprouts of *Phaseolus vulgaris* was able to enhance the activities of studied biomarker

enzymes. It was also observed that the dosage given was able to restore the creatinine concentration of the kidney and improved lipid profiles and reduced glutathione concentrations. There was reduced plasma and organs malondialdehyde concentrations with significant enhanced antioxidant enzymes activities as was observed in this study. However, further studies need be done to isolate and characterize possible active compounds in the aqueous extract of the sprouts of *Phaseolus vulgaris*.

Table 4: Triglyceride concentration in (mmol/dL) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	1.24±0.019^{a}	2.00±0.03^{a}	2.57±0.04^{a}
2	0.865±0.01^{b}	1.90±0.01^{a}	1.76±0.04^{b}
3	4.12±0.03^{c}	1.54±0.02^{a}	1.12±0.03^{c}
4	4.69±0.02^{c}	0.68±0.01^{b}	1.03±0.02^{c}
5	2.03±0.02^{a}	2.77±0.01^{c}	1.66±0.01^{b}
6	2.01±0.01^{a}	1.77±0.00^{a}	1.36±0.02^{c}
7	2.32±0.01^{a}	1.31±0.03^{a}	1.23±0.02^{c}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along the column are determined as significantly different ($p<0.05$).

Table 5: Total Cholesterol level in (mmol/dL) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	3.67±0.04^{a}	4.40±0.05^{a}	4.38±0.02^{a}
2	4.07±0.02^{b}	3.46±0.06^{b}	3.69±0.04^{b}
3	5.90±0.37^{c}	3.44±0.74^{b}	3.46±0.22^{b}
4	8.50±0.67^{d}	3.64±0.24^{b}	3.44±0.44^{b}
5	4.03±0.01^{b}	3.53±0.07^{b}	3.76±0.22^{b}
6	5.46±0.36^{c}	3.99±0.27^{c}	3.86±0.94^{b}
7	5.24±0.63^{c}	3.82±0.47^{c}	3.57±0.05^{b}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 6: LDL-cholesterol concentration in (mmol/L) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	0.78±0.16^{a}	1.58±0.32^{a}	0.45±0.00^{a}
2	4.25±0.63^{b}	3.36±0.63^{b}	1.56±0.15^{b}
3	13.20±1.02^{c}	7.16±0.10^{c}	2.01±0.23^{b}
4	14.23±0.16^{e}	8.81±0.55^{d}	7.94±2.52^{c}
5	0.87±0.16^{a}	2.59±0.79^{e}	0.59±0.04^{a}
6	2.00±0.15^{d}	3.45±0.80^{b}	1.35±0.05^{b}
7	2.14±0.32^{d}	3.24±0.42^{b}	2.91±0.32^{d}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 7: HDL-cholesterol concentration in (mmol/dL) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	11.32±0.35^{a}	5.43±0.28^{a}	3.11±0.26^{a}
2	7.54±0.24^{b}	3.84±0.87^{b}	1.68±0.54^{b}
3	4.60±1.34^{c}	4.79±0.45^{a}	1.54±0.23^{b}
4	3.91±0.45^{c}	2.72±0.38^{c}	1.66±0.15^{b}
5	12.86±0.58^{a}	8.58±0.48^{d}	2.89±0.66^{a}
6	7.38±0.46^{b}	5.52±1.95^{a}	2.44±0.34^{c}
7	5.67±0.28^{d}	4.19±0.24^{a}	2.04±0.46^{b}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 8: Creatinine concentration in (mg/dl) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY
1	0.06±0.02^{a}	2.80±0.05^{a}
2	3.95±0.03^{b}	0.99±0.02^{b}
3	4.88±0.02^{c}	0.82±0.02^{b}
4	6.92±0.02^{d}	0.46±0.02^{c}
5	1.19±0.08^{e}	1.31±0.08^{d}
6	1.72±0.12^{f}	1.34±0.00^{d}
7	2.10±0.05^{g}	1.19±0.10^{d}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 9: Lipid peroxidation (MDA**)** in (nmoles of malonadialdehyde/mg protein) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	2.87±0.12^{a}	0.45±0.24^{a}	2.23±0.12^{a}
2	3.56±0.76^{b}	2.46±0.34^{b}	3.11±0.98^{b}
3	3.55±0.11^{b}	2.76±0.32^{b}	4.65±1.44^{c}
4	4.12±1.45^{c}	3.44±0.98^{c}	15.00±1.34^{d}
5	0.67±0.02^{d}	1.76±0.98^{d}	0.45±0.23^{e}
6	0.62±0.21^{d}	2.12±0.84^{b}	2.11±0.85^{a}
7	0.43±0.21^{d}	2.23±0.48^{b}	3.23±1.23^{b}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 10: % inhibition ability of Superoxide dismutase (SOD) in selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	HEART
1	31.21±4.65^{a}	34.54±4.56^{a}	31.43±6.34^{a}
2	41.21±6.08^{b}	42.45±4.55^{b}	35.56±2.11^{b}
3	50.54±7.71^{c}	42.54±5.26^{b}	35.76±8.42^{b}
4	51.43±4.84^{c}	43.56±7.28^{b}	40.78±5.12^{c}
5	33.56±3.65^{a}	40.21±3.96^{b}	38.54±4.22^{b}
6	42.45±7.47^{b}	38.45±3.68^{b}	37.89±3.42^{b}
7	34.66±5.35^{a}	42.43±7.84^{b}	48.54±6.23^{d}

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 11: Catalase activity (mmoles/min/mL) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	LIVER
1	$1.0x10^{-3}$±0.001a	$3.0x10^{-3}$±0.0001	$1.0x10^{-3}$±0.0001a
2	$1.0x10^{-3}$±0.0001b	$2.0x10^{-3}$±0.0001b	$1.0x10^{-3}$±0.0001a
3	$2.0x10^{-3}$±0.0001c	$1.0x10^{-3}$±0.00024a	$1.0x10^{-3}$±0.0001a
4	$2.0x10^{-3}$±0.0001c	$1.0x10^{-3}$±0.0001a	$1.0x10^{-3}$±0.0001a
5	$1.2x10^{-2}$±0.001d	$2.0x10^{-3}$±0.0001b	$3.0x10^{-3}$±0.0001b
6	$2.0x10^{-2}$±0.001d	$3.0x10^{-3}$±0.0001c	$4.0x10^{-3}$±0.001c
7	$3.0x10^{-2}$±0.0001e	$2.0x10^{-3}$±0.0001b	$7.0x10^{-3}$±0.001d

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$).

Table 12: Reduced Glutathione (µmole/gm) of selected organs of doxorubicin-induced female Wistar albino rats treated with aqueous extract of Sprouts of *Phaseolus vulgaris*

GROUP	PLASMA	KIDNEY	LIVER
1	0.42±0.02[a]	0.13±0.03[a]	0.1±0.03[a]
2	0.04±0.01[a]	0.06±0.02[b]	0.02±0.01[b]
3	0.011±0.00[b]	0.06±0.01[b]	0.01±0.00[a]
4	0.06±0.00[c]	0.01±0.00[a]	0.01±0.00[a]
5	0.42±0.00[d]	0.07±0.01[b]	0.09±0.02[c]
6	0.42±0.003[d]	0.13±0.00[a]	0.14±0.00[d]
7	0.41±0.01[d]	0.07±0.01[b]	0.22±0.01[c]

Mean of triplicate results ±SEM. Means that do not share the same superscripts along each column are determined as significantly different ($p<0.05$)

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