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Original Research Article

Inhibitory Activity of Ethanolic Extract of Horseradish (*Moringa oleifera)* (Lam) on Oxidative Stress in some organs of Dexamethazone Induced Hypertensive Wistar Albino Rats.

ABSTRACT

Local communities, world over prevent and treat indigenous diseases using local herbal remedies. *Moringa oleifera* is one of the many plants used in herbal preparations in West Africa for treating numerous human ailments such as malnutrition, cardiovascular diseases and uterine conditions among others. Despite its wide use by communities around the world, there is inadequate scientific information available on the actual pharmacological effects of ethanolic extract of *Moringa oleifera* leaves on the heart and kidney dysfunction. The aim of this study however was to determine the inhibitory activity of ethanolic extract of horseradish on oxidative stress in the heart and kidney of dexamethazone induced hypertensive wistar albino rats. Air dried *Moringa oleifera* leaves were pulverized and ethanolic crude extract was prepared. The animals were grouped into four of five animals each. Group A animals served as control and fed with only water and feed only while Groups B and C animals were administered with 0.5mL of 40% ethanolic extract of *Moringa oleifera* leaf and 0.5ml of 1.67mg/kg body weight dexamethasone respectively. Group D animals were treated with 0.5ml of 1.67mg/kg body weight dexamethasone and 0.5mL of 40% ethanolic extract of *Moringa oleifera* leaf intermittently for twenty one days. The results obtained from the study showed that the ethanolic extract of *Moringa oleifera* leaf possessed ability to inhibit and reverse the dexamethasone mediated tissues oxidative damage of both organs as seen in cholesterol, reduced glutathione and malondialdehyde concentrations. The same protective trend was also observed in activities of alkaline phosphatase, aspartate transaminase, alanine transaminase and catalase enzymes in both organs of the hypertensive rats. Hence, ethanolic extract of *Moringa oleifera* leaf reduced the extent of antioxidant loss and restoration of organ dysfunction caused by dexamethasone in the rats.

Keyword: *Moringa oleifera,* oxidative stress, dexamethazone, chemoprevention, antioxidant.

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Introduction

Herbal medicine is the oldest form of healthcare known to mankind and most cultures have long folk medicine histories that include the use of plants. The WHO recognizes herbal medicines as a valuable and readily available resource for Primary Health Care and it has endorsed their safe and effective use (Tilburt and Kaptchuk, 2008). It however recommends that many herbal remedies still need to be studied scientifically while recognizing the experience obtained from their prolonged safe use over the years in the treatment of various conditions in both humans and animals, such as cardiovascular diseases (CVDs) and obstetric conditions.

In recent decades, cardiovascular diseases have emerged as major causes of morbidity and mortality in many countries with hypertension being the commonest (Akinkugbe, 1990). Hypertension is generally defined as an abnormal persistently raised blood pressure greater than 140/90mmHg (Massie, 2004) and not due to physical exercise. It is estimated that a sixth of the world population is afflicted by sustained high blood pressure (Kearney *et al.,* 2005). Hypertension is a chronic disease and its management requires prolonged treatment which is very expensive and often not accessible to poor individuals hence people resort to the use of herbal medicines.

Obstetric conditions are also a common problem especially in developing countries and more so in the rural areas. Obstetric conditions are those maternal conditions that are as a result of a mother being pregnant or arise in the process of giving birth. These conditions can be direct or indirect (Johanna *et al.,* 2003). Direct conditions occur before or within 6 weeks of delivery (such as haemorrhage, abortion, eclampsia and sepsis) while indirect conditions include anaemia, malaria, hepatitis and cardiovascular disease. There are also psychological stressors like puerperal psychoses, post-partum depression (baby blues), suicide, and strong fear of pregnancy and childbirth resulting from obstetric complications, interventions or cultural practices (AbouZahr, 2003). The management of these conditions often involves the use of non-pharmaceutical approaches like exercise and nutrition but also to a large extent allopathic medicine. Despite their proven efficacy, allopathic medicines are more expensive and are also presumed to be associated with a lot of side effects and they are moreover not readily accessible to the majority of the people who need them.

On the other hand, herbal remedies are seen as less expensive and less toxic (Hughes and Bradly, 2004). In Nigeria, rural people often have to travel long distances to reach the nearest

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health centre and here the 'modern/western' type of medicine is often out of stock or may be unaffordable. These hardships force people to resort to their local remedies which are plentiful, available, and affordable and are already known to be efficacious in managing certain illnesses. People are thus increasingly willing to manage their medical needs by using complementary and alternative medicines like herbs (Hughes and Bradly, 2004). Among the medicinal plants that are commonly used in management of various conditions is *Moringa oleifera.* This herb has been reported in the management of cardiovascular disease such as hypertension (Nath *et al.,* 1992). Substances in *Moringa oleifera* which are similar to those derived from other herbs (for example glycosides) have become a basis for some of the commercial medications used today for the treatment of heart disease, high blood pressure, pain, obstetric and other medical problems such as diabetes, cancer, and AIDS (Peltzer *et al.,* 2008). Traditionally women use herbal preparations for the process of labour. Herbs are also prescribed by traditional birth attendants and healers for various reasons including increasing chances of having twins, correcting a mal-positioned fetus, anaemia in pregnancy among others (Azriani *et al.,* 2007). In Nigeria the practice of using herbs has been passed on for generations and it is used not only by rural but also by many 'modern' women who continue using the herbal adjuncts in addition to their regular antenatal and postnatal prescriptions. *Moringa oleifera* has been reported to be used by women for contraception and as an abortifacient (Nath *et al.,* 1992). Herbs such as *Moringa oleifera* are reportedly used for treatment of painful uterus, inducing uterine contractions, management of retained placenta and post partum bleeding among other conditions and have thus been found useful in obstetric care (Kamatenesi-Mugisha, 2002).

Materials and Methods

Sample collection and preparation

Fresh leaves of *Moringa oleifera* were obtained from a Federal University of Technology satellite Estate in Akure, Ondo State, Nigeria. The leaf identification was carried out in the Department of Plant Science, Ekiti State University, Ado Ekiti, Nigeria by plant Taxonomist.

Fresh leaves of *Moringa oleifera* were collected and air dried under shade and ground into powder with Marlex Excella laboratory blender. The ethanolic extract of *Moringa oleifera* leaves was made. 200g of the powder was weighed and mixed in 500mL of ethanol in a cocked bottle, shaken and allowed to stand overnight with constant shaking on mechanical shaker.

Experimental protocol

The study was performed on twenty male wistar albino rats housed in ventilated cages in the

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Animal House of Biochemistry Department, Ekiti State University, Ado-Ekiti, Nigeria. They were acclimatized for two weeks before administration of the drugs. Animals were divided into four groups of five rats each. Group A served as the positive control and received distilled water and rat feed. Group B animal were administered with 0.5mL of 40% ethanolic extract of *Moringa olifera*. Group C animal served as the negative control and were orally administered with 0.5mL single dose of dexamethasone (1.67mg/kg body weight) while Group D animals were orally given 0.5mL dexamethasone (1.67mg/kg body weight) followed by 0.5mL of 40% ethanolic extract of *Moringa oleifera.* Animals were kept at optimum temperature with a 12hour light/dark cycle and given rat feed and water. The period of induction and treatment lasted for three weeks.

Preparation of organ homogenate and plasma collection

After three weeks of induction and treatment of the rats, they were sacrificed anesthetically using chloroform. Blood was collected using syringes and needles from the heart into anti-coagulant bottles. The organs (kidney and heart) of interest were also collected which were homogenized in 6.7mM potassium phosphate buffer and the supernatants were collected after spinning at 10,000 rpm in a centrifuge.

Biochemical Assay

Standard Randox kits were used to determine Cholesterol, Total protein, Alkaline Phosphatase (ALP), Aspartate Transaminase (AST) and Alkaline Transaminase (ALT).

ALT

$$\propto -oxoglutarate + L - alanine \xrightarrow{\text{GPT}} L - glutamate + pyruvate$$

Alanine Aminotransferase was measured by monitoring the concentration of pyruvate hydrazone formed with 2, 4-dinitrophenylhydrazine.

AST

$$\propto -oxoglutarate + L - aspartate \xrightarrow{\text{GOT}} L - glutamate + oxaloacetate$$

AST was measured by monitoring the concentration of oxaloacetate hydrazone formed with 2, 4-dinitrophenylhydrazine.

CHOLESTEROL

The cholesterol was determined after enzymatic hydrolysis and oxidation. The indicator quinoneimine is formed from hydrogen peroxide and 4-aminoantipyrine in the presence of phenol and peroxidase.

$$\text{Cholesterol ester} + H_2O \xrightarrow{\text{Cholesterol esterase}} \text{Cholesterol} + \text{Fatty acids}$$

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$$\text{Cholesterol} + O_2 \xrightarrow{\text{Cholesterol oxidase}} \text{Cholestene -3-one} + H_2O$$

$$2H_2O + \text{phenol} + \text{4-Aminoantipyrine} \xrightarrow{\text{Peroxidase}} \text{quinoneimine} + 4H_2O$$

Determination of plasma Malondialdehyde (MDA)

Lipid peroxidation was determined by measuring the formation of thiobarbituric acid reactive substances (TBARS) according to the method of Varshney and Kale (1990). An aliquot of 0.4mL of the plasma or other organ homogenates was mixed with 1.6mL of Tris-KCl buffer to which 0.5mL of 30% trichloroacetic acid (TCA) was added. Then 0.5mL of 0.75% TBA was added and placed in a water bath for 45 minutes at 80°C. This was then cooled on ice and centrifuged at 3000*g*. The clear supernatant was collected and absorbance measured against a reference blank of distilled water at 532nm. The MDA level was calculated according to the method of Adam-Vizi and Seregi (1982). Lipid peroxidation in units/mg protein or gram tissue was computed with a molar extinction coefficient of 1.56 x 10^5 $M^{-1}Cm^{-1}$.

Calculation

$$\text{MDA (units/mg protein)} = \frac{\text{Absorbance x volume of mixture}}{E_{532nm} \text{ x volume of sample x mg protein}}$$

Determination of reduced glutathione

The method of Jollow *et al*. (1974) was followed in estimating the level of reduced glutathione (GSH). 0.2mL of sample was added to 1.8mL of distilled water and 3mL of the precipitating solution was mixed with sample. The mixture was then allowed to stand for approximately 10minutes and then centrifuged at 3000g for 5 minutes. 0.5mL of the supernatant was added to 4mL of 0.1M phosphate buffer. Finally 0.5mL of the Ellman's reagent was added. The absorbance of the reaction mixture was read within 30 minutes of colour development at 412nm against a reagent blank.

Determination of catalase activity

This experiment was carried out using the method described by Sinha (1972). 0.2ml of sample was mixed with 0.8ml distilled H_2O to give 1 in 5 dilution of the sample. The assay mixture contained 2mL of solution (800µmol) and 2.5mL of phosphate buffer in a 10mL flat bottom flask. 0.5mL of properly diluted enzyme preparation was rapidly mixed with the reaction mixture by a gentle swirling motion. The reaction was run at room temperature. A 1mL portion of the reaction mixture was withdrawn and blown into 1mL dichromate/acetic acid reagent at 60

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seconds intervals. The hydrogen peroxide content of the withdrawn sample was determined by the method described above. The mononuclear velocity constant, K, for the decomposition of H_2O_2 by catalase was determined by using the equation for a first-order reaction: K = 1/t log S_0/S**, w**here S_0 is the initial concentration of H_2O_2 and S is the concentration of the peroxide at t min. The values of the K are plotted against time in minutes and the velocity constant of catalase $K_{(0)}$ at 0 min determined by extrapolation. The catalase contents of the enzyme preparation were expressed in terms of Katalase feiahigkeit or 'Katf' according to von Euler and Josephson (1927).

$$\text{Kat. f} = \frac{K_{(0)}}{\text{mg protein/ml}}$$

Determination of Superoxide Dismutase (SOD)

The level of SOD activity was determined by the method of Misra and Fridovich (1972). 1mL of sample was diluted in 9mL of distilled water to make a 1 in 10 dilution. An aliquot of the diluted sample was added to 2.5ml of 0.05M carbonate buffer (pH 10.2) to equilibrate in the spectrophotometer and the reaction started by the addition of 0.3ml of freshly prepared 0.3mM adrenaline to the mixture which was quickly mixed by inversion. The reference cuvette contained 2.5ml buffer, 0.3ml of substrate (adrenaline) and 0.2ml of water. The increase in absorbance at 480nm was monitored every 30 seconds for 150 seconds.

Calculation

$$\text{Increase in absorbance per minute} = \frac{A_3 - A_0}{2.5}$$

where A_0 = absorbance at 0 second
A_3 = absorbance at 150 seconds

$$\%\ \text{inhibition} = \frac{\text{increase in absorbance for substrate}}{\text{increase in absorbance of blank}} \times 100$$

1 unit of SOD activity was given as the amount of SOD necessary to cause 50% inhibition of the oxidation of adrenaline to adrenochrome during 1 minute.

Statistical Analysis: The experimental results of the analyses were obtained in triplicates. Various formulae were used to calculate the individual parameter and enzyme activities. The means and standard deviations of the triplicates results were determined using Microsoft Office Excel 2007

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RESULTS AND DISCUSSIONS

Table 1: Specific activity of alkaline phosphatase (ALP) in selected tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	Specific activity (IU/mg protein)		
Groups	**Heart**	**Kidney**	**Plasma**
A	41.40 ±1.06	5.52 ±0.42	16.56 ±2.10
B	39.78 ±0.56	11.04 ±0.22	19.32 ±1.64
C	13.80 ±0.43	30.36 ±0.12	32.76 ±0.06
D	25.52 ±0.23	8.28 ±0.76	11.04 ±1.26

Mean of triplicate results ±SEM

Table 1 showed the activity of alkaline phosphatase in the heart, kidney and serum of hypertensive induced rats treated with ethanolic extract of *Moringa oleifera* leaf. We observed about 67% decrease in ALP activity in the heart of the rats treated with dexamethazone when compared with the control (group A) while the ethanolic extract caused about 28% reversal in the activity of ALP in the heart when compared with control. There was a contrary observation in the kidney as the drug showed increased ALP activity when compared with the control though treatment with the extract caused a reversal to the control as seen in group A. These observations showed the toxic effect of the drug and the ability of the ethanolic extract of the plant to reverse the toxic effect on both organs of the animals. The activity of the enzyme was also monitored in the plasma. Normally, enzymes will not always be found in the serum except there is damage to one or more organs of the body. Therefore, enzymes from diseased organs may become manifested in the serum resulting in increased activity since they must have leaked from the diseased organ. The results obtained showed that the ethanolic extract of the plant in groups B and D in both organs and plasma caused a reversal in the ALP activity, adjusting their values toward those recorded in the respective controls. The observations in this work showed a resemblance to trends observed in the effect of aqueous extract of nutmeg in bromate induced renal toxicity in rats (Oseni *et al.,* 2015). Increase in plasma level of ALP is due to increased synthesis, in presence of increasing organ dysfunction, as measurement of ALP activity is of clinical and toxicological importance as changes in its activity is indicative of kidney damage by toxicants or in diseased conditions (Singh *et al.,* 2001).

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Table 2: Specific activity of aspartate transaminase (AST) in selected tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	Specific activity (IU/mg protein)		
Groups	**Heart**	**Kidney**	**Plasma**
A	163.00 ±5.98	82.00±3.39	29.50±2.88
B	161.00 ±6.34	76.00±7.23	24.50±7.89
C	130.00 ± 4.86	115.50±8.80	123.00±3.25
D	140.00 ± 2.86	68.50±5.54	67.00±2.78

Mean of triplicate results ±SEM

Figures Tables 2 and 3 showed the AST and ALT activities in the tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf, the results obtained showed that the extract reversed the effects of the drug in both organs. These tissues participate in a variety of metabolic activities and contain a host of enzymes. The increased plasma AST and ALP activities of the hypertension induced animals showed that the drug resulted in membrane disruption, cellular leakage and loss of functional integrity of cell membrane the organs of the animals in the group C while the extract performed corrective roles as observed in the treated animals in group D while the results of animals in group B showed that the extract maintained the organs integrity.

Table 3: Specific activity of alanine transaminase (ALT) in selected tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	Specific activity (IU/mg protein)		
Groups	**Heart**	**Kidney**	**Plasma**
A	5.40 ±1.65	3.00 ±1.21	67.00 ±2.67
B	6.25 ±0.80	5.60 ±1.10	69.58 ±2.43
C	168.20 ±5.34	20.80 ±3.07	125.00 ±2.30
D	6.80 ±0.75	7.60 ±1.98	57.40 ±1.64

Mean of triplicate results ±SEM

The elevated activities of AST and ALT in plasma are indicative of cellular leakage and loss of the functional integrity of cell membranes (Drotman and Lawhorn, 1978). Administration of dexamethasone significantly raises the plasma level of AST and ALT activities in rats as

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observed in our results, which indicated that apart from the hypertensive effect of the drug, it can also cause damage to other organs of the body, measurement AST and ALT activities in rats as observed in our results is of clinical and toxicological importance as changes in their activities are indicative of tissues damage by toxicants or in diseased conditions (Singh *et al.,* 2001).

The high level of activities of AST, ALT and ALP in the kidney and heart tissues of the rats and their corresponding decreased activities in the plasma is indicative of non toxicity of the ethanolic extract in these organs.

AST in plasma was increased in dexamethasone-induced rats. A marked elevation in the concentration of the enzyme was also recorded in the kidney and the heart after the injection of the drug. This observation was supported by Fleischer and Schwartz (1971) who reported that any damage done to the cell membrane may lead to leakage of AST and ALP, which is a marker enzyme in the plasma membrane, into extracellular fluid. The study is also corroborated by the work Rajesh and Latha, (2004) that recorded the same trend in CCl_4-intoxicated rats treated with Kamilari. Oral administration of ethanolic extract of *Moringa oleifera* leaf caused a decrease in the activity of the above enzymes, which may be a consequence of the stabilization of plasma membrane as well as repair of damage caused to the organ by dexamethasone. This honever indicate that the ethanolic extract displayed high degree of protection in the organs and plasma.

Table 4: Reduced GSH in selected tissues of hypertensive induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	(µg/mL)		
Groups	**Heart**	**Kidney**	**Plasma**
A	0.769 ±0.43	0.114 ±0.04	0.641 ±0.42
B	0.841 ±0.03	0.126 ± 0.02	0.763 ±0.04
C	0.280 ±0.04	0.053 ± 0.10	0. 201 ±0.06
D	0.652 ±0.08	0.123 ± 0.03	0. 428 ±0.05

Mean of triplicate results ±SEM

Glutathione is a small tripeptide protein synthesized in the liver (Kaplowitz, *et.,* 1985). It is a potent antioxidant with high redox potential and it also serves as a co-factor for several oxidative stress detoxifying enzymes (glutathione peroxidase and glutathione transferase) (Valko *et al.,* 2007; Parris, 1997). Glutathione also helps in the regeneration of some important antioxidant vitamins such as C and E. Depletion of GSH has been reported in apoptosis and many degenerative conditions (Parris, 1997). The results of the present study showed that the level of

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glutathione (GSH) was significantly decreased in the plasma, heart and kidney homogenates of the animals fed with dexamethazone when compared with the control group A animals. This depletion in blood and organs glutathione is attributable primarily to the dexamethasone, a xenobiotic and an inducer of hypertension. The effects of ethanolic extract of horseradish (*Moringa oleifera*) leaf treatments on the organs and plasma concentration of reduced Glutathione (GSH) showed a significant reversal to the control levels in the tissues and plasma as seen in Table 4. The observations in this study were however similar to what was obtained by Ologundudu *et al.,* (2010) in their work on effect of *Hibiscus sabdariffa* anthocyanins on 2, 4-dinitrophenylhydrazine-induced tissue damage in rabbits. The reduction in glutathione to the level that was observed in this study could lead to a devastating decrease in the total antioxidant status of the animals because glutathione helps in recycling cellular antioxidants, inhibits free radical damage and plays a key role in the detoxification of harmful compounds (Robert *et al*., 2000). This agrees with earlier works carried out by (Unt *et al*., 2008; Dominquez *et al*., 1998) who reported reduced total plasma antioxidant capacity in uncontrolled hypertension. However, the plant extract intake by the hypertensive rats increased their glutathione status to near the control level and this is remarkable as this implies that *Moringa* ethanolic extract could have an ameliorating effect on the altered antioxidant status of the hypertensive rats. It has been reported that decreased hepatic and serum GSH has been consistent with exposure to toxic and oxidative agents which may also lead to more free ROS leading to excessive oxidative damage (Vijaya *et al.,* 2011; Ahmed *et al.,* 2008; Videla *et al.,* 1991). The results obtained in this work revealed that dexamethazone treated group showed reduced glutathione in both heart, kidney and plasma when compared with the control which however corroborate the results of other previous investigators.

Table 5 revealed the effects of ethanolic extracts of horseradish (*Moringa oleifera*) leaf treatments on the catalase activity of dexamethasone induced hypertensive rat. Catalase is an enzyme which functions in the detoxification of hydrogen perioxide. The reduction in catalase activity after injection with dexamethasone in the heart, kidney and plasma respectively is another significant finding in this study. This decreased concentration in catalase activity of organs and plasma is attributable in part to the reduced synthesis of this antioxidant enzyme whose concentrations would have fallen as a result of the dexamethasone that was injected into

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the animals. This study is in agreement with earlier reports by (Erukainure *et al*., 2012; Udoh *et al*., 2007; Tagami *et al*., 1992) who reported a decreased red blood cell catalase activity in diabetic conditions, while treatment with aqueous extracts of *Moringa oleifera* leaf caused slight increase in catalase activity.

Table 5: Specific activity catalase in selected tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	(µg/ml)		
Groups	**Heart**	**Kidney**	**Plasma**
A	18.40±1.20	10.3±0.20	11.42±0.20
B	22.56±2.50	9.62± 0.01	10.72±0.04
C	4.25±0.20	1.66± 0.01	3.42 ±0.01
D	16.50±0.75	9.18± 0.01	8.97 ±0.01

Mean of triplicate results ±SEM

Table 6 revealed the total cholesterol concentration in heart, kidney and plasma of hypertension induced rats that were treated with ethanolic extract of *Moringa oleifera* leaf. The observations in this study revealed that dexamethazone caused hypercholesterolemia which was subsequently reversed by the ethanolic extract of *Moringa oleifera.*This was however contrary to observation by Oseni *et al.,* 2015 where total cholesterol concentration was depleted as a result of rat fed with bromate. However the reverse of the total cholesterol concentration to almost control level was observed by the ethanolic extract of *Moringa oleifera.* The ethanolic extract also showed its protective ability against hypercholesterolemia on the normal animals fed with the extract as seen in Table 6 group B animals

Table 6: Total cholesterol concentration in selected tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	mMol/dL		
Groups	**Heart**	**Kidney**	**Plasma**
A	21.419± 2.09	11.990 ± 3.11	60.477± 6.34
B	19.138 ± 3.23	8.349 ± 1.87	53.547± 4.23
C	77.486 ± 5.76	16.379 ± 2.98	101.430±6.98
D	26.930 ± 3.87	13.859 ±5.87	67.107±3.47

Mean of triplicate results ±SEM

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Table 7 showed the effects of ethanolic extract of horseradish (*Moringa oleifera)* leaf treatment on the malondialdehyde concentration in dexamethasone-induced hypertensive rats. The concentration of plasma Malondialdehyde (MDA) was shown to be significantly increased in the heart, kidney and plasma of hypertensive rats when compared with the control. However, the hypertensive rats, when placed on *Moringa oleifera* ethanolic extracts had a remarkable decrease in their cardiac, renal and plasma malondialdehyde levels when compared with the control, thus indicating the extract ability to protect against cellular lipid peroxidation caused by the drug and free radical scavenging ability of the ethanolic extract of *Moringa oleifera* leaf in hypertensive rats. The ethanolic extract also showed its protective ability against cellular lipid peroxidation on the normal animals fed with the extract as seen in Table 7 group B animals.
The ability of the ethanolic extract to inhibit the process of lipid peroxidation *in vivo* may be due to the free radical scavenging activities of its phytochemical components. The observations in this study however allude to previous work (Oseni *et al.,* 2015) on effects of aqueous extract of nutmeg on potassium bromated induced renal toxicity and Olorunnisola *et al.,* 2012 on protective effect of *T. violacea r*hizome extract against hypercholesterolemia-induced oxidative stress in Wistar rats

Table 7: Malondialdehyde concentration in selected tissues of hypertension induced rats treated with ethanolic extract of *Moringa oleifera* leaf.

	(Units/ mg)		
Groups	**Heart**	**Kidney**	**Plasma**
A	0.22 ± 0.01	0.12±0.002	0.50±0.002
B	0.12±0.001	0.08±0.003	0.32±0.004
C	0.31±0.001	0.35±0.010	1.10±0.030
D	0.15±0.001	0.29±0.001	0.30±0.002

Mean of triplicate results ±SEM

CONCLUSSION AND RECOMMENDATION

Moringa oleifera leaf extract has chemopreventive and protective benefits on Dexamethasone mediated tissues oxidative damage in rat as it significantly reduced the extent of antioxidant loss and restoration of organ dysfunction caused by Dexamethasone in rat.

The results of this study show preventive and protective effect on tissues functions which might be due to the presence of some bioactive compounds in plant ethanolic extract. On the

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basis of our study however, it can be concluded that *Moringa oleifera* leaf ethanolic extract has plasma, cardiac and renal antitoxic and protective effects as well as antioxidant abilities. Further investigations may therefore be necessary to elucidate the active components of *Moringa oleifera* leaf and establish their chemical nature.

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