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Aqueous Extract of *Tetrapleura tetraptera* (Mimosaceae) Prevents Hypertension, Dyslipidemia and Oxidative Stress in High Salt-sucrose Induced Hypertensive Rats

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Abstract: Background: *Tetrapleura tetraptera* (Schumach and Thonn) Taub stem bark is used in African folk medicine to treat hypertension. In the present study, the antihyperlipidemic and antioxidant effects of *Tetrapleura tetraptera* aqueous extract was investigated in high salt-sucrose-induced hypertensive rats. **Methods:** Hypertensive rats were obtained from normotensive Wistar rats by giving daily, 2 mL/100 g salt solution (9%) p.o., with free access to sucrose solution (10%) as drinking water. Another set of rats were divided into three groups of five rats each and treated respectively with salt-sucrose and the aqueous extract of *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril (20 mg kg^{-1}). The effects of plant extract were evaluated after 3 weeks on blood pressure, lipid profile, oxidative status and liver function of animals and compared to those of normotensive control rats. Blood pressure was evaluated by invasive method and biochemical parameters were evaluated by colorimetric and kinetic methods. **Results:** Chronic salt-sucrose consumption increased systolic arterial blood pressure (30.05%) and heart rate (15.36%) as compared to control. *Tetrapleura tetraptera* aqueous extract (100 and 200 mg kg^{-1}) or captopril significantly prevented the increase in blood pressure and heart rate and inhibited salt-sucrose-induced lipid peroxidation in the liver. *Tetrapleura tetraptera* countered salt-sucrose induced oxidative stress by enhancing the activity of antioxidant enzymes (catalase, superoxide dismutase) and glutathione content. The plant extract significantly reduced the high concentration of serum Total Cholesterol (TC), glucose, triglyceride (TG) and low density lipoprotein (LDL-C) and increased high density lipoprotein (HDL-C) observed in salt-sucrose hypertensive rats. *Tetrapleura tetraptera* also prevented the increase in atherogenic index. **Conclusions:** these finding supports the traditional use of *Tetrapleura tetraptera* extract and suggested that the bark of this plant could protect from salt-sucrose damage by enhancing activities of enzymes and holding up the increase of lipid markers and membrane peroxidation.

Key words: *Tetrapleura tetraptera*, rats, antihyperlipidemic, antioxidant activity

INTRODUCTION

Hypertension is the leading risk factor linked to increasing complications of cardiovascular diseases, coronary heart diseases, stroke and renal failure (Taneja and Mandal, 2010). Hypertension causes end organ damage to the heart, kidneys and the central nervous system (atherosclerosis occurs in 30% of the cases and congestive heart failure, stroke, renal failure and retinopathy in more than half of the cases) (Faraji and Tarkhani, 1999). Cardiovascular disease is the leading cause of death and a major cause of disability not only in the United States but also worldwide (WHO, 2002). World Health Organization indicate that total cholesterol concentrations superior at 147 mg dL^{-1} (3.8 mmol L^{-1}) account for 18% of cerebrovascular disease and 56% of coronary heart disease on a global basis (WHO, 2002). There is also a powerful association between hypertension and cardiovascular disease (JNC, 2003), with approximately two thirds of strokes and one half of coronary heart disease cases worldwide occurring in the setting of systolic blood pressure superior at 115 mmHg (WHO, 2002).

Reactive oxygen species (ROS) have also been shown to play a central role in the pathogenesis of metabolic disorders such as dyslipidemia and hypertension

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(Hopps *et al*., 2010). Various preclinical and clinical studies have shown that high salt-sucrose is associated with an increased formation of free radicals along with an imbalance in antioxidant status which leads to increase in oxidative damage of cellular components and oxide nitrite (Roberts *et al*., 2000; Hopps *et al*., 2010). Antioxidative substances are believed to suppress the onset and development of atherosclerosis and in addition, flavonoids and phenolic compounds have been proved to have antioxidative effects (Choi *et al*., 2010). Thus, substances with both antioxidative and hypocholesterolemic properties are expected to be effective in preventing the formation and/or progression of atherosclerosis (Carew *et al*., 1987).

Tetrapleura tetraptera is a single-stemmed, robust, perennial tree belonging to the Mimosaceae family; with dark green leaves and thick, woody base and spreading branches. *Tetrapleura tetraptera* has been used in folk medicine in the treatment of hypertensive disorders, inflammation and several women's diseases such as breast and uterus cancers (Ojewole and Adesina, 1983). In the centre of Cameroun, *Tetrapleura tetraptera* is used in diabetics and cardiovascular affections treatment. Cardiovascular and neuromuscular actions of scopeletin from *Tetrapleura tetraptera* fruits were described (Ojewole and Adesina, 1983). This plant is also frequently used in Tropical African traditional medicine for the management and/or control of an array of human ailments, including arthritis and other inflammatory conditions, asthma, diabetes mellitus, hypertension, epilepsy and schistosomiasis (Aladesanmi, 2007). However, relatively less has been studied about the preventive effect of *Tetrapleura tetraptera* bark on hypertension, dyslipidemia and oxidative stress. The present study was therefore conducted to evaluate the potential benefits of orally administered *Tetrapleura tetraptera* stem bark aqueous extract on hypertension, oxidative stress and lipid profiles in high salt-sucrose-induced hypertensive rats.

MATERIALS AND METHODS

Plant material and extraction: Specimens of *Tetrapleura tetraptera* were collected from Nkolossan in the centre region of Cameroon in July 2009. The plant material was authenticated at the National Herbarium, Yaounde, where a voucher specimen N°31310/HNC was deposited. The barks of this plant were used in this study. *Tetrapleura tetraptera* stem bark was dried at room temperature and grounded into a fine powder. The powder (500 g) was macerated in 5 L of distilled water for 24 h according to the traditional method. The solution obtained after filtration with Whatman No. 1 filter paper, was dried in drying-cupboard (45°C) and gave 35.1 g (7.02% yield) of a brown powder.

Induction of experimental hypertension: For cardiovascular experiments, twenty five male Wistar rats (from the animal house of the Faculty of Science, University of Yaounde I-Cameroon) weighing in average 170 g were used. Animals were housed in polyethylene cages in groups of five rats per cage at room temperature, under a 12/12 h light/dark natural cycle with free access to standard laboratory rat food and tap water. Prior authorization for the use of laboratory animals in this study was obtained from the Cameroon National Ethical Committee (Reg. N° FWAIRD 0001954). At the experimental period, one group received daily salt-sucrose (Ssu) solution (2 mL/100 g p.o., 9% salt solution with free access to a 10% sucrose solution as drinking water) whereas, the other groups received concomitantly salt-sucrose and the aqueous extract of *Tetrapleura tetraptera* at doses of 100 and 200 mg kg^{-1} (SsuEx 100 and SsuEx 200) or captopril 20 mg kg^{-1} (SsuCap 20). The last group made of five rats received water throughout the three weeks of experiments.

Measurement of blood pressure and heart rate: Three weeks after the beginning of the different treatments, arterial blood pressure and heart rate of all rats were measured as described by Bopda *et al*. (2007). Briefly, rats were anesthetized with an intraperitoneal injection of carbamate ethyl, 98% (1.5 g kg^{-1}). The trachea was exposed and cannulated to facilitate spontaneous breathing. The arterial blood pressure was measured from right carotid artery via an arterial cannula connected to a pressure transducer coupled with a hemodynamic recorder Biopac Student Lab. (MP35) and computer. After a 20 min stabilization period, arterial blood pressure (systolic, mean and diastolic) and heart rate were computerized.

Determination of lipid profile and hepatic function: After blood pressure and heart rate measurement, rats were killed by decapitation and blood was collected in dried tubes. Serum was separated by centrifugation at 3600 rpm for 15 min. Commercial diagnostic kits (Fortress, UK) were used to determine serum Total Cholesterol (TC), HDL-cholesterol (HDL-C), triglycerides (TG), Gamma glutamyltransferase (GGT), Glucose, Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT). Chronolab AG Switzerland kit was used for Alkaline phosphatase (ALP). Atherogenic Index (AI) was calculated according to Wakayashi and Kobaba (2002)

method, using the following equation: AI = (TC-HDL-C)/TC. LDL-Cholesterol (LDL-C) was estimated according to the Friedewald *et al*. (1972) equation: LDL-C = TC-(TG/5)-HDL-C.

Oxidative stress markers investigation: After blood collection, the liver was rapidly dissected out, weighted and homogenized at 20% in Tris-HCl 50 mM buffer solution. Homogenates were centrifuged at 10,000×g for 30 min. Reduced glutathione (GSH) content in liver was determined by the method of Ellman (1959). Superoxide dismutase (SOD) and catalase (CAT) activities were determined according to the methods of Misra and Fridovich (1972) and Sinha (1972), respectively. Tissue lipid peroxidation was estimated by measuring the thiobarbituric acid reactive substances (TBARS) and was expressed in terms of malondialdehyde (MDA) content, according to the method of Wilbur *et al*. (1949). Nitrite (NO) contents of the tissue were determined by the methods of Ikeda *et al*. (2003).

Statistical analysis: All data were expressed as Mean±SEM. The statistical significance was evaluated by Student's t-test using the Statistical Package for the Social Sciences (SPSS) 10.1. The difference between the groups was compared using one-way analysis of variance (ANOVA) followed by the Duncan post hoc test. A value of $p<0.05$ was considered statistically significant.

RESULTS

Effect of the aqueous extract of *Tetrapleura tetraptera* on arterial blood pressure and heart rate: After 3 weeks of treatment, systolic, mean and diastolic arterial blood pressures were significantly higher in hypertensive salt-sucrose-treated rats (Table 1). The heart rate of rats receiving salt-sucrose diet increased significantly as compare to normotensive rats. The *Tetrapleura tetraptera* aqueous extract significantly and dose-dependently reduced mean arterial blood pressure by 38.56% (100 mg kg^{-1}) and 42.40% (200 mg kg^{-1}). Captopril prevented by 49.32% the increase in mean arterial blood pressure. The rise in heart rate was significantly prevented by treatment with *Tetrapleura tetraptera* aqueous extract or captopril in salt-sucrose-induced hypertensive rats.

Effect of *Tetrapleura tetraptera* on serum enzymes and lipid profile: The changes in serum AST, ALT, GGT and ALP activities and lipid profile are shown in Table 2 and 3. AST and ALT activities were significantly ($p<0.001$) increased in high salt-sucrose group, respectively by 85.53 and 56.06% compared to the control group. High sucrose-salt feeding in rats promoted an increased in GGT (47.94%) and ALP (60.51%) in high salt-sucrose group compared to control. *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril prevented salt-sucrose-induced higher AST activity by 55.44, 76.07 and 88.97%, respectively. Higher ALT activity was also significantly ($p<0.01$) reduced by the plant extract treatment. GGT and ALP activities were also decreased in *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril treated rats, compared to those only on salt-sucrose regimen.

As shown in Table 3, serum HDL-C was significantly ($p<0.05$) decreased by 21.11% in high salt-sucrose group when compared to control. Serum TC, glucose, LDL-C, TG and the calculated AI were significantly ($p<0.05$)increased in these animals. The aqueous extract of *Tetrapleura tetraptera* stem barks (100 and 200 mg kg^{-1}) as well as captopril (20 mg kg^{-1}) resulted in a significant decrease in serum TC, glucose, LDL-C, TG and AI when compared to salt-sucrose untreated rats. At the dose of Several mechanisms could be proposed in this study for the blood pressure-reducing effect of the aqueous stem bark extract of *Tetrapleura tetraptera*, including 200 mg kg^{-1}, the plant extract reduced these parameters by

Table 1: Haemodynamic effects of the extract

	Systolic pressure (mmHg)	Means pressure (mmHg)	Diastolic pressure (mmHg)	Heart rate (ppm)
Control	135.53±1.77	115.51±1.34	105.50±1.27	387.86±2.47
Ssu	193.78±3.26^{c}	175.14±2.58^{c}	165.81±2.79^{c}	458.29±4.26^{c}
SsuE×100	125.55±1.79^{cy}	107.60±1.39^{cy}	98.62±1.34^{cy}	295.45±4.15^{cy}
SsuE×200	115.80±1.19^{cy}	100.87±1.76^{cy}	93.43±2.12^{cy}	384.47±4.67^{cy}
SsuCap 20	103.86±4.44^{cy}	88.76±4.73^{cy}	81.21±4.96^{cy}	369.38±4.36^{cy}

Values are Means±Standard deviation, n = 5; means followed by different letters in the same row differ significantly. $^{c}p<0.001$, significantly different compared to salt-sucrose hypertensive rats

Table 2: Effects of aqueous extract *Tetrapleura tetraptera* on serum AST, ALT, GGT and ALP parameters

	Treatments				
Parameter (u L^{-1})	Control	Ssu	SsuEx 100	SsuEx 200	SsuCap 20
AST	4.04±0.25	27.92±0.88^{c}	12.44±1.20^{cy}	6.68±0.76^{cy}	3.08±0.38^{cy}
ALT	7.60±0.16	17.30±2.53^{c}	12.80±1.58^{cy}	9.70±0.47^{y}	8.48±1.58^{y}
GGT	1.90±0.25	3.65±0.63^{b}	1.11±0.25^{y}	1.05±0,50^{y}	2.06±0.12^{y}
ALP	23.39±3.47	59.23±0.29^{c}	22.85±1.73^{y}	16.45±3.18^{y}	19.01±3.61^{y}

Values are Means±Standard deviation, n = 5; means followed by different letters in the same row differ significantly. $^{a}p<0.05$, $^{b}p<0.01$, significantly different compared to salt-sucrose hypertensive rats

Table 3: Effects of *Tetrapleura tetraptera* aqueous extract on serum lipid parameters and glucose levels

	Treatments				
Parameter	NC	Ssu	SsuEx 100	SsuEx 200	SsuCap 20
Total cholesterol (mg dL^{-1})	109.46±2.91	417.47±3.88^{c}	144.98±3.39$^{c\beta}$	77.24±1.94$^{\gamma}$	103.29±5.81$^{\gamma}$
HDL-cholesterol (mg dL^{-1})	51.97±3.67	41.00±1.11^{a}	45.69±0.77	52.00±0.19	52.92±4.99$^{\gamma}$
LDL-cholesterol (mg dL^{-1})	44.26±0.44	345.26±5.85^{c}	80.55±3.14$^{c\beta}$	19.73±1.60$^{b\gamma}$	46.44±0.77$^{\gamma}$
Triglycerides (mg dL^{-1})	67.52±1.60	156.06±4.32^{c}	93.65±2.62$^{a\gamma}$	27.29±2.62$^{a\gamma}$	19.65±0.24$^{\gamma}$
Glucose (mg dL^{-1})	100.67±0.60	190.54±0.17^{c}	145.98±2.48$^{c\gamma}$	88.91±1.46$^{c\beta}$	107.15±3.15$^{\gamma}$
Atherogenic Index	0.50±0.02	0.90±0.00^{c}	0.68±0.00^{b}	0.33±0.02^{a}	0.48±0.02$^{\beta}$

Means±Standard deviation, n = 5; means followed by different letters in the same row differ significantly. $^{a}p<0.05$, $^{b}p<0.01$, $^{c}p<0.001$, significantly different compared to salt-sucrose hypertensive rats

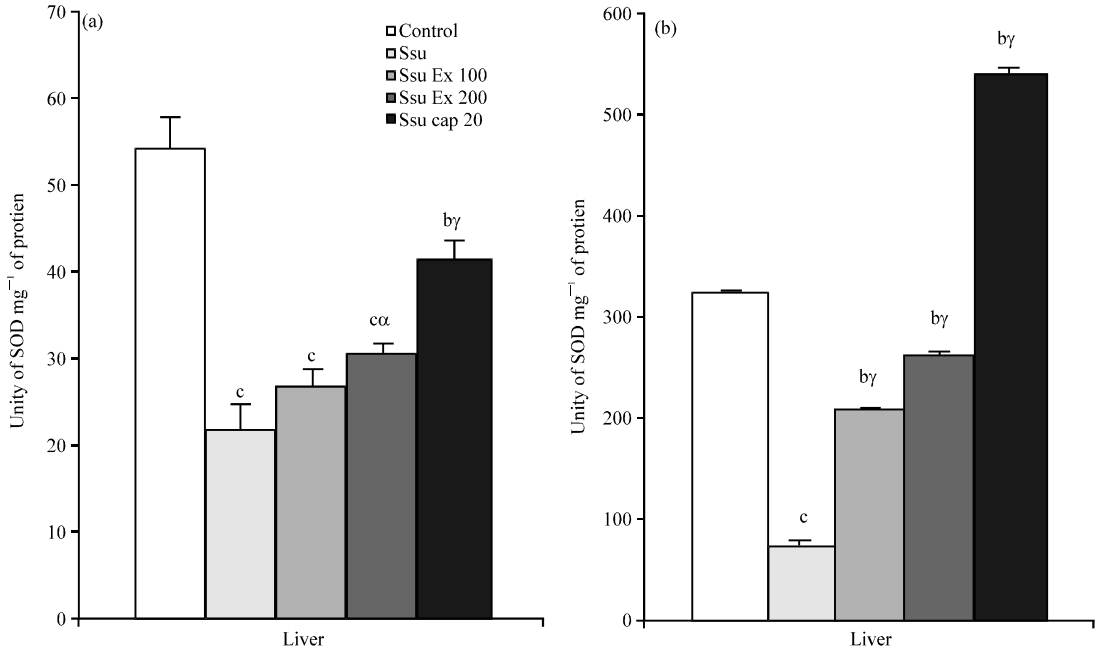

Fig. 1: Effect of *Tetrapleura tetraptera* on tissues SOD and Catalase in liver tissue of high salt-sucrose feeding rats. Values are Means±Standard deviation, n = 5; means followed by different letters in the same row differ significantly. $^{\alpha}p<0.01$, $^{\gamma}p<0.001$, significantly different compared to normal control rats, $^{\beta}p<0.01$, $^{\beta}p<0.001$, significantly different compared to sucrose/salt hypertensive rats. Ssu: high-salt-sucrose, SsuEx 100: high-salt-sucrose+aqueous extract (100 mg kg^{-1}), SsuEx 200: high-salt-sucrose+aqueous extract (200 mg kg^{-1}), Cap 20: high-salt-sucrose+captopril (20 mg kg^{-1}), Conc: concentration

81.50% for TC, 53.34% for glucose, 94.28% for LDL-C, 82.51% for TG and 63.53% for AI.

Effect of *Tetrapleura tetraptera* on the hepatic antioxidant enzymes activities and liver lipid peroxidation: Liver content in TBARS, GSH, nitrites (NO) and hepatic antioxidant enzyme activities (SOD and CAT)are presented in Fig. 1-3. Lipid peroxidative markers TBARS was significantly higher in high salt-sucrose group as compared to normal control ($p<0.001$) *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril significantly ($p<0.001$) lower these values as compared to high salt-sucrose treated rats. However, NO content in *Tetrapleura tetraptera*-treated animals remains significantly higher in liver when compared to salt-sucrose control group. The activities of liver antioxidants parameters such as SOD, CAT and GSH were significantly decreased by 59.98, 77.34 and 74.66%, respectively in high salt-sucrose rats as compared to control group. A significant improvement of these three parameters has been observed in *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril groups. At the dose of 200 mg kg^{-1}, the plant extract increased these parameters by 61.21% for GSH, 71.94% for CAT and 28.61% for SOD as compared to high salt-sucrose feeding rats.

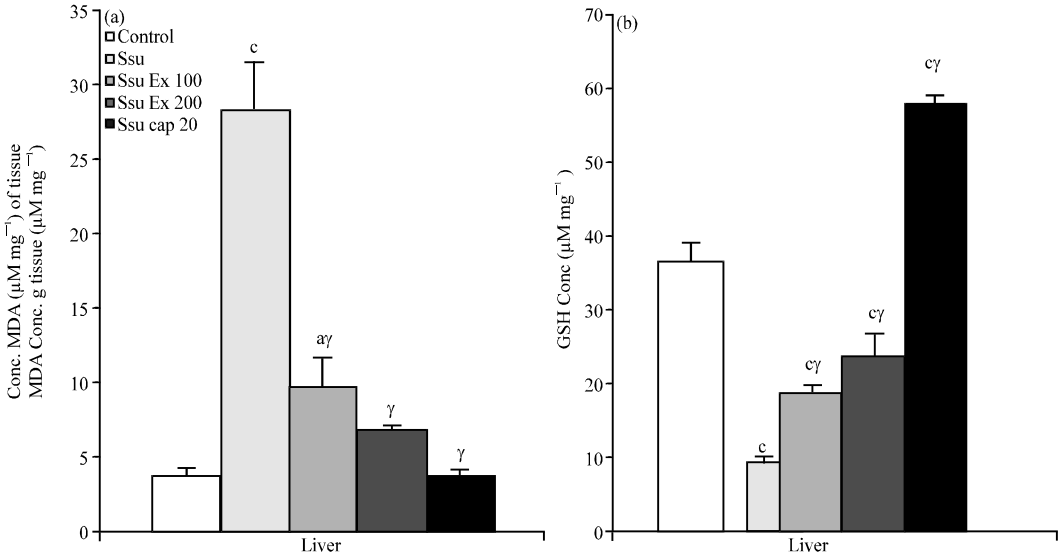

Fig. 2: Effects of *Tetrapleura tetraptera* on tissues MDA and GSH levels in liver tissue of high salt-sucrose feeding rats. Values are Means±Standard deviation, n = 5; means followed by different letters in the same row differ significantly. $^{a}p<0.05$, $^{c}p<0.001$, significantly different compared to normal control rats, $^{\gamma}p<0.001$, significantly different compared to sucrose/salt hypertensive rats. Ssu: high-salt-sucrose, SsuEx 100: high-salt-sucrose+aqueous extract (100 mg kg^{-1}), SsuEx 200: high-salt-sucrose+aqueous extract (200 mg kg^{-1}), Cap 20: high-salt-sucrose+captopril (20 mg kg^{-1}), Conc: concentration

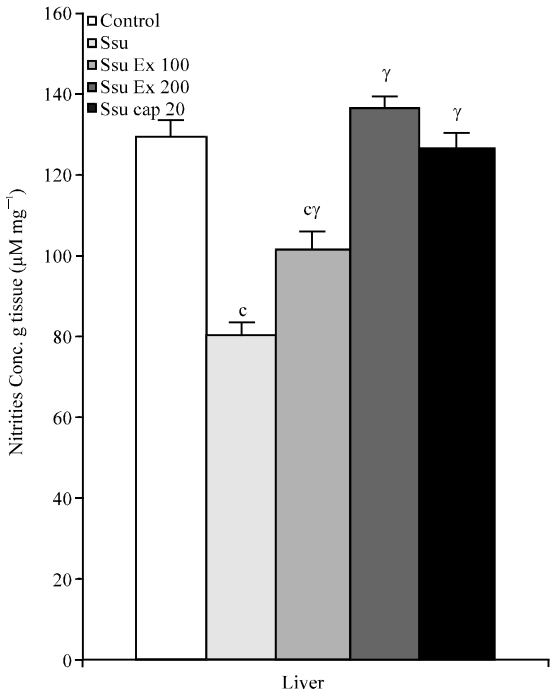

Fig. 3: Effects of *Tetrapleura tetraptera* on tissues Nitrites levels in liver tissue of high salt-sucrose feeding rats. Values are Means±Standard deviation, n = 5; means followed by different letters in the same row differ significantly. $^{c}p<0.001$, significantly different compared to normal control rats, $^{\gamma}p<0.001$, significantly different compared to sucrose/salt hypertensive rats. Ssu: high-salt-sucrose, SsuEx 100: high-salt-sucrose+aqueous extract (100 mg kg^{-1}), SsuEx 200: high-salt-sucrose+aqueous extract (200 mg kg^{-1}), Cap 20: high-salt-sucrose+captopril (20 mg kg^{-1}), Conc: concentration

DISCUSSION

The present study showed that hypertension and dyslipidemia induced by high salt-sucrose in rats was associated with an oxidative stress characterized by a decrease in superoxide dismutase production, in tissue liver, leading to elevated plasma concentrations of MDA. In fact, it has been reported that addition of high salt to a high sucrose diet causes even more marked elevation in blood pressure in Wistar rats (Preuss and Preuss, 1980). High sucrose intake appears also to elevate blood pressure only with normal or high dietary salt intake (Johnson *et al*., 1993). The plant extract caused a significant and dose-dependent decrease arterial blood pressure in salt-sucrose-induced hypertensive rats. antioxidative, effect on heart function and lipid parameters. Results of our study clearly demonstrated the role of *Tetrapleura tetraptera* in countering the lipidemic-oxidative alterations accompanying salt-sucrose-induced hypertension in rats. In the human body, high levels of triglycerides in the bloodstream have been linked to atherosclerosis and, by extension, the risk of heart disease and stroke (Choi *et al*., 2010). The relationship of dietary carbohydrates to cardiovascular diseases appears to be mediated through indirect mechanisms, contribution to total energy and its effect on overweight and obesity; influence on central obesity; effects on plasma lipids, especially triglycerides and effects on glycaemic control (Reddy and Katan, 2004). Triglycerides level was significantly ($p<0.001$) decreased in *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril treated groups as compared to untreated salt-sucrose hypertensive animals. Elevated total cholesterol is a risk factor for coronary heart disease because the build-up of plaque in the artery may lead to narrowing (high blood pressure) or complete blockage (heart attack) of the vessel (Karantonis *et al*., 2006). It is widely accepted that reduction in serum HDL-C is a risk factor for developing atherosclerosis. HDL-C facilitates the translocation of cholesterol from the peripheral tissue, such as arterial walls to liver for catabolism. The increase in HDL-C may slow down the atherosclerotic process (Nofer *et al*., 2002). In addition, atherogenic index (AI), defined as the ratio of LDL-C and HDL-C, is believed to be an important risk factor of atherosclerosis (Fki *et al*., 2005).

Our results showed that the sucrose-salt feeding in rats increased the concentration of serum LDL-C and reduced HDL-C. *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) as well as captopril (20 mg kg^{-1}) attenuated these effect so that, serum concentrations of LDL-C were decreased in rats receiving both high salt-sucrose feeding and plant extract or captopril. Significant lowering of total cholesterol, triglycerides, LDL-cholesterol and raise in HDL-cholesterol is a very desirable biochemical state for prevention of atherosclerosis and ischemic conditions (Jouad *et al*., 2003; Daisy *et al*., 2009). High sucrose-salt feeding appears to reduce HDL cholesterol levels and increase the fraction of small dense LDL, both of which may impact adversely on vascular diseases. This dyslipidemic pattern is consistent with the elevation of plasma triglycerides (Reddy and Katan, 2004). One of the findings of this study is that, *Tetrapleura tetraptera* aqueous extract has an interesting effect of lipid profile. In fact this plant extract prevents from the increase in the factors causing coronary heart diseases and cardiovascular diseases and then may prevent atherosclerosis.

Serum glucose level of sucrose-salt feeding rats was significantly increased compared to control group. However, slight decrease in serum glucose level was observed in *Tetrapleura tetraptera* or captopril treated groups compared to untreated sucrose-salt feeding rats. The glycaemic index of foods might also be a determinant of the extent to which carbohydrates can influence the glycaemic status. Carbohydrate diets with high-glycaemic index might have adversely impact on glucose control, with associated changes in plasma lipids (Reddy and Katan, 2004). *Tetrapleura tetraptera* aqueous extract has been reported to increase glucose uptake and utilization and improve the function of pancreatic beta cells and may also decrease glucose absorption in the gastrointestinal tract (Osman *et al*., 2010). In the present study, the decrease in the glucose level in experimental groups may be due to the glucose lowering effects of *Tetrapleura tetraptera* as earlier demonstrated using chemical compounds isolated for this plant (Aladesanmi, 2007).

Oxidative stress is one of the causative factors that link hypercholesterolemia with atherogenesis (Ong *et al*., 2009). Oxidative stress is known to increase after various forms of vascular insult (Shi *et al*., 2001). It occurred as a consequence of imbalance between production of reactive oxygen species and the antioxidative process in favor of radical production (Dringen, 2000). Hypertension induced by high salt-sucrose feeding in rats brings about remarkable modification in the antioxidant defense mechanisms. It has been demonstrated that hypertension induced by high salt-sucrose feeding in rats diminishes the antioxidant defense system and decreases the activities of SOD, CAT and GSH, elevating the lipid peroxide content (Fki *et al*., 2005). Glutathione (GSH) is known to be the major compound in the intracellular redox status regulation and it is an important substrate and cofactor in many drug's metabolism. Glutathione plays an important role in cell detoxification and protection from

hazardous compounds. A decrease in the amount of glutathione and increase in the amount of MDA may result In the destruction of membrane integrity (Tauseef *et al*., 2007). In this study, the decrease in reduced glutathione and the increase in MDA levels of salt-sucrose-induced hypertensive rats indicate that hyperlipidemic condition was unfortunately related to living cells damage. MDA level is the most important factor indicating increased lipid peroxidative level (Osman *et al*., 2010). The increase in the level of MDA observed in high salt-sucrose compared to control group in the liver could be linked to the generation of free radicals, resulting in the peroxidation of membrane lipids. MDA is an index of the level of oxygen free radicals production. It has been review that a decrease in lipid peroxidation leads to a reduction of atherosclerosis caused by hypercholesterolemia (Yokozawa *et al*., 2003). When compared to the rats treated only with salt-sucrose, aqueous extract or captopril, prevented MDA elevation caused by high sucrose-salt feeding. The observed data suggested that aqueous extract might be capable of lowering or slowing down salt-sucrose mediated lipid peroxidation. On the other hand, our results have shown that salt-sucrose feeding increase serum GGT activity with is also used as a marker for liver diseases in clinical practice (Lee *et al*., 2004). The elevation of serum GGT in salt-sucrose untreated animals might also be interpreted as reflective of oxidative stress under our experimental conditions. The activity of this enzyme was significantly reduced in *Tetrapleura tetraptera*-treated rats, demonstrated again an antioxidative properties of our extract.

NO, a free radical has a number of biological activities and accordingly has attracted much attention recently. It is a potent vasodilator released from endothelial cells and, under certain conditions, from macrophages (Yates *et al*., 1992). The role of NO in association with atherosclerosis is not well understood. It is known that NO can react with and neutralize surperoxide ions and may hypothetically inhibit lipid peroxidation (Yates *et al*., 1992). Furthermore, NO stimulates cellular guanylate cyclase to raise the concentration of cyclic guanosinc monophosphate (cGMP) which may up regulate the level of antioxidant enzymes such as superoxide dismutase (SOD) and catalase. These data support our finding that NO exerts a protective role in LDL peroxidation, this protection may in part account for the pathogenesis of atherosclerosis in animals deficient in NO (Gryglewski *et al*., 1988). In this study, we observed a decrease of NO in the liver of untreated salt-sucrose rats compared to control group. This result suggested a rising of superoxide ions and lipid peroxidation due to high salt-sucrose consumption. The level of nitrites significantly increased in *Tetrapleura tetraptera* (100 and 200 mg kg^{-1}) or captopril treated groups as compared to of untreated salt-sucrose rats. This may be relating to a direct superoxide anions scavenging effect of the plant extract and support antioxidant activities by ROS inhibition of bioactive compounds of *Tetrapleura tetraptera* or captopril.

In conclusion, present study showed that oral administration of *Tetrapleura tetraptera* aqueous extract exhibited an antihypertensive and antidyslipidemia effects on high salt-sucrose feeding rats. This effect might be related to its antioxidant potential and supports the traditional use of the stem bark of *Tetrapleura tetraptera.*

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