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The Interaction Between Angiotensin Converting Enzyme Inhibitor (Captopril) and Heat Stress in The Male Albino rats. 2-Tissue Analysis

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ABSTRACT

Daily exposure to heat stress causes sustained elevation of blood pressure in rats. It is known that the renin-angiotensin system is activated during episodes of behavioral stress, and the purpose of this work was to assess the action of captopril in the development of stress induced hypertension in rats.

Animals were divided into four groups. The first group served as a control, while the other groups were subjected to heat stress of 40°C and high hamidity of 80% for 10 successive days. The second group was served as heat stress, while the third and the fourth groups were received low and high doses of captopril (0.7 & 1.4 mg/kg. b.wt., respectively). After 10 days of treatment, half of animals from each group were decapitated and brain, liver, muscle, heart and kidney were separated and analysed. The other half of animals were left for another 10 days without any additional treatment for recovery.The results revealed a significant decrease in total protein of liver, heart, kidney, total lipids of heart, muscle and brain and total cholesterol of liver. On the other hand, insignificant change was noticed in muscle and brain total protein. Similarly, AST and ALT activities were also within the normal values for all the organs examined.Results exhibited that renin-angiotensin system may be important in the development of stress-induced hypertension in rats.

INTRODUCTION

Hypertension has become a relatively common problem in recent years and it is often of long duration and refractory to standard antihype - rtensive therapy. Epidemiologic studies indicate that the risks of damage to kidney, heart, and brain are directly related to the extent of blood pressure elevation. Even mild hypertension in young or middle-aged adults increases the risk of eventual and organ damage. The risk and therfore the urgency of instituting the rapidincrease in proportion to the magnitude of blood pressure elevation. In fact, hyperten -sion is usually a symptomatic until over end organ damage is imminent or has already occurred. Angiotensin converting enzyme (ACE) inhibitors is popular in the treatment of hypertension. Captopril is one of them and it has been shown to be effective in lowering blood pressure in hypertensive patients. Laderle (1985) considered that captopril may have

theoretically some advantages as compared with other antihypertensive drugs, which may have adverse effects on the patients. Zhang and Xu (1994) stated that captopril signific -antly improved the cardiac function recovery and prevented the ischemia and reperfusion injury in the hypertrophied heart.

Captopril therapy has been reported to be associated with renal failure, hemolytic anaemia and skin rash (Luderer *et al*., 1981). Also, captopril lowered serum creatinine in rats (Vargas *et al*., 1994) and had a stimulatory effect on arachidonic acid metabolism, in addition to its free radical scavenging effect (Gulluoglu *et al*., 1996). Cutaneous reaction and renal dysfunction have also been demonstrated by Smit *et al*. (1984) and Swales (1995), respectively. Ganapathy *et al*. (1985) observed an inhibition of hepatic prolibase in captopril-treated rat and human. Sakr (1995), stated that captopril caused renal and hepatic lesions. On the other hand, Zhang and Xu (1994) found that captopril prevented the schema and repair fusion injury in the hypertrophied heart according to inhibition of the cardiac renin-angiotensin system. Also, captopril decreased the mobility of rats in the open field (Vernigora *et al*., 1996) and affected the behavior of the home cage emergence rats and open field escape rats (Prickaerts *et al*., 1996).

Coste *et al*. (1995) found that ten days of air-jet stress caused a significant elevation of blood pressure in borderline hypertensive rats exposed to air-jet stress without receiving captopril but not in animals given captopril concurrently with air-jet stress. So, they concluded that the renin-angiotensin system may be important in the development of stress-induced hypertension in the borderline hypertensive rats.

It is known that the renin-angiotensin system is activated during episodes of behavioral stress. In a previous study, we examined the effects of angiotensin converting enzyme (ACE) inhibitors and heat stress on some haematologial and biochemical parameters in the serum of male albino rats. The purpose of the present study was planned to assess the effect of both captopril and heat stress on the physiological function of some vital organs as liver, heart, kidney, brain and muscle.

MATERIAL AND METHODS

Forty male albino rats weighed about (120 - 150g) were used in this experiment. The animals were housed in suitable cages inside a thermostatic chamber, in which the room temperature was controlled by thermestors and the relative humidity was measured by thermohygrometer.

They were acclimatized for 10 days before the beginning of the experiment, and fed *ad libitum* with a commercial diet. They were allocat ed into four equal groups. One group acted as a control, others were put in home cage's temperature at 40°C and humidity 80%. One of these groups was acting as a heat stress control, the other two groups had oral treatment with a solution of an active
gradient of captopril in distilled water (captopril, 99.98% or dry, 0.11% water, Epico) at 0.7 and 1.4 mg/kg.b.wt for the third and fourth groups, respectively. Half of the group was decapitated after 10 days of treatment while the other half was kept 10 days after the last dosing without any additional treatment in order to follow up any recovery signs.

At the end of each period, animals were weighted then decapitated and rapidly dissected and selected organs (heart, liver, brain, kidney and muscle) were taken, then cleaned and weighted, and pieces of each were weighted put in appropriate amount of 30% potassi -um hydroxide for total protein determination, in concentrated sulph -oric acid for total lipids, or in saline and hemoginized for determination of cholesterol and estimation of AST and ALT activities.

Total protein was estimated using Biuret method as described by Doumas (1975). Total lipids were determined using the method of Knight *et al*. (1972). In case of cholesterol level, it was measured according to the method of Jung and Parekh (1971). ALT and AST activities were demonstrated accor -ding to the method of Rabbo *et al*. (1963).

To compare the results of different experimental animal groups, the student "t" test was used. Significant differences between the means of control and treated groups were considered only at $P<0.05$ (Sokal and Rahif, 1981).

RESULTS

Table (1) & figure (1) exhibited non significant change in percentage of organ/body weight ratio for all groups in both treated and recovery periods for each of liver, kidney, brain and testis organ.

On the other hand, the present study indicated significant elevation ($P\leq0.01$) in percentage of heart weight/body weight ratio in (control + heat stress) group after treatment period (10 days), this ratio recorded significant decreased ($P\leq0.01$) in both (heat stress + low dose captopril) and (heat stress + high dose captopril) group after treated period, the same results were noticed for percentage of spleen wt./body wt. ratio as shown in Table (1) and Figure (1).

It is clear that heat stress resulted in an initial reduction of liver total protein. This reduction was highly significant ($P < 0.01$) till the end of the experiment except in the case of low dose treatment which recorded a significant decrease ($P < 0.05$) after the recovery period (table 2 and figure 2).

After 10 days of treatment, all of rats treated with captopril showed a highly significant ($P < 0.01$) decrease in heart protein. The group exposed to heat stress showed a significant ($P < 0.05$) decrease till the end of the experiment. After the recovery period, low dose of captopril treated (0.7 mg/kg. b.ut) showed a significant ($P < 0.05$) decrease in heart protein, while the high dose groups was still higher ($P < 0.01$).

However, highly significant decrease of kidney protein ($P < 0.01$) was recorded after 10 days of treatment in all treated groups. After the recovery period rats exposed to heat stress or that treated with low dose of captopril showed insignificant change, while the grouptreated with a high dose was still significant ($P < 0.05$).

However, all treated rats did not show appreciable changes both muscle and brain total protein as compared with their corresponding control group (table 2 and figure 2).

The obtained results presented in (table 3 and figure 3) indicated that the level of total skeletal muscle, heart and brain lipids showed a highly significant decrease ($P < 0.01$) for both stress and all doses used of captopril throughout the experimental period. Similarly, a highly significant decrease ($P < 0.01$) of the total liver lipids was recorded for heat stress and low dose of captopril (0.7 mg/kg. b.wt). While high dose of captopril showed insignificant change during the treated period

followed by significant decrease ($P < 0.05$) after the
recovery period. On the other hand, total kidney lipids showed highly significant decrease for all treated groups after the treated period and lasted to the end of the experiment (except the group of heat stress which showed insignificant change after the recovery period).

Heat stress and captopril treatment of rats induced a signif -icant decrease ($P < 0.01$) for the

level of cholesterol of liver after 10 days of treatment. This decrease lasted to the end of the experiment i.e. after 20 days (table 4 and figure 4). Furthermore, a high significant decrease ($P < 0.01$) of heart choles -terol was recorded for heat stress and low dose (0.7 mg/kg. b.wt) treated groups after 10 days of treatment. While, high dose of captopril (1.4 mg/kg. b.wt) showed a significant decrease ($P < 0.05$) of heart cholesterol.

After the recovery period, no significant changes was recorded for captopril treated groups. But, heat stress groups was till show a significant decrease ($P < 0.05$). The same results were obtained for kidney cholesterol after the treated period, while insignificant changes were recorded for all treated groups after the recovery period. Concer -ning skeletal muscle and brain cholesterol highly significant decre -ase ($P < 0.01$) were observed in all treated rats after the treated period. On the other hand, non significant change was recorded after the recovery period for captopril treated groups. While, heat stress group was still pronounced ($P < 0.01$) as shown in (table 4 and figure 4).

The present study indicated that, AST and ALT activities (except ALT of liver) of male albino rats tended to increase in heat stress even if captopril was used (tables 5 & 6 and figures 5 & 6). However, after the recovery period, the same results were noticed except that ALT
activity of liver were still lesser than that of the control groups.
Yet, it was still within the normal values for all groups after the treated period (10 days) or the recovery period in comparison with that of the control groups.

DISCUSSION

It is well known that heat stress in middle and old age is associated frequently with degenera -tive cardiovascular disease, particul -arly arteriosclerosis, hypertension and myocardial ische -mia (Ferguson and O'Brien, 1960). Also, Coste *et al*. (1995) stated that daily exposure to air-jet-stress (AJS) caused sustained elevation of blood pressure in borderline hypertensive rats. Hypertension, congestive heart failure and myocardial infraction are common diseases. Most of these disorders necessitate drug treatment of long duration. Angiotensin-converting enzyme inhibitors are now the usual treatment for those disorders. Intensive antihypertensive therapy may be followed by functional impairment of many organ system (Kumar *et al*., 1976 and Cove *et al*., 1979).

Taguma *et al*. (1985) was the first to report that captopril treatment reduced heavy proteinuria in patients with advanced diabetic nephropathy. Since there were several studies have been carried out to evaluate the proteinuria-reducing or renal-protective effect of ACE inhibitors in patients with chronic renal failure or diabetic nephropathy (Marre *et al*., 1988, Bedogna *et al*., 1990; Heeg *et al*., 1987 and Parving *et al*., 1988), as well as in

animal models of chronic renal disease (Andrson *et al*., 1986; Zats *et al*., 1986 and Beukers *et al*., 1989). The present work revealed that the level of skelelal, liver and kidney proteins was lower than that of control rats after 10 days of heat stress and captopril admin - istration and it lasted to the end of the experiment (20 days of treatment). This might result from tissue degradation or changes of cell permeability. This is in harmony with Helal and Zahkouk (1999) who recorded an increase in serum protein level after captopril. In support of this, the remarkable decrease of body weight recorded by Helal and Zahkouk (1999). The decrease of liver protein level throughout the experimental period, might be a result of cytotoxic effects of captopril especially to the liver.

In previous work, there was significantly increase of total serum protein for all treated groups. This was accompanied with a decrease of tissue proteins in all treated groups in the present study. It is clear that the increase of serum protein and the decrease of liver, heart and kidney protein resulted from tissue degradation of cell permeability. This is in harmony with the increased blood glucose level mostly through gluconeogensis and/or haemoconcentration. The decrease of tissue proteins could be a reflection to inhibition of DNA and/or RNA and hence protein synthesis. A decrease of nucleic acids, total protein of liver in birds (Saleh, 1990) and different mammals (El-Fiky *et al*., 1992 and Amer *et al*., 1994) has been reported.

The hazardous effect of heat stress may occure during prenatal growth and still unknown during postnatal growth (El-Sayed, and Kariem 1996). The bad effect of hyperthermia on tissues may be attributed to the inhibition of tissue protein synthesis as reported by Millan *et al*., (1979) or denaturation of protein which represents the main cause of cell death (Westra and Dewey, 1971 and Rosenbery *et al*., 1971).

In the present work, significant decrease of both total lipids and cholesterol was observed in different organs. In a previous study, Helal and Zhakhouk (1999) reported that captopril and heat stress induced significant decrease of ser -um total lipids accompanied by significant increase of serum cholest -erol. The decrease of tissue cholesterol levels correlated well with the proposed impairment of different organ function specially liver function. Several theories had been advanced to explain the reason of cholesterol lowering mechanisms, including the stimulation of cholest - erol excretion into the intestine, stimulation the oxidation of cholesterol to bile salts, blocking the re-absorption of cholesterol from the gastrointestinal tract, preventing the re-absorption of bile, salts and inhibition of cholesterol synthesis (Levy, 1977).

The present study showed a decrease in ALT activity of liver which is a good sign of the disorder of liver function, and clear to the damage of liver tissues. These results are agreement with the findings of Helal and Zahkouk (1999). The effect of heat stress on the liver is in accordance with Saissy *et al*. (1996), who reported that exertional heat stroke can cause fulminant liver failure, resulting either from the direct effect of heat on the hepatic parenchyma, or from acute hepatic ischemia due to blood redistribution made worse by the hypersecretion of antidiuretic hormone, a potent portal vasoconstrictor, which occurs in the heat acclimated subject.

Also, Sort *et al*. (1996) recorded the first case of severe and recurrent

liver impairment due to heat stroke. It was clear from this study that captopril has a limited effect on the different tissue organs, even after the recovery period.

In the present study, the significant increase in percentage of heart wt./body wt. ratio may be an adapted result to heat stress after treatment period, this was in agreement with. Hore (1975) who stated that, at higher temperatures the optimum fibre length is greater for the development of the maximum tension, moreover heat stress in middle and old age is associated frequently with degenerative cardiovascular disease, particularly arteriosclerosis, hypertension, myocardial ischemia & myocardial infarction Ferguson and O'Brien (1960) Coste *et al*., (1995) and Helal and Zahkouk, (1999). Angiotensin converting enzyme (ACE) inhibitors are now the usual treatment for those disorders. Intensive antihypertensive therapy may be followed by functional impairment of many organ system (Kumar *et al*., 1976 and Cove *et al*., 1979).

The decrease in the percentage of heart wt./body wt. ratio in low and high dose captopril treatment was in agreement with the findings of several studies. (Urata *et al*., 1990; Urata *et al*., 1991 & Kanazawa *et al*. 1995) they stated that captopril treatment attenuate the increase in heart weight./body weight ratio might partly explain the existence of angiotensin-forming pathways in the heart, which are not dependent on angiotensin converting enzyme, also Kimura *et al*., (1996) attributed the decrease in left ventricular weight/body weight ratio
in rats to the treatment with both taurine and enalapril (ACE inhibitor).

In the present work, the increase in percentage of spleen weight/body weight ratio after exposure to heat stress was noticed , this is in support with the findings of Ji-Y *et al*., (1995), Kimura *et al*., (1996), which attributed the increase in the ratio of spleen/body wt. in immunos-timulators mice to heat and cold stress. In contrast the treated animals with low and high doses of captopril exhibited a significant decrease in percentage of spleen weight/body weight ratio.

From the present data, it is well recommended to use captopril treatment in patients who suffered from hyperlipodemia, hyperpotei nemia and hypercholestrolemia as it's well know that findings on different stresses can't be necessarily extrapolated to other stresses. Because each stress factor act through its own mechanism and pathway. Nevertheless, the present findings would encourage similar undertaking on other stress, drugs and phyla. Thus should be of interest when considering possible application on other stresses and drugs at latter stage.

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Table (1): Show the percentage of body weight changes under the effect of heat stress and captopril (0.7 and 1.4 mg/kg. b.wt) organ/body weight in male albino rats.

Parameters / Organs		Treated period (10 days)				Recovery period (10 days)			
		Control	Heat stress	heat stess + low dose	heat stess + high dose	Control	Heat stress	heat stess + low dose	heat stess + high dose
Liver	Mean ±S.E Probability	4.92 0.10	4.90 0.28	4.40 0.29 insig.	4.42 0.21 insig.	4.88 0.13	4.74 0.12 insig.	4.60 0.14 insig.	4.78 0.06 insig.
kidney	Mean ±S.E Probability	0.76 0.02	0.74 0.02	0.72 0.04 insig.	0.74 0.02 insig.	0.76 0.04	0.86 0.24 insig.	0.72 0.04 insig.	0.78 0.04 insig.
Heart	Mean ±S.E Probability	0.46 0.02	0.64 0.02	0.56 0.02 < 0.01	0.44 0.02 < 0.01	0.52 0.04	0.50 0.03 insig.	0.50 0.03 insig.	0.46 0.02 insig.
brain	Mean ±S.E Probability	0.88 0.03	0.86 0.02	1.04 0.07 insig.	0.98 0.04 insig.	0.82 0.04	0.83 0.02 insig.	0.88 0.07 insig.	0.88 0.02 insig.
Testes	Mean ±S.E Probability	1.54 0.04	1.58 0.03	1.70 0.07 insig.	1.62 0.06 insig.	1.56 0.04	1.54 0.02 -	1.72 0.04 -	1.74 0.04 -
spleen	Mean ±S.E Probabil	0.32 0.03	0.58 0.02	0.48 0.04 < 0.01	0.52 0.04 < 0.01	0.36 0.02	0.30 0.03 insig.	0.42 0.04 insig.	0.40 0.03 insig.

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Table (2): Effect of heat stress and captopril (0.7 and 1.4 mg/kg. b.wt) on total protein (mg/g tissue) of liver, heart, kidney, muscle and brain of male albino rats.

Organ / Parameters		*Treated period (10 days)*				*Recovery period (10 days)*			
		Control	*Heat stress*	*heat stess + low dose*	*heat stess + high dose*	*Control*	*Heat stress*	*heat stess + low dose*	*heat stess + high dose*
Liver	*Mean*	*69.0*	*62.0*	*60.0*	*55.0*	*67.0*	*61.5*	*61.0*	*55.0*
	± S.E	*0.9*	*0.8*	*0.4*	*0.6*	*2.1*	*2*	*1.4*	*1.2*
	Probability		*< 0.01*	*< 0.01*	*< 0.01*		*< 0.01*	*< 0.05*	*< 0.01*
Heart	*Mean*	*21.0*	*18.3*	*18.0*	*16.1*	*20.0*	*18.0*	*18.1*	*14.2*
	± S.E	*0.5*	*0.4*	*0.3*	*0.2*	*0.6*	*0.4*	*0.5*	*0.6*
	Probability		*< 0.05*	*< 0.01*	*< 0.01*		*< 0.05*	*< 0.05*	*< 0.01*
Kidney	*Mean*	*19.2*	*17.1*	*16.0*	*14.0*	*18.5*	*16.5*	*16.0*	*14.0*
	± S.E	*0.4*	*0.3*	*0.3*	*0.4*	*0.8*	*0.5*	*0.4*	*0.7*
	Probability		*< 0.01*	*< 0.01*	*< 0.01*		*-*	*-*	*< 0.05*
Muscle	*Mean*	*26.5*	*22.5*	*20.5*	*20.0*	*24.0*	*20.8*	*20.0*	*18.0*
	± S.E	*1.9*	*1.2*	*0.6*	*0.5*	*1.2*	*1.4*	*0.6*	*0.7*
	Probability		*-*	*-*	*-*		*-*	*-*	*-*
Brain	*Mean*	*18.0*	*16.0*	*14.0*	*15.0*	*18.0*	*16.0*	*16.0*	*15.0*
	± S.E	*0.9*	*1.1*	*0.8*	*0.7*	*0.8*	*0.4*	*0.5*	*0.4*
	Probability		*-*	*-*	*-*		*-*	*-*	*-*

Table (3): Effect of heat stress and captopril (0.7 and 1.4 mg/kg. b.wt) on total lipids (mg/g tissue) of liver, heart, kidney, muscle and brain of male albino rats.

Organ / Parameters		*Treated period (10 days)*				*Recovery period (10 days)*			
		Control	*Heat stress*	*heat stess + low dose*	*heat stess + high dose*	*Control*	*Heat stress*	*heat stess + low dose*	*heat stess + high dose*
Liver	*Mean*	*116.0*	*100.0*	*105.0*	*110.0*	*112.0*	*95.0*	*100.1*	*107.0*
	± S.E	*2.5*	*1.5*	*2.1*	*1.9*	*1.3*	*1.4*	*1.2*	*1.3*
	Probability		*< 0.01*	*< 0.01*	*N. S*		*< 0.01*	*< 0.01*	*< 0.05*
Heart	*Mean*	*70.0*	*60.0*	*65.0*	*55.0*	*69.0*	*58.4*	*68.1*	*55.0*
	± S.E	*0.5*	*0.7*	*0.4*	*0.6*	*0.3*	*0.2*	*0.9*	*0.4*
	Probability		*< 0.01*	*< 0.01*	*< 0.01*		*< 0.01*	*< 0.01*	*< 0.01*
Kidney	*Mean*	*50.0*	*40.0*	*43.0*	*35.0*	*48.0*	*48.4*	*40.2*	*38.0*
	± S.E	*1.4*	*1.7*	*0.9*	*0.8*	*1.2*	*1.3*	*0.6*	*0.7*
	Probability		*< 0.01*	*< 0.01*	*< 0.01*		*-*	*< 0.01*	*< 0.01*
Muscle	*Mean*	*42.0*	*31.0*	*38.0*	*28.0*	*40.0*	*30.6*	*37.2*	*32.5*
	± S.E	*0.4*	*0.5*	*0.5*	*0.3*	*1.1*	*1*	*0.9*	*0.8*
	Probability		*< 0.01*	*< 0.01*	*< 0.01*		*< 0.01*	*< 0.01*	*< 0.01*
Brain	*Mean*	*37.0*	*32.0*	*30.0*	*28.0*	*35.0*	*30.0*	*32.0*	*26.0*

	± S.E Probability	0.9	0.8 < 0.01	0.2 < 0.01	0.4 < 0.01	0.4	0.6 < 0.01	0.8 < 0.01	0.3 < 0.01

Table (4): Effect of heat stress and captopril (0.7 and 1.4 mg/kg. b.wt) on total cholesterol (mg/g tissue) of liver, heart, kidney, muscle and brain of male albino rats.

Parameters / Organ		Treated period (10 days)				Recovery period (10 days)			
		Control	Heat stress	heat stess + low dose	heat stess + high dose	Control	Heat stress	heat stess + low dose	heat stess + high dose
Liver	Mean ± S.E Probability	33.0 0.4	25.0 0.2 < 0.01	29.0 0.1 < 0.01	31.0 0.2 < 0.01	31.0 0.2	29.0 0.1 < 0.01	30.0 0.2 < 0.01	32.0 0.2 < 0.01
Heart	Mean ± S.E Probability	18.5 0.3	16.5 0.3 < 0.01	17.0 0.2 < 0.01	17.5 0.1 < 0.05	18.0 0.1	17.5 0.2 < 0.05	17.8 0.3 -	17.9 0.2 -
Kidney	Mean ± S.E Probability	14.0 0.1	12.5 0.2 < 0.01	13.0 0.2 < 0.01	13.5 0.3 < 0.05	13.8 0.2	13.0 0.1 -	13.7 0.2 -	13.9 0.1 -
Muscle	Mean ± S.E Probability	13.0 0.2	11.2 0.1 < 0.01	12.0 0.1 < 0.01	12.3 0.2 < 0.01	13.0 0.3	12.0 0.1 < 0.01	12.6 0.1 -	12.8 0.3 -
Brain	Mean ± S.E Probability	36.0 0.2	34.0 0.3 < 0.01	34.4 0.3 < 0.01	34.6 0.2 < 0.01	35.1 0.2	34.0 0.1 < 0.01	35.2 0.2 -	35.4 0.2 -

Table (5): Effect of heat stress and captopril (0.7 and 1.4 mg/kg. b.wt) on AST activity (u/g tissue) of liver, heart, kidney, muscle and brain of albino rats.

Parameters / Organ		Treated (10 days)				Recovery (10 days)			
		Control	Heat stress	heat stess + low dose	Heat stess + high dose	Control	Heat stress	heat stess + low dose	heat stess + high dose
Liver	Mean	19.1	23.0	22.0	21.0	20.1	22.5	21.5	21.0
	± S.E	0.3	0.3	0.5	0.2	0.3	0.4	0.2	0.3
Heart	Mean	22.0	24.0	23.0	23.0	21.0	23.0	21.5	21.2
	± S.E	0.3	0.4	0.2	0.3	0.4	0.2	0.3	0.2
Kidney	Mean	17.1	20.1	19.5	18.5	16.8	19.5	18.5	18.0
	± S.E	0.2	0.3	0.2	0.4	0.2	0.3	0.4	0.2
Muscle	Mean	19.5	22.0	22.0	21.9	19.1	22.0	21.8	20.5
	± S.E	0.2	0.3	0.3	0.2	0.4	0.2	0.3	0.3
Brain	Mean	15.0	17.1	17.0	16.5	15.5	16.8	16.5	15.5
	± S.E	0.3	0.4	0.2	0.3	0.3	0.3	0.2	0.4

Table (6): Effect of heat stress and captopril (0.7 and 1.4 mg/kg. b.wt) on ALT activity (u/g tissue) of liver, heart, kidney, muscle and brain of male albino rats.

Parameters / Organ		Treated period (10 days)				Recovery period (10 days)			
		Control	Heat stress	heat stess + low dose	heat stess + high dose	Control	Heat stress	heat stess + low dose	heat stess + high dose
Liver	Mean	23.0	17.5	15.0	14.5	24.0	16.2	14.0	13.5
	±S.E	0.2	0.3	0.4	0.2	0.1	0.3	0.2	0.2
Heart	Mean	19.5	22	23.0	22.8	19.0	22.5	21.2	20.0
	±S.E	0.4	0.2	0.3	0.1	0.3	0.2	0.2	0.2
Kidney	Mean	16.4	20.5	19.5	18.5	16.0	18.0	17.2	17.8
	±S.E	0.2	0.3	0.3	0.4	0.3	0.2	0.2	0.3
Muscle	Mean	20.5	23.2	22.5	22	19.5	21.5	21.0	20.0
	±S.E	0.3	0.4	0.3	0.1	0.3	0.2	0.3	0.4
Brain	Mean	21.8	25.0	23.0	22.8	20.8	22.4	21.8	21.0
	±S.E	0.4	0.3	0.3	0.4	0.3	0.2	0.3	0.4

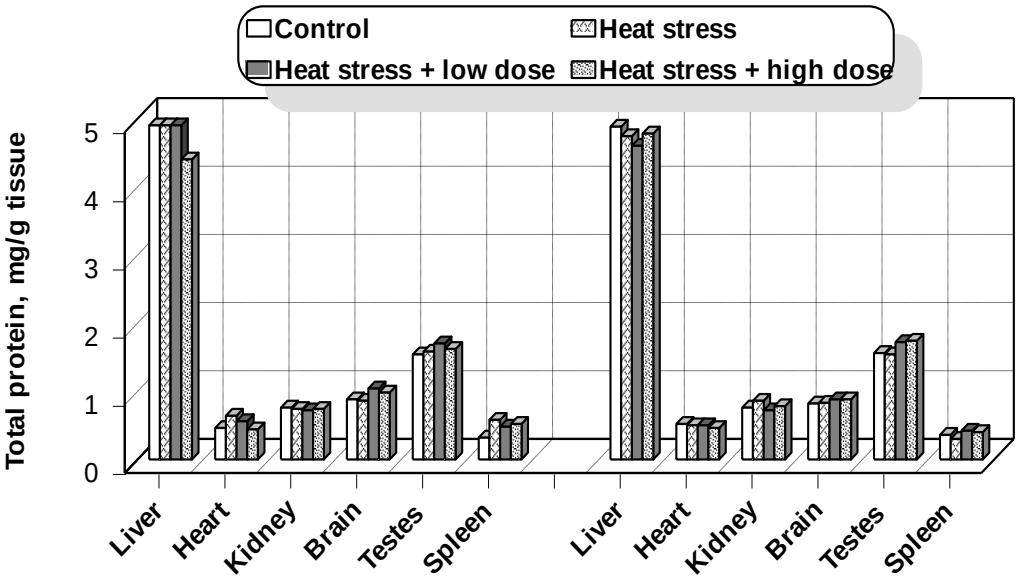

Fig. (1): Digramatic representation show the percentage of organs/body weight changes under the effect of heat stress and captopirol (0.7 and 1.4 mg/g b. wt.) in malevalbino rats.

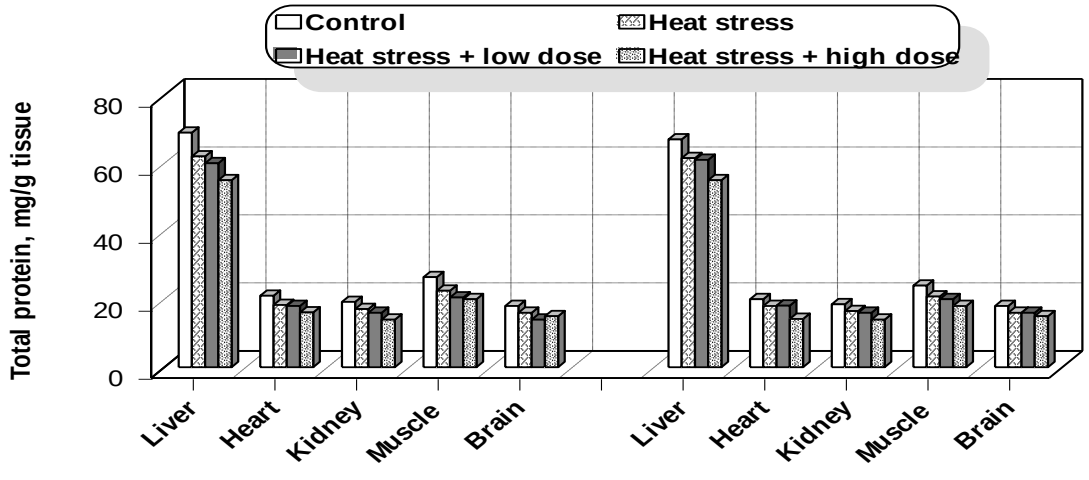

Fig. (2): Digramatic representation show the effect of heat stress and captopirol (0.7 and 1.4 mg/g b. wt.) on total protein of some organs after treatment and recovery period.

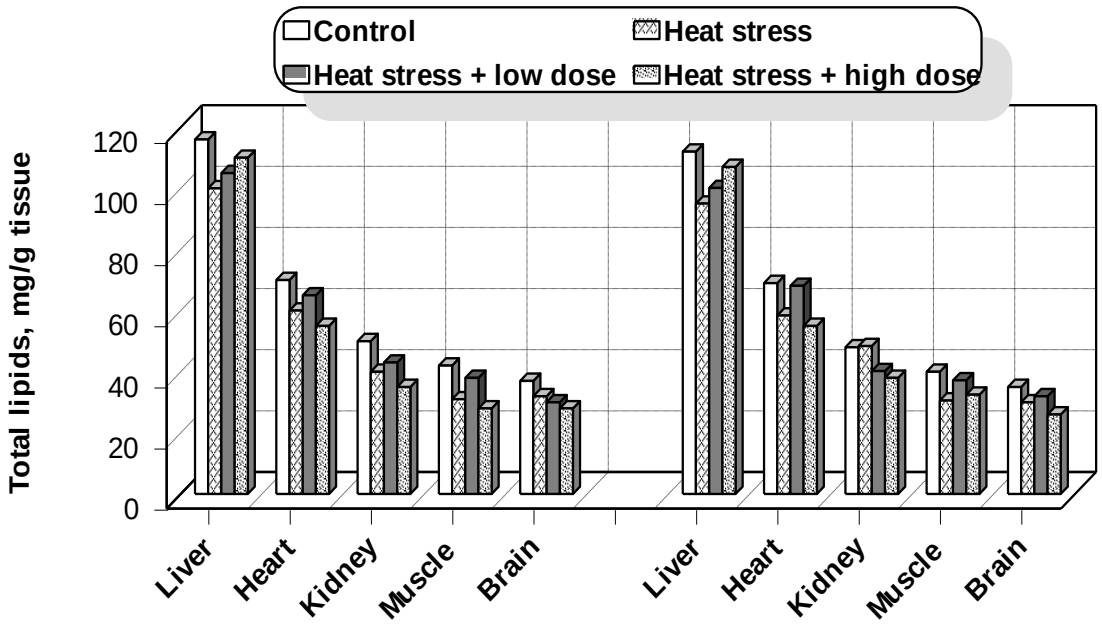

Fig. (3): Digramatic representation show the effect of heat stress and captopirol (0.7 and 1.4 mg/g b. wt.) on total lipids of some organs after treatment and recovery period.

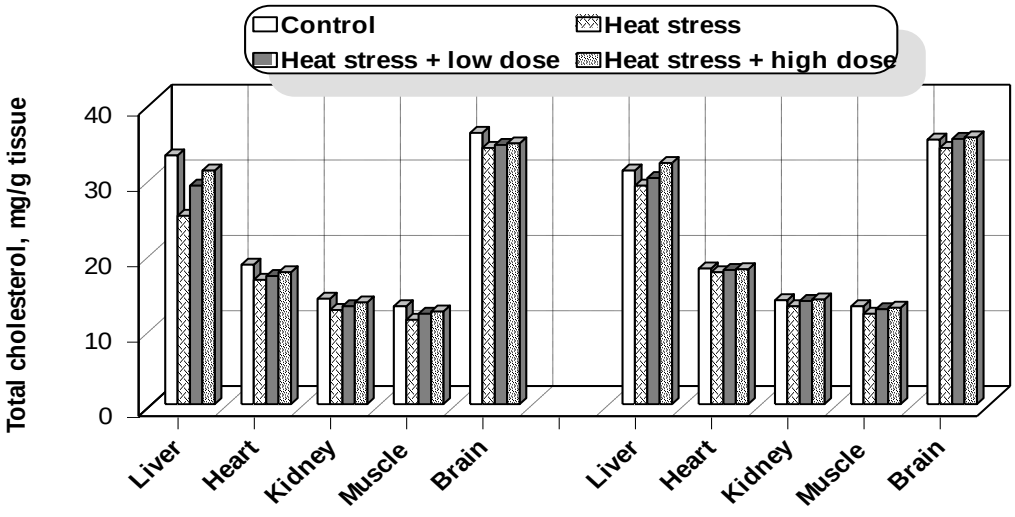

Fig. (4): Digramatic representation show the effect of heat stress and captopirol (0.7 and 1.4 mg/g b. wt.) on total cholesterol of some organs after treatment and recovery period.

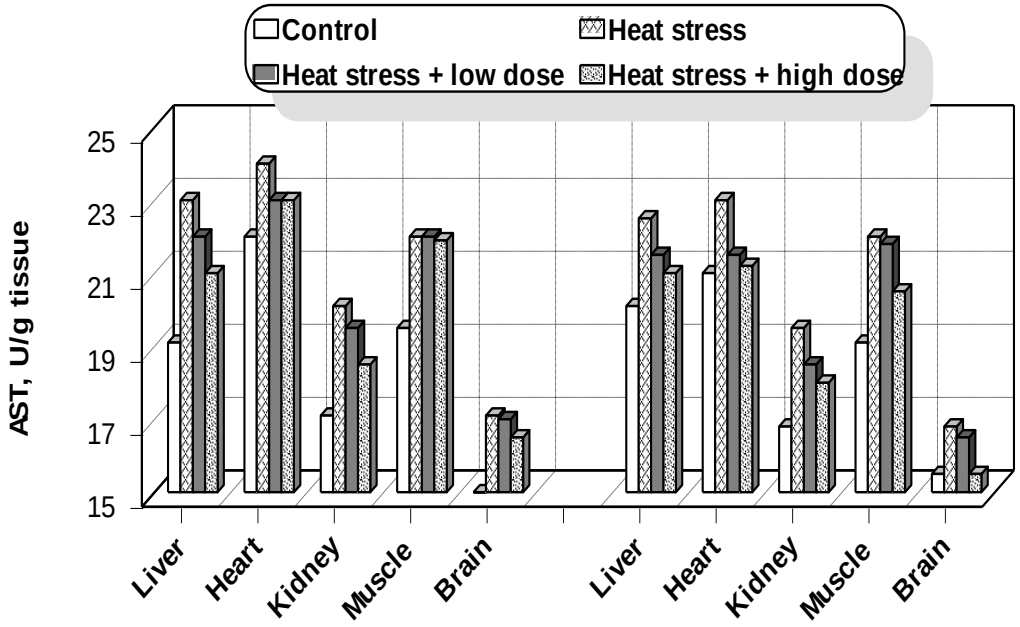

Fig. (5): Digramatic representation show the effect of heat stress and captopirol (0.7 and 1.4 mg/g b. wt.) on AST of some organs after treatment and recovery period.

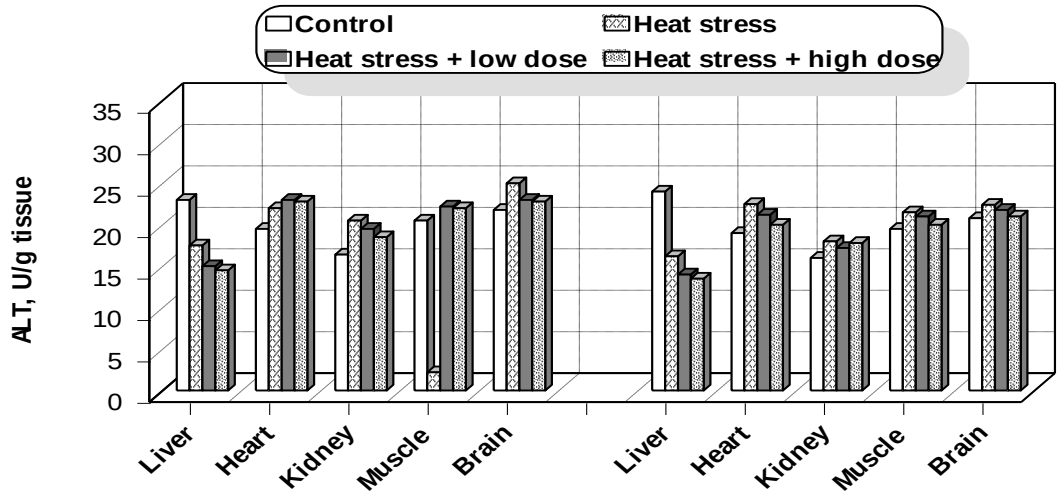

Fig. (6): Digramatic representation show the effect of heat stress and captopirol (0.7 and 1.4 mg/g b. wt.) on ALT of some organs after treatment and recovery period.

التفاعل بين مثبط الأنزيم المحول للإنجيوتنسين (الكابتوبريل) وتأثير إرتفاع درجة الحرارة

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التعرض اليومى لإرتفاع درجة الحرارة تسبب إرتفاع كبير لضغط الدم فى حيوانات التجارب (الفئران البيضاء). وأنه معروف أن نظام الرنين – انجيوتنسين نشط خلال تنظيم إرتفاع درجة الحرارة. والهدف من هذا البحث هو تقدير تفاعل الكابتوبريل فى تحسن إرتفاع ضغط الدم فى الفئران.

قسمت الحيوانات إلى أربع مجموعات وعوملت كالآتى :

المجموعة الأولى : إستخدمت كمجموعة ضابطة بينما المجموعات الأخرى تعرضت لدرجة حرارة 40 ^{5}م ودرجة رطوبة 80% لمدة 10 أيام متتالية. وقد وضعت المجموعة الثانية تحت تأثير إرتفاع درجة الحرارة فقط وعوملت المجموعتان الثالثة والرابعة بجرعات مختلفة من الكابتوبريل (0.7 ، 1.4 مجم/كجم من وزن الجسم) على الترتيب وبعد عشرة أيام من المعالجة تم ذبح نصف عدد الحيوانات وقد تم فصل الأعضاء المختلفة من الجسم مثل المخ، الكبد ، العضلات ، القلب والكلى وذلك لتحليل بعض القياسات البيوكيميائية مثل الدهون، البروتينات والكوليسترول، الإنزيمات الناقلة لمجموعة الأمين AST , ALT والنصف الآخر من الحيوانات تركت لمدة 10 أيام أخرى بدون إضافة أى معاملة وهى تسمى فترة الإستشفاء.

وقد أوضحت النتائج إنخفاض ملحوظ فى البروتين الكلى للكبد، القلب ، الكلى والدهون الكلية لكل من القلب ، العضلات والمخ والكوليسترول الكلى للكبد.

ومن ناحية أخرى لوحظ تغيير غير معنوى فى بروتينات العضلات والمخ وكذلك لوحظ أن نشاط الإنزيمات الناقلة لمجموعة الأمين ALT, AST كانت طبيعية لكل الأعضاء التى حللت.