METABOLIC EFFECTS OF TAURINE ON EXPERIMENTALLY INDUCED HYPERLIPIDEMIA IN RATS

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A B S T R A C T

Hyperlipidemia is a known risk factor for the development of cardiovascular disease including atherosclerosis. This study was designed to evaluate the effect of oral intake ofTaurine (TU) on lipid profile, glucose, insulin, insulin resistance (HOMA) in serum and anti-oxidant enzyme activities catalase (CAT), superoxide dismutase (SOD), reduced glutathione(GSH) and L-MDA, in liver of high fat diet induced hyperlipidemia in male albino rats by feeding high fat diet.One hundredmale albino rats were divided into four equal groups of 25 rats each Group I :(Control normal group): rats fed normal diet. Group II: (hyperlipidemic group): rats fed high fat diet (HFD) and administered no drugs. Group III (HFD +TU): rats fed HFD and administeredtaurine once daily (500 mg/kgb.wt./day, orally) for 8 weeks. Group IV (control positive): rats received the control normal diet andadministered taurine once daily (500mg/kg b.wt. Orally) for 8 weeks. Blood samples were collected after 3, 6 and8 weeks from the onset of taurine administration for determination of serum glucose, insulin, insulin resistance, total cholesterol(TC), triacylglycerol(TAG), phospholipids, Low density lipoprotein-cholesterol (LDL-c), Very low density lipoprotein-cholesterol (VLDL-c) and High density lipoprotein-cholesterol (HDL-c) levels in addition to antioxidant enzymes activities in liver (CAT),(SOD),(GSH) and MDA concentration in liver tissue .the obtained results revealed that, rats fedHFD exhibited significant elevation of serum TC, TAG, (VLDL-C), MDA with marked decreased in serum phospholipids concentrations compared to rats fed normal diet. Meanwhile, administration of taurine to HFD-fed rats tended to prevent hyperglycemia, improve dyslipidemia and other changes relevant to high fat diet mainly through improving activities of anti-oxidant enzyme and scavenging free radical and enhancement cholesterol metabolism to convert it to bile salts, which consequently reduce lipid profile in serum and insulin resistance. These results suggest that, taurine is effective in improving the obesity and coronary heart disease.

Keywords: taurine; obesity; antioxidant enzymes; Insulin; Lipids profile.

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1. INTRODUCTION

Lifestyle-related disorders, namely obesity, diabetes, hyperlipidemia and hypertension, are threatening human health and are regarded as important risks in the development of cardiovascular disease (CVD). CVD has been the first cause of human death in the United States and Taiwan.(Lloyd-Jones et al., 2009) Cerebrovascular disease, heart disease, and hypertensive disease are second, third, and tenth major causes of death in Taiwan, respectively (Department of Health, Executive Yuan, ROC, 2008**).** The common epidemic reason for hyperlipidemia is excessive or improper lipid intake. Hyperlipidemia is a condition associated with increased level of lipids and cholesterol in plasma leading to various disorders including coronary artery disease. Hyperlipidemia is a highly predictive risk factor for atherosclerosis, Coronary artery disease and cerebrovascular disease

(Mohaleet al., 2008). Obese individuals develop resistance to the cellular actions of insulin, characterized by an impaired ability of insulin to inhibit glucose output from the liver and promote glucose uptake in fat and muscle **(**Hribal et al., 2002). Hyperlipidemia also induces oxidative stress, and malondialdehyde (MDA) is one of the products in lipid peroxidation. Plasma MDA levels increased markedly in animals with obesity and diabetes mellitus.This elevation indicatedincrease of lipid oxidation in tissues (Moussa, 2008). Humans with apparent increase in Malondialdehyde- Modified LDL were shown to be more predisposed to developing arteriosclerosis. Dietary cholesterolcan increase the level of serum cholesterol to levels which can place an individual at increased risk for the development or exacerbation of atherosclerosis (Olubaetal., 2008). Coronary Heart Disease (CHD) increases dramatically as the plasma concentration of LDL - cholesterol increases.Consequently, the development of methods for lowering LDL cholesterol levels has become a major focus of medical research. (Oluba et al., 2008). Antioxidants are known to play a vital role in preventing many of the health disorders associated with aging, including degenerative diseases such as diabetes, Alzheimer's disease, and cardiovascular disease. Medical researchers continue to discover new antioxidant compounds as well as new applications for these protective nutrients.Amino acids have been recognized as important signaling mediators in different cellular functions (Jim, 2005). Taurine (TA) is a sulphur containing β-amino acid and an antioxidant that is present in most animal tissues and it is essential for the normal functioning of different organs (Brosnan and Brosnan, 2006). The source of (TA) in the body is mainly from dietary intake from meat and especially seafood (Ito et al., 2012).

2.2- MATERIALS AND METHODS

2.1. Experimental animals:

One hundred white male Albino Wister rats (8-10 weeks old age), weighing 165-225 gm. were used in the experimental investigation of this study. Rats were kept at constant environmental and nutritional conditions throughout the period of experiment. Animals were housed in separate metal cages, fresh and clean drinking water was supplied ad-libitum. All rats were acclimatized for minimum period of two weeks prior to the beginning of study.

2.2. Ration and additives:

The animals were fed on constant ration through the course of the experiment in the form of concentrated diet composed of (7-10% fat, 68-70% CHO, 18-20% protein, 1-2% vitamins and minerals; 210 kcal/100 gr/day) normal control diet (NCD).

2.3. Taurine (2-amino ethane sulfonic acid):

Taurine is supplied by GALL PHARMA, Austria Pharmaceutical form: taurine 500 mg GPH capsules. Dosage: - taurine was orally administration 500mg\kg\day Taurine was freshly prepared (dissolved in 0.9 % saline) and administered in daily oral dose of 500 mg/kg body weight using stomach tube for group III and group IV for 8 weeks.

2.4. Induction of hyperlipidemia :

The experimental induction of hyperlipidemia inmale rats was induced by feeding the rats on the prepared high fat diet (HFD) for 21 days before the beginning of the experiment. The high fat diet (HFD) was prepared by adding of (1% cholesterol, 0.5% cholic acid, 5% hydrogenated fat) to the normal chew. The diet was prepared and necessary vitamins and minerals were added. For fatty diet the chow, in powder form, was mixed fat until become homogenous in a dough-like consistency. This dough was shaped with a paste

injector. Obtained chow blocks were dried and used for feeding (Altunkaynak, 2005). 21 days after hyperlipidemia induction, treatment with taurine were given and continued for eight weeks.

2.5. Design of the experimental work:

Rats under study were randomly divided into four main equal groups, 25rats each, placed in individual cages and classified as follows: Group 1: Control Normal group:received no drugs, served as control non-treated for all experimental groups. Group II :(High fat diet): rats received high fat diet (HFD), served as high fat diet inducedhyperlipidemicrats group.
Group III: (HFD +taurine): rats were fed HFD and administered taurine (500 mg/kg b.wt./day/orally) for 8 weeks. Group IV: (CND +taurine): rats were maintained on CND and received taurine (500mg/kg b.wt./day/orally)for 8 weeks.

2.6. Sampling:

Blood samples: Blood samples were collected at the third, sixth and eighth weeks from the start of treatment with taurine. Samples were collected from the venous plexus located at the medial canthus of the eye by heparinzed capillary tubes. The collected blood was allowed to clot at room temperature for an hour; and then refrigerated for further an hour for clot retraction. Clear serum were separated by centrifugation at 3000 p.m. for 10 minutes and then collected in Eppendrof's tubes using automatic micropipettes processed directly for glucose determination then kept in deep freezer at -20 ^{0}C for subsequent biochemical analysis. Tissue samples (Liver): After blood samples collection the rats were sacrificed. Livers were removed, rinsed in ice-cold 0.9% sodium chloride solution, quick frozen in a deep freeze at -20°C for subsequent biochemical analyses. All liver samples were analyzed for the determination of L-malondialdehyde (L-MDA), antioxidant enzymes (Catalase and superoxide dismutase) and reduced Glutathione (GSH).

2.7. Biochemical analysis:

Serum (TC), (TAG), HDL-c, LDL-c, VLDL-c and phospholipids were determined according to the method described by Meiattini *et al*, (1978); Buccolo and David, (1973); Lopes-Virella*et al*., (1977); Friedewald *et al*., (1972); Bauer, (1982); Takeyama *et al*, (1977); respectively. Moreover, Serum glucose, insulin and Homeostasis model assessment for insulin resistance (HOMA-IR) were determined according to the method described by Tietz, (1995); Sacks, (1994) and Haffner*et al*., (1997); respectively. In addition to liver antioxidant enzymes (CAT and SOD), reduced glutathione (GSH) and L-MDA were determined according to the method described by Xu *et al*., (1997); Paoletti and Macali, (1990); Beutler, (1963) and Mesbah*et al*., (2004); respectively.

2.8. Statistical analysis:

The results were expressed as mean±SE and statistical significance was evaluated by two way ANOVA using SPSS (version 10.0) program followed by the post hoc test, least significant difference (LSD). Values were considered statistically significant when $p< 0.05$.

3. RESULTS

3.1. Effect of treatment with taurine on serum total cholesterol, triacylglycerol, HDL-C, LDL-C and VLDL-C concentrations, phospholipids, Glucose, insulin and HOMA concentrations in normal and high fat diet -induced hyperlipidemia in male rats.

The obtained results in table (1) revealed that, a significant increase in serum levels of TC, TAGs,VLDL-c, glucose,insulin and HOMA.On the other hand, a significant decrease in serum phospholipids were observed in high fat diet induced hyperlipidemia rats groups after three weeks of the experiment.

Table (1): Effect of treatment with taurine on serum Glucose insulin and insulin resistance concentrations in normal and HFD –induced hyperlipidemia in male rats.

Experimental Groups	Glucose (mg/dl)			insulin(μIU/ml)			Insulin resistance		
	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8 weeks
Group I: (Control negative NCD)	113.46± 3.68^{a}	90.48±5.33^{b}	94.53±9.08^{ab}	2.25±0.25^{ab}	11.31±3.57^{a}	16.54±1.49^{a}	0.61±0.06^{ab}	2.41±0.81^{ab}	3.54±0.48^{b}
Group II : (HFD induced hyperelipidemia)	130.76±5.44^{a}	119.37±9.23^{a}	114.68±6.83^{a}	3.07±0.54^{a}	15.13±2.65^{a}	19.30±0.74^{a}	1.03±0.23^{a}	4.79±0.85^{a}	5.71±0.47^{a}
Group III: (HFD+taurine 500 mg/kg.b.wt)	91.34±8.80^{b}	88.44±7.15^{b}	90.98±5.36^{b}	1.71±0.41^{b}	12.49±2.78^{a}	13.71±0.30^{a}	0.35±0.09^{b}	2.64±0.80^{ab}	2.98±0.26^{b}
Group IV: (NCD+taurine 500mg/kg.b.wt)	109.132±7.83^{ab}	81.37±7.14^{b}	95.19±6.53^{ab}	1.20±0.07^{b}	10.93±1.04^{a}	17.33±3.19^{a}	0.31±0.04^{b}	2.11±0.37^{b}	4.03±1.0^{ab}

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same column are significantly different at ($P \leq 0.05$).

Table (2): Effect of treatment with taurine on serum total cholesterol, triacylglycerol and phospholipids concentrations in normal and HFD – induced hyperlipidemia in male rats.

Parameters / Experimental Groups	Total Cholesterol (mg/dl)			Triacylglycerols (mg/dl)			phospholipids (mg/dl)	
	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks
Group I: (Control negative NCD)	94.66±1.33^{bc}	71.43±5.05^{b}	64.93±3.72^{b}	87.49±4.37^{b}	86.45±3.24^{b}	73.70±6.51^{b}	185.89±18.47^{a}	81.98±14.24^{a}
Group II : (HFD induced hyperlipidemia)	125.32±11.62^{a}	97.93±4.80^{a}	98.27±11.67^{a}	145.72±23.00^{a}	106.65±9.16^{a}	105.22±4.67^{a}	81.61±10.10^{c}	64.70±6.68^{a}
Group III: (HFD+taurine500 mg/kg.b.wt)	99.98±8.69^{b}	65.71±4.74^{b}	73.03±5.79^{b}	97.85±11.60^{b}	69.98±4.58^{b}	81.73±5.92^{b}	89.61±5.77^{bc}	101.10±1.84^{a}
Group IV: (NCD+taurine 500mg/kg.b.wt)	73.32±3.65^{c}	71.86±2.95^{b}	75.45±4.85^{b}	109.75±7.96^{ab}	69.16±4.08^{b}	78.88±6.46^{b}	129.44±14.16^{b}	76.48±15.37^{a}

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same column are significantly different at ($P \leq 0.05$).

Table (3): Effect of treatment with taurine on serum high density lipoprotein cholesterol (HDL-c), Low density lipoprotein cholesterol (LDL-c) and Very low density lipoprotein cholesterol (VLDL-c) concentrations in normal and high fat diet-induced hyperlipidemia in male rats.

Parameters	HDL-C (mg/dl)			LDL-C (mg/dl)			VLDL-C(mg/dl)		
Experimental groups	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8 weeks
Group I: (Control negative (NCD)	36.48±128^{ab}	28.80±1.01^{a}	20.96±0.89^{b}	40.69±2.17^{a}	25.34±4.25^{a}	29.23±3.62^{a}	17.50±0.87^{b}	17.29±0.65^{b}	14.74±1.30^{b}
Group II : (HFD induced hyperlipidemia)	44.80±4.17^{a}	37.12±4.59^{a}	26.72±1.38^{a}	51.38±6.45^{a}	39.48±4.29^{a}	50.51±11.14^{a}	29.14±4.60^{a}	21.33±1.83^{a}	21.04±0.93^{a}
Group III: (HFD+taurine500 mg/kg.b.wt)	32.64±3.97^{b}	19.36±1.02^{a}	22.72±2.05^{ab}	47.77±13.45a	32.36±5.00^{a}	33.97±4.86^{a}	19.57±2.32^{b}	14.00±0.92^{b}	16.35±1.18^{b}
Group IV: (NCD+taurine 500mg/kg.b.wt)	40.75±3.93^{ab}	36.56±10.69^{a}	18.72±1.67^{b}	10.99±5.78^{b}	21.47±13.65^{a}	40.95±7.36^{a}	21.59±1.21^{ab}	13.83±0.82^{b}	15.78±1.29^{b}

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same column are significantly different at ($P \leq 0.05$).

Table (4): effect of treatment with taurine on Catalase (CAT), Superoxide dismutase (SOD) and Reduced Glutathione (GSH) activities and L – Malondialdehyde (L-MDA) concentrations in liver of normal and high fat diet induced hyperlipidemia in male rats.

Animal Groups	CAT (mmol/min / gm tissue)			SOD (U/ gm tissue)			GSH (mg/min/ gm tissue)			L – MDA (nmol/gm tissue)		
	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8weeks	3 weeks	6 weeks	8 weeks	3 weeks	6 weeks	8 weeks
Group I: (Control negative NCD)	5.63± 0.29^{a}	3.46±0. 32^{a}	3.73±0. 46^{a}	0.64±0. 07^{a}	0.39±0. 01^{a}	0.44±0. 02^{a}	32.06±0. 98^{a}	28.54±2. 07^{b}	24.16±1. 17^{b}	73.46±8. 10^{b}	55.33±3. 70^{b}	53.59±4. 86^{b}
Group II : (HFD induced hyperlipidemia)	1.26± 0.13^{c}	1.20±0. 09^{b}	1.43±0. 13^{b}	0.47±0. 02^{b}	0.36±0. 02^{a}	0.40±0. 02^{a}	25.53±1. 06^{b}	24.41±0. 96^{b}	21.02±1. 17^{b}	108.66±4 .80^{a}	82.16±5. 20a	75.76±6. 24^{a}
Group III: (HFD+taurine500 mg/kg.b.wt)	2.11± 0.19^{b}	1.34±0. 09^{b}	1.61±0. 11^{b}	0.36±0. 04^{bc}	0.22±0. 02^{b}	0.25±0. 02^{b}	27.11±1. 71^{b}	40.43±1. 85^{a}	46.88±3. 01^{a}	72.80±8. 97^{b}	56.16±4. 23^{b}	38.98±3. 82^{c}
Group IV: (NCD+taurine 500mg/kg.b.wt)	2.14± 0.24^{b}	0.97±0. 11^{b}	1.05±0. 11^{b}	0.24±0. 03^{c}	0.38±0. 01^{a}	0.39±0. 03^{a}	34.06±0. 64^{a}	25.86±1. 35^{b}	42.60±2. 35^{a}	58.62±3. 38^{b}	72.38±1. 85^{b}	65.50±2. 60^{ab}

Data are presented as (Mean ± S.E). S.E = Standard error.

Mean values with different superscript letters in the same column are significantly different at ($P \leq 0.05$).

Treatment of hyperlipidemic rats fed HFD with taurine significantly decreased serum TC, TAGs,VLDL-c, glucose, insulin and HOMA.Meanwhile, the value of serumphospholipids non-significantly increase in compared to HFD non treated rats group.

3.2. Effect of taurine treatment liver MDA, GSH, Catalase and superoxide dismutase in normal and HFD –induced hyperlipidemia in male rats.

The obtained results presented in table (2) showed that, a significant increase in the liver L- Malondialdehyde concentration were observed in the HFD rats compared to the control group,Meanwhile, a significant decrease in GSH, Cat and SOD activity in HFD non treated group. Treatments with taurine significantly reduce level MDA. On the other hand, taurine treatment significantly elevated GSH level and Catalaseactivity.

4. DISCUSSION

Hyperlipidemia, including hypercholesterolemia and hypertriglyceridemia, is a major risk factor for the development of cardiovascular diseases (Makni et al., 2008). Elevated levels of plasma total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C) and triglyceride (TG) as well as reduced levels of plasma high density lipoprotein cholesterol (HDL-C) are often associated with an increased risk of coronary heart disease (Smith et al., 2004). In addition, hyperlipidemia can induce oxidative stress in liver (Bolkent et al., 2005). Lipids have been noted to perform important functions in the body, but may cause various health problems if present in excess amounts. The term hyperlipidemia refers to the elevated lipid levels in the body including high cholesterol and high triglyceride levels (Braamskamp et al., 2012). Lipids have been considered as "fats" in the bloodstream, which is commonly divided into cholesterol and triglycerides. However, the cholesterol circulates in the bloodstream and is involved in the structure and function of cells, whereas, the triglycerides are either used immediately or stored in the fat cells (Iughetti et al., 2010). When plasma cholesterol exceeds the level required, it results in the development of atherosclerosis and stroke (Inoue et al., 2002).Atherosclerosis is an emphatically serious condition where medium and large arteries become clogged up by fatty substances results in formation of plaques. Disorders of lipid and lipoprotein metabolism i.e. dyslipidemia are traditional risk factors for atherosclerosis. Accumulations of cholesterol and LDL are main cause for formation of atherosclerotic plaque, which results in strokes, heart attack and eventually death (Turner, et al., 1998). The obtained data presented in (Tables 1) revealed that, a significant increase in serum glucose concentration, non-significant increase in serum insulin concentration was observed in High fat diet-induced hyprlipidemic rats all over the period of the experiments when compared with normal control group. In addition, a significant increase in HOMA was observed in High fat diet-induced hyprlipidemic rats after eight weeks of the experiments when compared with normal control group. These results are nearly similar tosung et al.; (2014) who demonstrated that, Glucose levels in HFD mice were higher than those of mice fed the normal diet. High fat diet acts as a source of saturated fat resulting in increase in body weight, increase in blood lipid concentration and increase in blood glucose levels(Pascot et al.; 2001) glucose and lipid metabolism, caused by the changes in energy expenditure (Tsutsumi et al.;2014). High fat diet also alters both basal and stress induced hypothalamic pituitary adrenal activity to increase adrenal glucocorticoid production in rats (Tannenbaum et al., 1997). Elevated glucocorticoids can subsequently lead to hypertriglyceridemia by decreasing the level of lipoprotein lipase (Mantha et al.; 1999). Insulin resistance has

been shown to be the major contributing factor to the metabolic syndrome, which comprises a cluster of risk factors for conditions such as obesity, dyslipidemia, hypertension, and hyperglycemia (Kim et al.; 2010). Our result with in agreement with results reported previously by (Zhang et al.; 2007) who has been shown that a HFD results in significant increase in body weight, blood glucose and insulin levels. Release of free fatty acids by lipoprotein lipase from increased serum triglycerides cause lipotoxicity, which results in insulin-receptor dysfunction. Free fatty acids also produce oxidative stress. The release of excessive free fatty acids provokes lipotoxicity, as lipids and their metabolites create oxidative stress. This affects adipose as well as non-adipose tissue, accounting for its pathophysiology in many organs, such as the liver and pancreas, and resulting in the metabolic syndrome (Gordon, 1997).

Treatment with Taurine to high fat diet induced hyperlipidemia in male rats resulted in significant decrease of serum glucose of hyperlipidemic treated group all over the period of the experiment, significant decrease of serum insulin after three weeks and significant decrease of HOMA after three and eight weeks of high fat diet induced hyperlipidemia treated group with Taurine. There is evidence indicating that taurine has hypoglycemic properties due to the potentiation of the effects of insulin (Lapsonet al.; 1983). Finally, taurine antioxidant properties protect pancreatic beta-cells against oxidative stress-induced decrease in function observed in some pathophysiological conditions (Kaniuket al.; 2007). These findings indicate that taurine is involved in distinct central and peripheral processes necessary for the control of glucose homeostasis. However, the exact mechanisms by which the amino acid affects blood glucose levels are still unknown (Carneiro et al.; 2009). It was previously described that taurine modulates the insulin signal transduction pathways by inhibiting the cellular protein tyrosine phosphatase activity that negatively regulates insulin signaling. Thus, taurine has the potential ability to prolong as well as increase insulin signaling. It is also possible that taurine being an antioxidant, would make the cells less susceptible to the consequence of stress-induced activation of serine kinases (Nandhiniet al., 2005).

The obtained data presentedin (Tables 2, 3) revealed that, a significant increase in serum total cholesterol concentration, Triacylglycerol, LDL-cholesterol, VLDLwas observed in High fat diet-induced hyprlipidemic rats allover the period**.** A large body of evidence has been presented showing that high-fat diet rich in saturated fatty acid results in hyperlipidemia the pronounced increase in Plasma cholesterol, TG and LDL levels in hyperlipidemic rats is in agreement with results reported previously by Xu etal., (2012) who demonstrated that, Plasma lipids were significantly increase in rats Fed a high-fat diet.The increased blood levels of total cholesterol, Low Density Lipoprotein Cholesterol (LDL-C) and Very Low Density Lipoprotein Cholesterol (VLDL-C) as well as lowered levels of High Density Lipoprotein Cholesterol (HDLC) has been identified in development of hypercholesterolemia (Ross, 1999). Excessive dietary intake of fat cause serum cholesterol to rise by down regulating LDL receptor synthesis as a result of which the uptake of LDL-C via LDL receptor is reduced which result in an increase of bloodcholesterol level (Dietschy et al., 1993).Therefore, the increased serum levels in the lipid rich lipoproteins (LDL-C and VLDL-C) indicate that more cholesterol and triglyceride are been transported from the liver to the extra-hepatic tissues to be taken up by those tissues. The increase in the serum HDL concentration may be due to the boost of HDL- C biosynthesis majorly in the liver and partly in the small intestine. HDL- C particles are formed basically from ApoAI and apoAII Apo lipoproteins, whose expression were shown to be influenced by nutritional

interventions, such as a switch from high-carbohydrate to a high-fat diet to lipid rich diet that was reported to increase the production rate of apoA-I rather than its clearance (Jiang et al., 2006). Treatment with Taurine to high fat diet induced hyperlipidemia in male rats significantly decrease serum cholesterol, Triacylglycerol, HDL, LDL and VLDL all over the period of the experiment .These results are nearly similar to those reported by Militantea and Lombardini (2004) who demonstrated that, The supplementation of the diet with taurine is known to have many cardiovascular benefits.Increased levels of lipid substances were induced in experimental animals through the use of high-fat diets, or were associated with genetic abnormalities or diabetes. Taurine was found to have significant effects in terms of alleviating dyslipidemic lesions. Examples of the lesions that are reversed to a certain degree by taurine are increased serum total cholesterol and triglyceride levels. Taurine can up regulate 7-α-hydroxylase, the rate-limiting enzyme in bile acids production (Yamori etal.; 2004). The obtained result in table (2) showed a significant decrease in serum phospholipids concentration was observed in high fat diet – induced hyperlipidemic rats after three week of experiment. This decrease is non-significant after six week of the experiment when compared with normal control group. Treatment with taurine non-significantly increase serum phospholipids level in high fat diet -induced hyperlipidemic rats after three weeks of the experiment, this increase is significant after six weeks of the experiment when compared with hyperlipidemic non-treated group. Administration of taurine to normal rats significantly decreases serum phospholipids concentration after three weeks of the experiment. Meanwhile non-significant decrease after six weeks when compared with normal control group. That disagreed with Hussein et al. 2004.Suggested that the marked increase in serum phospholipids concentration in rats fed on hyperlipidemic diet may be due to increased activity of choline phosphotransferase enzymes involved in phospholipid synthesis. And also dis agreed withMorisakiet al.(1983)who reported that, in rats fed on high cholesterol diet, the activities of all enzymes involved in lipid synthesis were significantly increased (acyl-coAsynthetase, acyl-coA : cholesterol acyltransferase and choline phosphotransferase). The obtained data presented in (Table 4) revealed that significant increase liver MDA. on the other hand, a significant decrease in GSH, Catalase (CAT) and super oxide dismutase (SOD) were observed in high fat diet induced hyperlipidemia. Oxidative stress has emerged as an important pathogenic factor in the development of hypertension and also most of the complications related to hypertension are associated with oxidative stress, induced by the generation of free radicals (Soanker, 2012). Our result provides a perfect correlation between lipid peroxidation products and decreased activities of CAT and SOD, which play an important role in scavenging the toxic intermediate products of incomplete lipid peroxidation. A decrease in the activity of these enzymes, as seen in liver of high fat diet induced hyperlipidemia in rats, can lead to the excessive availability of superoxide and peroxyl radicals, which in turn generate hydroxyl radicals, resulting in the initiation and propagation of more lipid peroxidation products (Sacks et al.; 1978). Hypercholesterolemia disturbed the oxidant-pro-oxidant balance in favor of pro-oxidation as observed in several studies (Balkan et al.; 2004).The efficiency of this defense system is apparently weakened in hypercholesterolemia, resulting in ineffective scavenging of free radicals which lead to tissue damage (Halliwell,1994). Treatment with Taurine to high fat diet induced hyperlipidemia in male rats resulted in significant decrease of liver L-MDA concentration in high fat diet

induced hyperlipidemic treated group, significantly increased liver GSH and catalase activity after three weeks of the experiment. These results are nearly similar to those reported by Yildirim et al. (2007) reported that, taurine effective in decreasing liver MDA levels and increasing GSH content and GSH-Px activity when given to 13–14 month old rats at a dose of 200 mg/kg/day ip for a week. Taurine is known to attenuate tissue lipid peroxidation either by scavenging or quenching oxygen-derived free radicals, hydrogen peroxide or hypochlorous acid directly, or by binding free metal ion species like Fe2+ or Cu2+ by its sulfonic acid group (Schaffer etal.;2003).Taurine administration has also been suggested to decrease enhanced oxidative damage by decreasing carbonyl group production Franconi et al. (2004). The normalization of the activities of enzymes such as SOD, CAT, GPx and GR by taurine is implicated in the reduced levels of lipid peroxidation .The present finding suggests that taurine controls lipid peroxidation by up regulating the antioxidant enzymes (Nandhini etal.; 2002). Taurine has beendemonstrated to act as a direct antioxidant that scavenges oxygenfree radicals, thus inhibiting lipid peroxidation and also as an indirectantioxidant that controls the increase in membrane permeabilityresulting from oxidative stress in liver (Koch et al., 2004).there was improvement in the activities of the hepatic and renal antioxidant enzymes in the taurine antioxidant and taurine antioxidant + chlorpyrifos + lead acetate groups (Ganiyat et al., 2014). It has been shown that taurine antioxidant exhibits its antioxidant capacity by enhancing the antioxidant system, forming chloramines with hypochlorous acid and replacing glutathione (GSH) in biological systems during oxidative stress (Devi and Anuradha, 2010).

CONCLUSION: From the obtained results it could be concluded that, administration of taurine to HFD-induced hyperlipidemia ameliorate serum biochemical parameters, enzymatic and non-enzymatic antioxidant defense system in high fat diet induced hyperlipidemia.We recommended that, administration of diet rich in taurine as a natural dietary product is very important and suitable attenuate the metabolic disorders of different body tissue and protection of vital organs against hyperlipidemia complications.

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التأثيرات الأيضية للتورين فى الفئران المحدث فيها زيادة دهون الدم تجريبياً

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زيادة دهون الدم من أكثر الأسباب التى تؤدى الى أمراض القلب. لقد أجريت هذه الدراسة لمعرفة التأثير العلاجى للتورين على التغيرات الكيميائية الحيوية التى تحدث فى دم وأنسجة الفئران المحدث فيها زيادة دهون الدم تجريبيا. هذا وقد استخدم لأجراء هذه الدراسة 100 من ذكور الفئران البيضاء أعمارها تتراوح من 8-10 أسبوع وأوزانها من (165-225جرام) وقد قسمت الى مجموعات متساوية اشتملت كل مجموعة على عدد 25 فأر وتم توزيعها كالاتي: المجموعة الاولى (المجموعة الضابطة) اشتملت على 25 فأر لم تعطى أي ادوية واستخدمت كمجموعة ضابطة للمجموعات الاخرى والمجموعة الثانية (المجموعة المحدث فيها زيادة دهون الدم تجريبيا): تكونت من 25 فأر تم زيادة معدل الدهون فى الدم عن طريق تناولهم عليقه عاليه الدهون (1% كوليسترول +5. % كوليك اسيد + 5% دهون مشبعة). المجموعة الثالثة (مجموعة المحدث فيها زيادة دهون الدم + التورين) تكونت من 25 فأر تم اعطائها التورين عن طريق الفم بجرعة مقدارها 500ميللى جرام لكل كيلو جرام من وزن الجسم مع استمرار تناول العليقه عاليه الدهون. المجموعة الرابعة: اشتملت 25 فأر تم احداث السمنة بها عن طريق تناول العليقة عالية الدهون ثم اعطائها التورين عن طريق الفم بجرعة مقدارها500 ميللى جرام لكل كيلو جرام من وزن الجسم مع استمرار تناولها العليقه عاليه الدهون طول فتره التجربة. وقد تم تجميع عينات الدم على فترات بعد 3-6-8 أسابيع من بدء العلاج بالتورين وذلك بعد 21يوما من احداث السمنة فى انابيب نظيفة وجافة ومعقمة. وقد تم فصل مصل الدم واستخدم مباشرة لقياس تركيز سكر الدم والانسولين ومقاومه الانسولين والكوليسترول الكلى والدهون الثلاثية والدهون عالية الكثافة والدهون منخفضة الكثافة والدهون الفوسفورية وال مالون الدهيد والكالسيوم والفوسفاتيز القاعدى وانزيمات الكبد الكتاليز والسوبر اكسيد ديسميوتيز والجلوتاثيون المختزل. وقد أسفرت نتائج التحاليل البيو كيميائيه عن وجود زيادة فى كلا من سكر الدم والانسولين والكوليسترول الكلى والدهون الثلاثية والدهون منخفضه الكثافة وعالية الكثافة ومستوى ال داى مالون الدهيد و الكالسيوم وانخفاض كل من الدهون الفوسفاتيه والفوسفاتيز القاعدى و مستوى نشاط انزيمات الاكسده والاختزال فى الكبد (الكتاليز والسوبر اكسيد ديسميوتيز و الجلوتاثايون المختزل. كما اوضحت النتائج ان اعطاء التورين يؤدى الى انخفاض فى كلا من سكر الدم والانسولين والكوليسترول الكلى والدهون الثلاثية والدهون عالية الكثافة والدهون منخفضه الكثافه ومنخفضه الكثافه جدا و الكالسيوم وانخفاض مستوى ال داى مالون الدهيد فى سيرم الفئران المحدث فيها زياده دهون الدم تجريبيا واوضحت النتائج ان اعطاء التورين ادى الى زياده مستوى الدهون الفوسفاتيه و الفوسفاتيز القاعدى فى سيرم الفئران المحدث فيها زياده دهون الدم واوضحت الدراسه ايضا ان اعطاء التورين ادى الى زياده مستوى نشاط انزيمات الكتاليز والجلوتاثيون المختزل فى الكبد بينما ادى الى انخفاض نشاط انزيم السوبر اوكسيد ديسميوتيز فى الكبدفى الفئران المحدث فيها زياده دهون الدم والتى عولجت بالتورين مقارنه بالفئران الغير معالجه والمحدث فيها زياده دهون الدم . وخلصت الدراسة أن التورين له تأثير جيد في خفض مستوى سكر الدم وتحسين نسبة الدهون العالية لذلك لديه القدرة من الحد من مضاعفات زياده دهون الدم والمتمثله في أمراض القلب وتصلب الشرايين وزياده مقاومه الانسجه لتاثير الانسولين والتى تزيد من فرص حدوث مرض السكرى من النوع الثانى اضافه الى التاثير الضار لزياده معدلات الشقوق الحره المصاحبه لزياده دهون الدم على الكبد ووظائف الاغشيه الحيه لخلايا الجسم .ولذلك ينصح بالتورين لمن يعانون من زياده دهون الدم وذلك لتاثيره كمضاد للاكسده فى تلافى الاثار الضاره لزياده الشقوق الحره اضافه الى دوره فى ايض الكوليستيرول عن طريق تحويله الى املاح صفراويه مما يسهم فى خفض معدلات الكوليسترول بالدم.

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