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Clinicopathological Effect of *Camellia sinensis* Extract on Streptozotocin-Induced Diabetes in Rats

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Abstract: Diabetes Mellitus presents a major challenge to healthcare systems around the world. One of the outcomes of diabetes is oxidative stress that is caused by the effect of hyperglycemia. Recent studies indicate that, oxidative agents in diabetes result in many complications such as cardiovascular disease, nephropathy, retinopathy and neuropathy. The present experimental study was carried out on 40 Sprague-Dawely Albino rats (weighing about 180±10 g) which were divided randomly into 4 groups. Diabetes was induced by a single intra-peritoneal injection of Streptozotocin (STZ, 60 mg/kg). The experimental groups received alcohol extract of *Camellia sinensis* (green tea) leaves (200 mg/kg) for a period of 4 weeks. Blood samples were collected for studying clinicopathological changes (hematological parameters, blood glucose level, lipid profile and some antioxidant enzymes activity) associated with the use of green tea extract on STZ-induced diabetic rats. Results revealed that, oral administration of green tea extract improved the stress picture and caused a significant decrease in serum glucose and total cholesterol levels in diabetic rats treated with green tea extract when compared to levels of diabetic control group. No significant changes were observed in hematological parameters, total triglycerides, LDL-c and HDL-c levels in non diabetic rats treated with green tea extract. It appears that, green tea extract had both antihyperglycemic and hypocholesterolemic effect and increased the activity of antioxidant enzymes on STZ-induced diabetic rats. Further studies are needed to determine its protective effects on the other diabetes complications.

Key words: Clinical Hematology · Clinical Biochemistry · Diabetes Mellitus · *Camellia Sinensis* (Green Tea)

INTRODUCTION

Diabetes Mellitus is one of the most common metabolic disorders, with an estimated worldwide prevalence of 246 million people in 2007 and forecasts to rise to 300 million by 2025 [1], consequently, diabetes presents a major challenge to healthcare systems around the world. Diabetes is a metabolic disorder of multiple etiologies characterized by chronic hyperglycemia with disturbance of carbohydrate, fat and protein metabolisms resulting from defects in insulin secretion, insulin action, or both [2]. One of the adverse effects of diabetes is that, diabetes exhibits enhanced oxidative stress and high reactive oxygen species (ROS) in pancreatic islets due to persistent and chronic hyperglycemia, thereby depletes the activity of antioxidative defense system and thus promotes free radical generation [3]. The increased ROS production causes tissue damage or many diabetic complications such as cardiovascular disease, nephropathy, retinopathy and neuropathy [4, 5]. The rise in free radical activity is suggested to play an important role in lipid peroxidation and protein oxidation of cellular structures resulting in cell injury and implicated in the pathogenesis of vascular disease, which are the main cause of morbidity and mortality in diabetes [6]. Streptozotocin (STZ) is frequently used to induce diabetes in experimental animals through its toxic effects on pancreatic - cells and as a potential inducer of oxidative stress [7, 8]. It has been reported that, diabetes induced by STZ is the best and the commonly used model for screening of antihyperglycemic activities. Many oral antihyperglycemic agents have significant side effects and some are ineffective in chronic diabetic patients [9]. Regarding the high prevalence of diabetes worldwide, there is a need for novel therapies which are more effective with less adverse effects. Herbal product are

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used for decreasing symptoms in diabetes [10]. One of the medicinal plants, which have been getting increasing attention lately, is *Camellia sinensis* (green tea).The present work was designed to assess the effect of *Camellia sinensis* (green tea) extract on hematological parameters, hyperglycemia, lipid profile and its positive roles in the correction of oxidative stress which are diabetes-related complication in STZ-induced diabetic rats.

MATERIALS AND METHODS

Preparation of *Camellia sinensis* (Green Tea) Extract: The dry *Camellia sinensis* (green tea) leaves were powdered by electrical mill. In order to prepare the extract, 150 g of powdered green Tea leaves was mixed with 1000 ml 95% ethanol and shacked constantly for 48 hours. After filtration, the suspension was evaporated in a rotary evaporator. The green tea extracts (GTE) were stored in 4°C refrigerator until usage [11].

Induction of Diabetes to Experimental Rats: Diabetes was induced by a single intra-peritoneal injection of 60 mg/kg body weight (b.w.) STZ (Sigma Compay, Aldrich, USA), that was dissolved in citrate buffer (0.1 M, PH: 4.5). After 72 hours of STZ administration, the tail vein blood was collected to determine fasting blood glucose level. Only rats with fasting blood glucose over 250 mg/dL were considered diabetic and included in the experiment [12]. GTE was administered orally by stomach tube for a period of 4 weeks.

Experimental Design: A total of 40 Sprague-Dawely Albino rats (weighing about 180±10 g) were obtained from the animal house, Faculty of Veterinary Medicine, Cairo University, Egypt. Rats were acclimated for a period of 7 days in our laboratory condition prior to the experiment. The rats were fed with standard laboratory diet and allowed to drink water *ad libitum*. Rats randomly selected were divided into 4 groups, comprising 10 rats each as follow; Group A: non-diabetic control rats; Group B; STZ diabetic control rats (60 mg/kg b.w.); Group C: non-diabetic rats treated with GTE (200 mg/kg b.w.); Group D: STZ diabetic rats treated with GTE (200 mg/kg b.w.).

Blood Samples for Clinicopathological Examinations: Blood samples from each group were collected at weekly intervals. The obtained blood sample from each rat (retro-orbital venous plexus) was divided into three parts. The first part was anticoagulated by di-potassium salt of ethylene diamine tetra-acetic acid (EDTA) and used for evaluating hemogram. The second part was collected in a clean centrifuge tube and allowed to clot, then centrifuged at 3000 rpm for 10 minutes for serum separation. The clear non hemolysed supernatant serum was harvested for biochemical studies. The third part was collected in sodium citrate containing tube and its plasma was taken after centrifugation then kept deep frozen until analysis of antioxidant enzymes.

Hematological and Serum Biochemical Studies

Hematological Studies: Total erythrocyte and leukocyte counts were done using an improved Neubauer hemocytometer. Packed cell volume (PCV%) was estimated by microhematocrit technique. Hemoglobin concentration was colorimetrically determined using cyanmethemoglobin method. Differential leukocytic count was performed on Giemsa stained blood smears [13].

Serum Biochemical Studies: Serum samples were prepared to assay the following biochemical studies; blood glucose level was determined as described by Trinder [14]. Serum total cholesterol was determined according to Allain *et al*. [15]. Serum high density lipoprotein cholesterol (HDL-c) was determined according to Warnick *et al*. [16]. Serum low density lipoprotein cholesterol (LDL-c) was calculated according to Friedewald *et al*. [17] with the following equation;

LDL= Total cholesterol -HDL-Triglycerides/5. Serum total triglycerides were determined according to Wahlefeld [18]. The above mentioned serum biochemical parameters were assayed using reagent kits supplied by StanBio Laboratories incorporation, USA.

The activities of antioxidant enzymes including glucose-6-phosphate dehydrogenase (G6PDH) and glutathione reductase (GR) were done on plasma samples according to Kornberg [19] and Goldberg and Spooner [20], respectively and assayed using Biodiagnostic commercial reagent kits.

Statistical Analysis: Values were expressed as mean ± SD. Statistical comparisons among the means of different experimental groups were made with completely randomized two ways ANOVA "Student-Newman-Keuls test" by COSTAT program version one. A probability "P" value of <0.05 was assumed for statistical significance.

Table 1: Erythrogram of different experimental groups (means ± SD)

	RBCs count (x10^6/µl)				PCV (%)				Hb concentration (g/dl)			
Weeks	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	5.96±0.6	5.92±0.67	5.97±0.51	5.93±0.57	36.90±2.72	36.50±2.38	36.41±2.47	36.60±2.95	12.50±2.62	12.60±2.78	12.11±1.53	12.43±2.33
1	5.51±0.53	5.30±0.7	5.66±0.45	5.75±0.6	36.01±2.15	34.80±1.53	36.92±2.97	34.90±2.04	12.10±1.12	11.90±1.45	12.30±1.68	11.42±2.27
2	6.72±0.49	5.06±0.37	6.85±0.42	5.08±0.61	37.17±1.14	32.51±1.98	37.55±1.13	32.75±1.93	12.75±2.13	11.50±2.29	12.65±1.97	11.93±1.36
3	6.64±0.56	4.24±0.33	6.48±0.66	4.92±0.56	37.64±2.29	32.44±2.58	37.93±1.14	32.99±2.81	13.19±2.41	11.38±1.04	13.09±1.93	12.01±1.45
4	6.13±0.57	4.43±0.67	6.15±0.3	4.50±0.69	37.63±1.96	32.10±1.43	37.96±2.55	33.48±2.04	13.50±2.63	11.16±1.85	13.60±1.37	12.20±1.23
LSD	1.62				3.69				0.94			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

Table 2: Values of MCV and MCHC of different experimental groups (means ± SD)

	MCV (fl)				MCHC (%)			
Weeks	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	61.91±0.6	61.66±0.67	60.99±0.51	61.72±0.57	33.88±2.72	34.52±2.38	33.26±2.47	33.96±2.95
1	65.35±0.53	65.66±0.7	65.23±0.45	60.70±0.6	33.60±2.15	34.2±1.53	33.32±2.97	32.72±2.04
2	55.31±0.49	64.25±0.37	54.82±0.42	64.47±0.61	34.30±1.14	35.37±1.98	33.69±1.13	36.43±1.93
3	56.69±0.56	76.51±0.33	58.53±0.66	67.05±0.56	35.04±2.29	35.08±2.58	34.51±1.14	36.40±2.81
4	61.39±0.57	72.46±0.67	61.72±0.3	74.40±0.69	35.88±1.96	34.77±1.43	35.83±2.55	36.44±2.04
LSD	19.87				3.92			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

RESULTS AND DISCUSSION

Clinicopathological Findings

Erythrogram: Mean values of erythrogram [packed cell volume (PCV%), hemoglobin concentration (Hb), erythrocytes count (RBCs), mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC)] of different experimental groups are illustrated in Tables1, 2.

Erythrogram mean values of different experimental groups, in comparison to those of control group revealed the presence of anemia in both diabetic groups (B&D) started from the 2nd week post STZ injection till the end of the experiment, which determined by significant decreases in values of PCV%, Hb concentration and RBCs counts and insignificant changes of MCV and MCHC values. Group D showed, GET treatment increased the lowered erythrogram parameters but still lower than those of control values. This anemia may be attributed to hyperglycemia and oxidative stress, which are the prominent features of diabetes mellitus (DM) and seem to play a crucial role in initiation of eryptosis cascade [21]. Eryptosis; a term used for apoptosis of erythrocyte and triggered with osmotic shock, oxidative stress, or energy depletion accompanied with DM [22]. Eryptosis is characterized with cell shrinkage, membrane blebbing, membrane phospholipids scrambling and phosphatidyl serine shifting from inner to outer membrane of erythrocyte resulting in increased aggregability and endothelial adhesiveness of erythrocyte, which considered the cause of anemia in DM patients [22]. In STZ-induced DM rats, eryptotic erythrocytes number is increased, which explained the anemia and the underlying or accompanying factors of microvascular injury, such as erythrocyte aggregation and endothelial erythrocyte adhesion in DM [21].

Leukogram: Mean values of leukogram [total leukocyte count (TLC), neutrophil, eosinophil, lymphocyte and monocyte counts] of different experimental groups are illustrated in Tables 3, 4.

Compared to the control group, results of groups (B&D) showed typical picture of stress which manifested by significant leukocytosis with significant neutrophilia, eosinopenia, lymphopenia and monocytopenia started from the 1st week post STZ injection till the end of the experiment. Group D showed, GET treatment improved the picture of stress by decreasing the leukocytosis but was

Table (3): Total leukocyte count (TLC), neutrophil count and eosinophil count of different experimental groups (means ± SD).

	TLC (x103/µl)				Neutrophil count (x103/µl)				Eosinophil count (x103/µl)			
Weeks	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	7.74±2.4	7.41±3.15	7.04±3.46	7.11±3.64	4.72±1.52	4.79±1.11	4.26±1.38	4.08±1.17	0.61±0.06	0.64±0.04	0.60±0.04	0.63±0.04
1	7.37±2.91	9.04±2.67	7.62±4.8	9.00±4.72	4.80±1.86	6.10±1.33	4.51±1.83	6.01±1.11	0.65±0.03	0.50±0.02	0.61±0.06	0.51±0.05
2	7.74±4.16	11.90±3.49	7.53±4.55	11.70±3.26	4.49±1.32	6.64±1.42	4.83±1.14	6.51±1.17	0.69±0.04	0.51±0.02	0.67±0.06	0.53±0.07
3	8.17±2.84	12.10±4.7	8.21±4.44	11.84±4.73	4.66±1.28	6.87±1.96	4.75±1.03	6.33±1.82	0.60±0.05	0.46±0.03	0.52±0.04	0.47±0.06
4	8.22±2.43	12.72±4.41	8.39±4.93	11.52±2.53	4.41±1.53	7.05±1.88	4.45±1.88	6.94±1.67	0.70±0.03	0.55±0.04	0.66±0.05	0.57±0.06
LSD	1.41				0.75				0.13			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

Table 4: Lymphocyte and monocyte counts of different experimental groups (means ± SD)

	Lymphocyte count (x103/µl)				Monocyte count (x103/µl)			
Weeks	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	2.54±2.66	2.41±1.26	2.44±1.62	2.51±1.29	0.84±0.13	0.81±0.18	0.80±0.14	0.82±0.14
1	2.58±2.73	2.01±1.67	2.41±1.08	2.39±2.54	0.75±0.14	0.52±0.14	0.70±0.11	0.59±0.13
2	2.61±2.24	2.00±2.78	2.23±2.42	2.38±2.64	1.00±0.17	0.72±0.17	0.97±0.12	0.84±0.16
3	3.34±1.72	2.99±1.64	3.21±2.52	3.16±2.95	1.10±0.16	0.84±0.18	0.98±0.14	0.89±0.08
4	3.12±1.73	2.92±2.43	3.14±1.77	3.18±1.97	1.89±0.22	1.15±0.2	1.78±0.17	1.26±0.06
LSD	0.46				0.17			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

Table 5: Values of serum glucose, total cholesterol and total triglycerides of different experimental groups (means ± SD)

	Glucose (mg/dl)				T. cholesterol (mg/dl)				T. triglycerides (mg/dl)			
Weeks	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	74.08±7.73	73.57±12.63	71.52±9.69	75.48±10.34	93.42±14.51	91.52±15.46	90.63±14.9	92.53±7.96	72.61±13.18	75.34±14.42	73.46±7.09	75.43±9.25
1	79.53±10.71	254.63±9.6	75.11±9.72	199.41±6.62	95.43±11.94	125.30±9.35	93.71±16.01	111.42±4.59	65.52±8.81	81.30±8.1	66.35±12.09	82.36±14.46
2	78.62±12.81	272.45±15.69	79.06±7.92	167.84±6.32	94.91±15.08	134.11±12.77	92.51±6.71	122.52±5.15	69.76±10.57	88.94±3.48	64.43±12.27	85.15±8.31
3	81.96±9.51	283.51±13.54	84.71±8.66	144.44±5.83	97.04±11.63	139.24±8.17	96.17±9.38	120.47±4.07	68.54±14.98	92.04±4.13	67.50±9.02	89.19±12.96
4	89.95±9.91	298.21±10.19	86.76±8.67	118.56±7.55	101.50±13.14	145.51±14.32	99.13±12.12	112.48±5.21	69.81±15.47	96.41±7.4	70.73±8.78	95.28±15.1
LSD	14.5				10.76				12.52			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

Table 6: Levels of serum high density lipoprotein (HDL-c) and low density lipoprotein (LDL-c) cholesterol of different experimental groups (means ± SD)

	HDL-c (mg/dl)				LDL-c (mg/dl)			
Weeks (p.i)	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	52.55±1.17	52.71±1.31	53.62±1.8	51.35±1.05	42.41±2.33	41.59±3.19	44.65±2.67	43.95±3.17
1	47.45±0.94	44.13±1.42	47.85±3.35	44.63±2.6	48.05±3.4	56.41±4.01	47.65±8.55	56.10±5.34
2	46.34±1.85	41.62±1.8	46.73±3.11	41.92±1.83	46.63±2.66	64.48±2.23	46.23±6.56	64.16±7.26
3	47.44±0.83	36.58±1.43	47.82±3.32	36.88±2.24	47.44±1.63	68.47±1.67	46.04±9.52	68.15±8.37
4	42.81±1.14	31.71±1.03	43.22±1.63	32.01±2.63	49.52±3.03	69.98±3.62	48.12±8.65	69.64±6.36
LSD	3.25				4.26			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

Table 7: Levels of plasma antioxidant enzymes activity (G6PDH and GR) of different experimental groups (means ± SD)

	G6PDH (mu/ml)				GR (U/L)			
Weeks	Group (A)	Group (B)	Group (C)	Group (D)	Group (A)	Group (B)	Group (C)	Group (D)
0	26.03±2.62	26.12±3.17	26.02±4.67	25.98±4.67	114.42±12.73	115.01±13.96	114.93±0.64	114.84±0.6
1	26.14±2.57	22.31±3.21	26.69±4.71	25.13±4.72	115.19±12.55	100.53±13.64	120.09±0.43	105.75±0.29
2	25.99±2.51	20.09±2.87	26.58±4.37	23.99±4.7	115.93±12.73	97.30±13.83	124.83±0.35	102.60±0.27
3	26.34±2.58	18.01±2.83	26.29±4.33	21.81±4.65	116.01±12.57	89.04±13.85	125.91±0.45	97.34±0.26
4	26.56±2.59	14.04±3.2	27.51±4.7	19.94±4.83	115.97±12.63	87.12±13.77	126.87±0.41	94.42±0.25
LSD	3.72				5.21			

Group (A) represents non-diabetic control rats.

Group (B) represents STZ diabetic control rats.

Group (C) represents non-diabetic rats treated with GTE.

Group (D) represents STZ diabetic rats treated with GTE.

LSD represents least significant difference between different groups at probability P< 0.05.

still higher than those of control values. Leukocytosis observed in diabetic groups (B&D) may be as a response to stressful condition (corticosteroid release) after induction of DM by STZ injection [23].

Serum Biochemical Evaluation: Statistical analysis of different serum biochemical parameters of different experimental groups is illustrated in Tables 5-7.

The STZ-induced diabetic rats (group B) exhibited a significant hyperglycemia compared to non-diabetic control rats (group A).This hyperglycemia resulted from selective cytotoxic effect of STZ on pancreatic - cells which resulted in DM in experimental rats. It is proposed that, the cytotoxic effect of STZ be closely related to free radical generation in pancreatic - cells which interfered with the cellular metabolic oxidative mechanisms [24]. Group D (STZ diabetic rats treated with 200 mg/kg GTE) had significant lower hyperglycemia in comparison to group B. Group C (non-diabetic rats treated with 200 mg/kg GTE) showed insignificant change in serum glucose level in comparison to group A. These findings indicated that, *Camellia sinensis* (green tea) extract acted as an antihyperglycemic agent rather than a hypoglycemic agent. Several mechanisms have been suggested for antihyperglycemic effect of green tea that include; enhancing insulin-stimulated glucose uptake, suppressing glucose absorption by sodium dependent glucose transporter SGLT1 [25], suppressing gluconeogenesis by decreasing expression of some genes such as phosphoenol pyrovate carboxykinase (PEPCK) [26] and ameliorating insulin resistance by increasing expression of glucose transporter IV (GLUT IV) [27].

Mean values of serum total cholesterol, total triglycerides and LDL-c concentrations were significantly higher in group (B) than those values of group (A). Group (B) had also significant lower levels of HDL-c than those of group (A). These hypercholesterolemia and hypertriglyceridemia have been reported to occur as a result of, excess of fatty acids in serum produced by STZ induced diabetes promotes its conversion into phospholipids and cholesterol in liver [28]. These two substances along with excess triglycerides formed at the same time in liver may be discharged into blood in the form of lipoproteins [29]. This abnormal high concentration of serum lipids in the diabetic groups is mainly due to an increase in the mobilization of free fatty acids from the peripheral fat depots, since insulin inhibit the hormone sensitive lipase [30]. Significant hyperlipidemia that characterized the diabetic state may therefore be regarded as a consequence of uninhibited actions of lipolytic hormones on the fat depots [30]. Results of group (D) revealed significant decrease of hypercholesterolemia in comparison to that of group (B) while, insignificant changes in mean values of serum total triglycerides, LDL-c and HDL-c concentrations were observed following the treatment of these rats with GTE. In group C, the effect of GTE on lipid profiles was not statistically significant. The possible mechanisms by which GTE can exert cholesterol lowering effect; are reducing the absorption of dietary and biliary cholesterol and promoting its fecal excretion [31]. Furthermore, another study by Singh *et al*. [32] indicated that, GTE caused to decrease the synthesis of cholesterol in cultured rat hepatoma cells.

Mean values of plasma antioxidant enzymes activity (G6PDH and GR) were significantly lower in group (B) than those of group (A). Oral administration of diabetic rats with GTE (group D) significantly raised activities of these antioxidant enzymes compared to diabetic control (group B). In group C, the effect of GTE on activities of these antioxidant enzymes was not statistically significant. Hyperglycemia observed in diabetic groups

considered the main cause for elevated free radical levels, followed by production of ROS, which increased lipid peroxidation and altered antioxidant defense and further impair glucose metabolism in biological system [33]. Overwhelming free radicals generated due to oxidative stress may develop several adverse effects commonly seen in diabetes such as neuropathy, nephropathy, retinopathy and vascular disorders [34]. The antioxidant enzymes (G6PDH and GR) are regarded as the first line of the antioxidant defense system against ROS during oxidative stress and act cooperatively at different sites in the metabolic pathway of free radicals [35]. In the present study, reduced activities of G6PDH and GR in plasma of diabetic rats (groups B&D) were observed. The oral administration of these diabetic rats with GTE increased the plasma activities of G6PDH and GR, this increase may be attributed to the role of GTE as an antioxidant and free radicals scavenger [36]. The antioxidants have been shown to brake the worsening of diabetes by improving pancreatic - cells function and enhancing antioxidant defense mechanisms in pancreatic islets which may be a valuable pharmacologic approach to managing diabetes [37]. The control of hyperglycemia leads to improvement in oxidative stress profile and enhancing antioxidant defense mechanisms in pancreatic islets helps them to cope better with oxidative stress [12]. From the before mentioned explanations, GTE probably acts through several different mechanisms covering ROS scavenger and/or enhancing antioxidant ability.

CONCLUSION

The current study concluded that, oral administration of *Camellia sinensis* (green tea) extract in dose of 200 mg/kg body weight may reverse the diabetes-induced disturbances of some clinicopathological parameters by improving the stress picture and decreasing serum glucose level and total cholesterol concentration in STZ-diabetic rats during a period of 4 weeks. The results of this study also imply that, green tea as a common and inexpensive drink has antihyperglycemic and hypocholesterolemic properties. Further studies should be carried out to determine the protective effects of green tea on diabetes complications.

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