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Research article

INVESTIGATION OF THE EFFECTS OF L-CARNITINE AND MAGNESIUM ON OXIDATIVE STRESS AND CYTOKINES IN THE TISSUE OF EXPERIMENTAL DIABETIC RATS

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The aim of this study was to determine the effects of L-carnitine and magnesium on the levels of tissue malondialdehyde, 8-hydroxy-2'-deoxyguanosine, and cytokines (tumor necrosis factor alpha, interleukin-6) in streptozotocin-induced experimental diabetes in rats. Eighty male Wistar albino rats (200-250 g) were divided into 8 groups with 10 rats in each group. The groups received the following treatments: Control group; 2 ml distilled water (by gavage); Group 2: 50 mg/kg (b.w.) i.p. streptozotocin; Group 3: 125 mg/kg (b.w.) magnesium; Group 4: 300 mg/kg (b.w.) L-carnitine; Group 5: 125 mg/kg (b.w.) magnesium +300 mg/kg (b.w.) L-carnitine; Group 6: 50 mg/kg (b.w.) streptozotocin +125 mg/kg (b.w.) magnesium; Group 7: 50 mg/kg (b.w.) streptozotocin +300 mg/kg (b.w.) L-carnitine and Group 8: 50 mg/kg (b.w.) streptozotocin +125 mg/kg (b.w.) magnesium+300 mg/kg (b.w.) L-carnitine administered for 4 weeks. Liver and kidney malondialdehyde, 8-hydroxy-2'-deoxyguanosine, tumor necrosis factor alpha and interleukin-6 levels did not change in the magnesium, L-carnitine, and magnesium + L-carnitine groups compared to the control. The highest levels of malondialdehyde, 8-hydroxy-2'-deoxyguanosine, tumor necrosis factor alpha and interleukin-6 were determined only in the group with diabetes (Group 2). Lipid peroxidation, DNA damage, and cytokine levels were significantly reduced in diabetic animals with the administration of magnesium and L-carnitine separately or in combination. Based on the obtained results it can be concluded that magnesium and L-carnitine may have antidiabetic effects, especially in combination.

Keywords: Cytokines, diabetes, L-carnitine, magnesium, oxidative stress

INTRODUCTION

Diabetes mellitus is a metabolic disease characterized by insufficiency of insulin secretion and resistance to the metabolic effects of insulin in the target tissues. Biochemical, morphological, and functional changes occur in tissues and organs in patients with

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diabetes mellitus [1,2]. Diabetes mellitus leads to disorders of carbohydrate, fat, and protein metabolism [1,3]. Oxidative stress plays a role in the pathophysiology and later complications of diabetes [4,5]. Localized tissue damage caused by changes in the antioxidant defense system and metabolic stress caused by changes in the energy metabolism, are the mechanisms that increase oxidative stress in diabetes [6,7].

Magnesium (Mg), which is involved in lipid, protein, carbohydrate, and nucleic acid metabolisms, is an important cofactor of more than 300 enzymatic reactions and also takes part in the synthesis of adenosine triphosphate (ATP) [8]. L-carnitine, which is endogenous in all mammalian species, is a natural quaternary ammonium compound that is a vital cofactor in the mitochondrial oxidation of fatty acids [9]. It is stated that the functions of magnesium and carnitine in mitochondria and their roles in the regulation of membrane permeability are well known [10,11].

Contrary to the study [12], which determined that Mg reduces oxidative stress [13] and that there is an increase in serum tumor necrosis factor alpha (TNF-α) and interleukin-6 (IL-6) levels in Mg deficiency, there is a study stating that these parameters do not increase in Mg deficiency [14]. Furthermore, various studies have shown that the beneficial effects of L-carnitine on lipid peroxidation and cytokines change depending on different doses (100-500 mg/kg/day, i.p. [15] and 50 μmol/L [16]). Although there are studies showing the positive effects of L-carnitine [15,16] and Mg [13,17,18] in diabetes for prevention, there are not enough studies [19], demonstrating the effects of their combinations in rats. In a study [19], it was determined that Mg and L-carnitine, especially in combination, may have antidiabetic effects in diabetic rats. The aim of this study was to determine the effects of L-carnitine and magnesium (Mg) on the levels of tissue malondialdehyde (MDA), 8-OHdG, and cytokines (TNF-α, IL-6) in streptozotocin (STZ)-induced experimental diabetes in rats.

MATERIAL AND METHODS

Chemicals

Magnesium as magnesium sulfate (MgSO4, 99.5%) was purchased from Merck (Cat. No. 105886), L-carnitine as L-carnitine fumarate was purchased from Solgar, and Streptozotocin (STZ) was acquired from Sigma-Aldrich (Cat.No. S0130). All other reagents were purchased from commercial sources.

Animals, diets, and experimental design

The study was approved by the Committee of Local Ethics Committee of Erciyes University Animal Experiments (Decision No 15/80 13/05/2015). Eighty male Wistar albino rats, weighing 200–250 g, were divided into 8 groups of 10 in each group, in University of Erciyes, Experimental Research Center. The rats were housed in polycarbonate cages (3–4 rats per cage), in coarse sawmill, under conditions of conventional laboratory animal housekeeping conditions (controlled temperature (21

± 2°C), humidity (50 ± 5%), air change (cycle), light (12 h light, 12 h dark)). The groups received the following treatments: Control group (n=10); 2 ml distilled water (by gavage), Group 2 (n=10): 50 mg/kg (b.w.) i.p. STZ, Group 3 (n=7): 125 mg/kg (b.w.) Mg, Group 4 (n=7): 300 mg/kg (b.w.) L-carnitine, Group 5 (n=8): 125 mg/kg (b.w.) Mg +300 mg/kg (b.w.) L-carnitine, Group 6 (n=10): 50 mg/kg (b.w.) STZ + 125 mg/kg (b.w.) Mg, Group 7 (n=8): 50 mg/kg (b.w.) STZ + 300 mg/kg (b.w.) L-carnitine and Group 8 (n=9): 50 mg/kg (b.w.) STZ + 125 mg/kg (b.w.) Mg + 300 mg/kg (b.w.) L-carnitine was administered for four weeks. The animals were fed with commercial pelleted feed, which met their daily nutrient requirement (Table 1). Animals were given water and feed, *ad libitum* throughout the experiment.

Table 1. Composition of commercial feed given to rats.

Dry matter (min.)	88,0	Calcium (min.-max.)	1,0-1,3	Vit A (min.)	15000 IU/kg
Crude Protein (min.)	23,0	Sodium (min.-max.)	0,5-0,6	Vit D3 (min.)	3300 IU/kg
Crude cellulose (max.)	5,0	Phosphorus (min.)	0,9	Vit E (min.)	40 mg/kg
Crude ash (max.)	8,0	NaCl (max.)	1,00	Vit B2 (min.)	5 IU/kg
Ash insoluble in HCl (max.)	1,0	Lysine (min.)	1,35	Vit B12 (min.)	20,0 mcg/kg
		Methionine(min.)	0,45	Vit K3 (min.)	5,0 mg/kg
		Cystine (min.)	0,35	Metabolic energy (min.)	3100 kcal/kg

Streptozotocin (50 mg/kg (b.w.)/day) was dissolved in 0.1 ml citrate buffer (pH 4.5) and given in a single dose, intraperitoneally (i.p.) to rats. Streptozotocin forms diabetes by destroying the beta cells of the pancreas within 3 days of administration [4]. For this reason, 3 days after STZ administration, fasting blood glucose levels started to be monitored with a glucometer. Animals with fasting blood glucose levels of up to 200 mg/dl [13,15] and with polyuria, polyphagia, and polydipsia were considered diabetic. In the study, 8 rats did not develop diabetes and 3 rats died as a result of the wrong application. The experiment lasted 4 weeks. At the end of the experiment, liver and kidney tissue samples were taken from the rats.

Tissue collection and biochemical analyzes

At the end of the experiment, animals were fasted for 12 h and then, anesthesia was induced. All the animals were sacrificed by cervical dislocation and then the liver and kidney were removed from all the animals. Tissue MDA (TBARS ELISA Kit, Cayman, USA, Cat. No: 10009055), 8-OHdG (Northwest Life Science Specialist and LLC, Washington, Code: NWK 8-OHdG 02), TNF-α (Cusabio, China, Cat. No: CSB-E11987r), and IL-6 (Cusabio, China, Cat. No: CSB-E04640r) levels were determined by enzyme linked immune sorbent assay (ELISA) according to the instruction of the manufacturers of the commercially available kits using an ELISA reader (μQuant, Bio-Tec, ELx50, USA).

Statistical analysis

Statistical analysis of the data was done with the SPSS 20.0 package program for Microsoft. The difference between the groups was determined by one-way analysis of variance (ANOVA). When the F-score was significant, Duncan's multiple range test was used to determine which group originated the difference. All data was expressed as means ± standard error mean (SEM). Differences between groups were considered statistically significant at $p<0.05$.

RESULTS

Tissue MDA Levels

There was no statistically significant difference between the control group and only Mg, L-carnitine, and Mg + L-carnitine groups in terms of liver and kidney MDA levels. The highest MDA levels were found only in the diabetic animals (Group 2) ($p <0.001$; Table 2). Increased lipid peroxidation due to diabetes decreased statistically with the administration of both Mg and carnitine in diabetic animals, separately or in combination ($p <0.001$; Table 2). These reductions in the liver were found to be more important in groups given only Mg. Additionally, significantly lower values ($p <0.001$; Table 2) were determined in kidney MDA in all diabetic + treatment (Mg, L-carnitine, and Mg + L-carnitine) groups.

Tissue 8-OHdG Levels

No difference was found between the control group and Mg, L-carnitine, and Mg + L-carnitine groups (Group 3-5) in terms of 8-OHdG levels. However, the highest liver 8-OHdG levels were determined in the diabetic group. Liver 8-OHdG levels, which show an increase due to diabetes, decreased significantly with administration of Mg and L-carnitine in diabetic groups separately ($p <0.05$; Table 2), but reductions in the kidney were not found significant ($p >0.05$; Table 2). The combination of Mg and L-carnitine caused a numerical decrease in 8-OHdG levels in both tissues ($p>0.05$; Table 2).

Tissue TNF-α and IL-6 Levels

While there was no statistically significant difference between the control group and only the Mg, L-carnitine, and Mg + L-carnitine groups in terms of liver and kidney TNF-α, and IL-6 levels, the highest increases were determined in TNF-α ($p <0.05$; Table 2) and IL-6 ($p <0.001$; Table 2) levels in only the diabetic group. The Mg, L-carnitine, and their combination significantly decreased these cytokine levels ($p <0.05$; Table 2) in the diabetic rats.

Table 2. Liver MDA, 8-OHdG, TNF-α, and IL-6 levels in rats with experimental diabetes, given L-carnitine and Mg

Parameters	Control n=10	Diabetes n=10	Mg n=7	L-carnitine n=7	Mg+ L-carnitine n=8	Diabetes+ Mg n=10	Diabetes+ L-carnitine n=8	Diabetes+ Mg+ L-carnitine n=9	P Value
MDA (µmol/L)	20.866±0.69^{c}	30.375±1.54^{a}	21.386±0.59^{bc}	22.231±1.67^{bc}	21.000±1.78^{c}	19.978±1.10^{c}	24.039±2.27^{bc}	25.776±1.36^{b}	0.000
8-OHdG (ng/mL)	2.279±0.21^{ab}	2.800±0.16^{a}	1.852±0.23^{b}	1.794±0.34^{b}	1.809±0.20^{b}	2.037±0.23^{b}	1.756±0.19 ^{b}	2.204±0.21^{ab}	0.032
TNF-α (pg/mL)	243.234±30.50^{b}	361.209±18.15^{a}	255.863±30.19^{b}	256.835±25.89^{b}	255.033±16.52^{b}	271.572±9.66^{b}	236.258±15.00^{b}	280.376±13.01^{b}	0.006
IL-6 (pg/mL)	3.263±0.12^{d}	13.351±0.88^{a}	3.684±0.918^{d}	3.060±0.36^{d}	2.150±0.68^{d}	9.300±0.23^{b}	9.567±0.15^{b}	6.598±0.96^{c}	0.000

$^{a\text{-}d}$Values within each row with different superscripts differ significantly. Data are expressed as means ± standart error mean (SEM), p <0.05 is significant tested by using One-way analysis of variance (ANOVA) test followed by Duncan's post-hoc test. Mg: magnesium, 125 mg/kg/b.w.; L-carnitine: 300 mg/kg/b.w.; MDA: malondialdehyde, 8-OHdG: 8-hydroxy-2'-deoxyguanosine; TNF-α: tumor necrosis factor alpha; IL-6: interleukin-6.

Table 3. Kidney MDA, 8-OHdG, TNF-α, and IL-6 levels in rats with experimental diabetes, given L-carnitine and Mg

Parameters	Control n=10	Diabetes n=10	Mg n=7	L-carnitine n=7	Mg+ L-carnitine n=8	Diabetes+ Mg n=10	Diabetes+ L-carnitine n=8	Diabetes+Mg+ L-carnitine n=9	P Value
MDA (µmol/L)	17.610±0.56^{c}	23.980±1.36^{a}	18.610±0.95^{bc}	18.258±0.16^{bc}	18.215±0.88^{bc}	18.852±1.25^{bc}	20.201±1.29^{bc}	21.182±0.62^{b}	0.000
8-OHdG (ng/mL)	2.30±0.16^{bc}	3.22±0.57^{a}	2.03±0.19^{c}	2.08±0.16^{c}	2.13±0.18^{bc}	2.69±0.23^{abc}	2.87±0.18^{ab}	2.49±0.10^{abc}	0.005
TNF-α (pg/mL)	179.50±14.71^{b}	320.94±28.51^{a}	161.89±12.26^{b}	164.36±6.08^{b}	195.98±10.74^{b}	182.08±12.73^{b}	172.18±10.74^{b}	201.13±10.12^{b}	0.000
IL-6 (pg/mL)	5.19±0.99^{b}	9.585±2.28^{a}	3.313±0.34^{b}	4.578±0.86^{b}	4.300±0.26^{b}	3.038±0.57^{b}	1.98±0.31^{b}	3.937±0.83^{b}	0.000

$^{a\text{-}d}$Values within each row with different superscripts differ significantly. Data are expressed as means ± standart error mean (SEM), p <0.05 is significant tested by using One-way analysis of variance (ANOVA) test followed by Duncan's post-hoc test. Mg: magnesium, 125 mg/kg/b.w.; L-carnitine: 300 mg/kg/b.w.; MDA: malondialdehyde, 8-OHdG: 8-hydroxy-2'-deoxyguanosine; TNF-α: tumor necrosis factor alpha; IL-6: interleukin-6.

DISCUSSION

Diabetes and oxidative stress

Diabetes mellitus is a chronic metabolic disease that develops partially or completely due to insulin deficiency, causing disorders in glucose uptake into cells and acute and chronic pathological complications [20]. The etiology of this disease has not been fully defined however, it has been stated that viral infection, autoimmune disease, and various genetic and environmental factors may be effective [20,21].

Oxidative stress, due to hyperglycemia in diabetes mellitus, may be seen mainly due to increased free radical production and/or a significant decrease in antioxidant defense [22,23].

Several studies have demonstrated that changes occur in serum and tissue oxidative stress parameters in diabetic rats. The MDA concentration is one of the most prominent markers of lipid peroxidation and is used as a biomarker of oxidative stress [21,24]. In a study [25], it was found that the levels of thiobarbutyric (thiobarbituric) acid (TBARS) in the liver tissue homogenates of Wistar albino rats with experimental diabetes (55 mg / kg STZ) increased. Abdelmageed et al. [26] found that in Wistar rats treated with 35 mg/kg STZ, that there was significantly increased hepatic and aortic MDA and decreased hepatic and aortic antioxidant levels in the liver tissue of diabetic rats. Other researchers [27] stated that STZ-induced (45 mg/kg, b.w.) diabetes caused a significant increase in erythrocyte, brain, kidney, and liver MDA content levels as a result of oxidative stress conditions. In addition to the above-mentioned STZ doses, a significant increase in MDA levels was found in the liver and kidney, due to diabetes in Wistar albino rats treated with 50 [28,29] and 60 mg [30,31] STZ.

In this study, the increase in liver and kidney MDA concentration in the diabetic group may be due to the formation of free radicals in tissues and the accumulation of hydrogen peroxide as a result of the increase in beta oxidation of fatty acids with the occurrence of enzyme inactivation during the glycation process due to insulin insufficiency as indicated by other researchers [21,23,24,27].

Free radicals play an important role in the mechanism of cytotoxicity and DNA damage created by STZ [22]. In diabetes, the antioxidant defense system is disrupted and the increasing reactive oxygen species causes DNA damage [25,32]. It has been determined that oxidative stress observed in diabetes mellitus plays an important role in the pathogenesis of vascular complications developing due to diabetes and that 8-OHdG has an important place in demonstrating oxidative stress and determining oxidative DNA damage in some studies [33,34]. Hsieh et al. [34] reported that the 8-OHdG levels of liver, kidney, pancreas, brain, and heart tissues in the diabetic rat (45 mg/kg b.w., i.p.) were significantly higher than the control group. In addition, levels of 8-OHdG in the liver [35,36] and kidney [35] tissues were significantly increased in rats with diabetes induced by 65 [36] and 60 [35] mg/kg STZ. Similarly, in this study, it was determined that the liver and kidney 8-OHdG levels increased significantly in

diabetic rats. These results are important in terms of showing that diabetes can cause DNA damage.

Leng et al. [37] investigated endothelial function in the thoracic aortic rings of Sprague-Dawley rats administered 65 mg / kg STZ (i.p. injection) and found that TNF-α and IL-6 levels increased significantly.

Some researchers have reported a significant increase in inflammatory markers, such as TNF-α and IL-6 in the liver and kidney of diabetic Wistar albino rats [30,31]. Wang-Fischer and Garyantes [38] reported that Sprague-Dawley rats injected with STZ (50-65 mg / kgb.w., i.v.) had significantly increased plasma TNF-α and IL-6 levels in diabetic rats compared to sham rats. In diabetes, the production of important proinflammatory cytokines is increased during inflammation and apoptosis resulting from hyperglycemia [39]. Together, oxidative stress and inflammation form a malicious series of biological events that eventually lead to tissue injury [31]. In the study presented, it was determined that TNF-α and IL-6 levels in liver and kidney increased in the diabetes group. This increase is due to the fact that TNF-α and IL-6 are precursor inflammatory cytokines and in accordance with Pradhan and Ridker [40] their amount is associated with increased complications in diabetic patients.

Diabetes and magnesium

Today, as an alternative to modern medicine, interest in food, plant, and dietary supplements, which have beneficial effects on health, is increasing. Especially in diabetic cases, natural resources such as vitamins and minerals are needed. It has been stated that Mg, a microelement, is not directly related to the mechanism of diabetes, but can help prevent complications from the disease [41]. Magnesium is an important ion in glucose homeostasis. As a cofactor in the glucose transport system of the plasma membranes, Mg has an important role in the activity of glucose oxidation enzymes, also Mg is an element that plays a role in insulin release, and can regulate the energy transfer mechanism from high-energy phosphate bonds [42,43]. Parvizi et al. [23] suggested that $MgSO_4$ (10 g/L) decreased renal MDA levels in diabetic rats (8 weeks, 20 mg / kg STZ), and therefore, they stated that Mg may shows a protective antioxidant activity against lipid peroxidation. Hans et al. [44] reported that although the cause of oxidative stress, which is one of the complications of diabetes, is not known exactly, it may result from the autoxidation of glucose and nonenzymatic glycation of proteins. In this study, the significant decrease in liver and kidney MDA levels determined in diabetic rats given Mg supports the findings of some researchers [23,44]. This suggests that Mg might have an effect in scavenging free radicals as an antioxidant [17,23].

Adequate studies, in which magnesium, 8-OHdG and cytokines were studied together could not be found. In this study, liver and kidney 8-OHdG levels, which show an increase due to diabetes and are indicative of DNA damage, decreased significantly with administration of Mg in the diabetic groups. This may be due to the protective

role of Mg in oxidative stress [17,23] and DNA damage, as it acts as a cofactor in the structure of enzymes involved in general metabolism. Sugimoto et al. [45], reported that magnesium deficiency increases the production of proinflammatory cytokines such as TNF-α and IL-1β in humans. In a study [46], it was found that Mg administered with high purity Mg (99.98% weight) in vivo rapidly lowered TNF-α and IL-6 levels. In the present study, it was thought that Mg decreased the levels of TNF-α and IL-6 in the liver but not in the kidney.

Diabetes and L-carnitine

L-carnitine, is a vitamin-like water soluble small molecule, which has a crucial role in fatty acid metabolism, and is likely to be a potential support in the treatment of diabetes [47]. Carnitine and acylcarnitines migrate between carnitine-dependent tissues such as gastrointestinal tract, liver, kidney, heart or skeletal muscle [48]. L-carnitine strengthens the opinion that it improves immune function in diabetic patients by increasing mitochondrial function, reducing oxidative damage, and delaying cell death in immune organs and blood [49]. L-carnitine was administered intraperitoneally (300 mg / kg) to rats with liver damage caused by carbon tetrachloride and it was observed that L-carnitine reduced hepatic oxidative stress and had an improving effect on diabetes [15]. Sayılan Özgün et al. [50] investigated the effect of intraperitoneal L-carnitine administration on NO metabolism in the plasma and liver in diabetic rats. They found that L-carnitine administration in diabetic rats had no significant effect on liver NO (oxidant parameter) levels. In a study, in which experimental diabetes was created with 65 mg / kg STZ in Wistar albino rats, L-carnitine was reported to improve the oxidative stress markers in the heart [51]. In another study [52], it was reported that it reduced increased MDA levels in the retina. In the present study, as with other researchers' findings [51,52], MDA levels in tissues decreased with L-carnitine administration in diabetic rats. This suggests that L-carnitine may be associated with an active role in the transport of fatty acids for energy production, possibly by reducing the availability of lipids for peroxidation [51,53]. Besides its role in lipid metabolism, L-carnitine also has antioxidant properties, so it is recommended as an adjunct in the treatment of diabetes [54].

Inadequate studies have been found on how diabetes may affect 8-OHdG levels, which are indicators of DNA damage. Only one study [55] investigated the effects of L-carnitine (100 mg / kg / day) on pancreatic, kidney, and liver 8-OHdG levels in STZ (65 mg / kg / b.w.)-induced diabetic Sprague-Dawley rats. It was determined that kidney 8-OHdG levels of diabetic rats treated with L-carnitine decreased significantly compared to the diabetic group. In this study, it was determined that L-carnitine caused a decrease in liver and kidney 8-OHdG levels in the diabetes + L-carnitine group compared to the diabetes group. This may be due to the level of L-carnitine used and it is believed that different doses can be researched. In addition, in this study, as in some other studies [52,56], it was found that giving 300 mg L-carnitine to diabetic rats had positive effects on both TNF-α and IL-6 tissue levels. This may be due to the

important physiological roles of L-carnitine tricarboxylic acid cycle (TCA), fatty acid oxidation, urea cycle, gluconeogenesis, etc. [57], as well as having anti-inflammatory properties [58].

Diabetes and magnesium + L-carnitine

In the case of diabetes, only one study could be found regarding the combined application of magnesium and L-carnitine [19]. Kaya-Karabulut et al. [19] evaluated the effects of L-carnitine (300 mg / kg / b.w.) and magnesium (Mg, 125 mg / kg / b.w.) as magnesium sulphate separately and / or combined in STZ-induced (50 mg / kg) experimental diabetes in Wistar albino rats. In diabetic rats, elevated serum MDA levels were decreased separately and / or combined for both substances. In this study, reductions were found in liver and kidney MDA, 8-OHdG, TNF-α, and IL-6 levels, probably due to the antioxidant and anti-inflammatory effects of magnesium and L-carnitine, in the diabetes + Mg + L-carnitine group compared to the only diabetic group.

CONCLUSION

The administration of both Mg and L-carnitine separately or in combination by oral route can have positive effects on oxidative stress, DNA damage, and cytokine levels in the liver and kidney tissues of diabetic rats. However, the results showed that the combination of Mg and L-carnitine was not more effective than the individual administration of 8-OHdG and TNF-α parameters in the liver and IL-6 levels in addition to these parameters in the kidney. It has been concluded that different doses of Mg and L-carnitine should be applied in order to determine the effects on diabetes.

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Authors' contributions

MŞ designed the study and collected samples for analysis, carried out biochemical analysis, conducted the statistical analysis and ensured the preparation of the article. ME participated in the design of the study and collected samples for analysis, statistical analysis and ensured the preparation of the article. ZSS participated in the design of the study, collected samples for analysis and ensured the preparation of the article. All authors read and approved the final version of the article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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ISPITIVANJE EFEKATA L-KARNITINA I MAGNEZIJUMA NA OKSIDATIVNI STRES I CITOKINE U TKIVU EKSPERIMENTALNO INDUKOVANOG DIJABETESA PACOVA

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Cilj ove studije je bio da se odrede efekti L-karnitina i magnezijuma na sadržaj tkivnog malonildialdehida, 8-hidroksi-2'-deoksiguanozina i citokina (faktor nekroze tumora- alfa i interleukin-6) kod streptozocin indukovanog dijabetesa pacova. Osamdeset muških Wistar albino pacova (200-250 g) je bilo raspodeljeno u 8 oglednih grupa, 10 pacova svaka. Grupe su bile tretirane na sledeći način: kontrolna grupa; 2 ml destilovane vode (preko sonde); grupa 2: 50 mg/kg (t.m.) i.p. streptozotocin; grupa 3: 125 mg/kg (t.m.) magnezijuma; grupa 4: 300 mg/kg (t.m.) L-karnitina; grupa 5: 125 mg/kg (t.m.) magnezijuma +300 mg/kg (t.m.) L-karnitina; grupa 6: 50 mg/kg (t.m.) streptozotocina +125 mg/kg (t.m.) magnezijuma; grupa 7: 50 mg/kg (t.m.) streptozotocin +300 mg/kg (t.m.) L-karnitin i grupa 8: 50 mg/kg (t.m.) streptozotocin +125 mg/kg (t.m.) magnezijum+300 mg/kg (t.m.)) L-karnitin aplikovani tokom 4 nedelje. Nivoi malondialdehida u jetri i bubrezima, 8-hidroksi-2'-deoksiguanozina, faktora nekroze tumora alfa i interleukina-6 nisu se promenili u grupama tretiranim magnezijumom, L-karnitinom i magnezijum + L-karnitinom, u odnosu na kontrolnu grupu. Najviši nivoi malondialdehida, 8-hidroksi-2'-deoksiguanozina, faktora nekroze tumora-alfa i interleukina-6 utvrđeni su samo u grupi sa dijabetesom (grupa 2). Peroksidacija lipida, oštećenje DNK i nivoi citokina značajno su smanjeni kod dijabetičnih životinja uz davanje magnezijuma i L-karnitina odvojeno ili u kombinaciji. Na osnovu dobijenih rezultata može se zaključiti da magnezijum i L-karnitin mogu imati antidijabetičko dejstvo, posebno u kombinaciji.