Egypt. J. Exp. Biol. (Zool.), 15(1): 101 – 110 (2019)
DOI: 10.5455/egysebz.20190608015059

AARU Impact Factor: 2.0

RESEARCH ARTICLE

Nabila I. El-Desouki
Mohamed A. Basyony
Ghada A. Tabl
Mohamed S. El-Aama

Role of coconut oil and vitamin D in alleviating glucose, C-peptide and histological alterations in the hepatic tissues of hyperglycaemic albino rats

ABSTRACT:

The purpose of the present study is to evaluate the effect of either vitamin D or coconut oil or both together on the histological changes of the hepatic tissues of diabetic adult male albino rats induced by using streptozotocin (STZ). The rats were divided into 7 equal groups (10 rats/each). The duration of the experiment was 30 days. Group I: normal control rat group without any treatments. Group II and group III: non-diabetic rat groups received orally coconut oil in a dose of 7.5 ml /kg b. w/d or vitamin D in a dose of 500 IU/kg b.w/d, respectively for 30 days. Group IV: diabetic rats group injected i. p. with a single dose of STZ dissolved in saline solution in a dose of 60 mg/kg b.w to induce diabetes. Groups V, VI, and VII: diabetic rats administered orally at the same previous doses with coconut oil or vitamin D or both together. The results recorded non-significant changes in the blood glucose and C-peptide levels of non-diabetic group. Significant increase in blood glucose level and a significant decrease in C-peptide of diabetic group as compared to the normal control ones. Diabetic group that received the coconut oil or vitamin D recorded a decrement in blood glucose levels and an increment in C-peptide; while the diabetic rats co-administered with vitamin D and coconut oil recorded a highly significant decrease in blood glucose levels and a highly significant increase in C-peptide as compared to diabetic group. Histologically, the rats of normal control group or that received either coconut oil or vitamin D showed normal structure of the liver tissue with H and E stain. The liver lobules are roughly hexagonal and consist of plates of hepatocytes radiating from a central vein. The central vein joins to hepatic vein to carry blood out from liver. Between the hepatocyte plates there are liver blood sinusoids, which are lined with two types of cells sinusoidal endothelial cells and phagocytic Kupffer cells. The diabetic rats demonstrated many histopathological changes in the liver tissue included loss of normal liver architecture, degeneration of hepatocytes, appearance of pyknotic nuclei, dilated and congested of central vein surrounded by fibrosis, dilation of hepatic blood sinusoids, activation of Kupffer cells, and infiltration of inflammatory leucocytes. The diabetic rats administered with either coconut oil or vitamin D elucidated improvement of liver histology and few pyknotic nuclei were seen, as well as slight dilation in the blood sinusoids and decrement of inflammatory cells were also demonstrated. While diabetic rats given both coconut oil and vitamin D together detected obvious improvement and recovery of the liver structure with the appearance of normal hepatocytes and disappearance of the inflammatory infiltrated leucocytes.

KEY WORDS:

Hyperglycaemia, Hepatic tissue, Histology, Glucose, C-peptide, Rats.

CORRESPONDENCE:

Nabila I. El-Desouki

Department of Zoology, Faculty of Science, Tanta University, Tanta 31527, Egypt.

E-mail: nabiladesoky@yahoo.com

Mohamed A. Basyony

Ghada A. Tabl

Mohamed S. El-Aama

Department of Zoology, Faculty of Science, Tanta University, Tanta 31527, Egypt.

ARTICLE CODE: 12.01.19

INTRODUCTION:

Diabetes mellitus is known hyperglycaemia, and it is due to the deficiency of insulin secretion or its action. It has been associated with a syndrome of disturbance in the homeostasis of carbohydrate, fat and protein metabolism

(American Diabetes Association, 2010). Diabetes mellitus has been categorized into type 1 and type 2 diabetes. Type1 diabetes refers to deficiency of endogenous insulin which is caused by a cellular mediated autoimmune destruction of the beta cells in the pancreas which produces insulin. Type 2 diabetes is a result of decreased response to insulin by its receptors, which is also referred to as insulin resistance (American Diabetes Association, 2011).

Streptozotocin (STZ) is used to induce diabetes which acts mainly by the generation of reactive oxygen species (ROS). Oxidative stress contributes significantly to the pathophysiology of several diseases which include diabetes. It preferentially accumulates in the GLUT2 glucose transporter in the pancreatic beta cells and subsequently leads to the death of the cells. Therefore, STZ is a model compound when studying diabetes as a result of ROS mediated beta cell toxicity (Lenzen, 2008).

Studies on the biological effects of coconut oil have proven that it ameliorates oxidative stress by boosting the antioxidant defence system, mopping up free radicals and reducing lipid peroxidation (Nevin and Rajamohan, 2006; Dosumu*et al*., 2010). Coconut oil has also the ability to suppress microbial and viral activities (VanImmerseel*et al*., 2004), promotes weight loss and enhances thyroid function (Takeuchi *et al*., 2008). Since glucose, generally comes from the food we eat, composes of many long molecule structures, it is difficult to enter the cells by itself. So, it needs insulin to do. However, coconut oil contains most of medium-chain fatty acids (MCFAs, C 6-12) which are smaller and lighter than glucose. So, it can get into the cells without a need of insulin. Coconut oil does the job similarly to insulin. It is because coconut oil gives the body healthy nutrients that are useful for the cells to produce energy (Iranloye*et al*., 2013; Famurewa*et al*., 2017).

Some studies have shown that vitamin D is necessary for normal insulin secretion. Vitamin D may play a functional role on glucose tolerance through its effects on insulin secretion and insulin sensitivity. It has been demonstrated that the secretion of pancreatic insulin is inhibited by vitamin D deficiency, and this deficiency is related to glucose intolerance and Diabetes mellitus type 2 (Maestro *et al.,* 2003; Al-Shoumer and Al-Essa, 2015). Liver disease could lead to impaired absorption of vitamin D, which impossibly connected to impaired bile acid production or gut oedema associated with portal hypertension. Low vitamin D levels and bone disease are well recognized complications of “cholestatic” liver disease, which decreases the production or flow of bile. Recently, studies have confirmed low vitamin D levels are also found in non-cholestatic liver disease (Eugene and Schiff, 2010).

Vitamin D is a fat-soluble vitamin, which is an essential micronutrient with major implications for human health (Nevin and Rajamohan, 2006). The biological active form of vitamin D is 1, 25 (OH) 2D3 (also known as active vitamin D3). Vitamin D receptors are widely distributed in more than 38 tissues (Dosumu *et al*., 2010). Macrophages and dendrite cells constitutively express vitamin D receptors, which indicate that vitamin D plays an important role in regulating and modulating the inflammatory response (Uchiyama and Mihara, 1978; Cretney and Tafunai, 2004). Several studies suggested that vitamin D plays an important role in decreasing the risk of many chronic diseases, including type 2 diabetes (Sun and Zigmam, 1978), cardiovascular disease (Cigolini*et al*., 2006) and the metabolic syndrome (Aebi, 1984).Vitamin D plays an important part in the regulation of calcium. Calcium helps to control the release of insulin, so alterations in calcium can have a negative effect on beta cell function, which may hinder normal insulin release (Talaei*et al*., 2013).

The current work is aimed to study the beneficial role of vitamin D or/and coconut oil on the blood glucose and C-peptide values, as well as the improvement of the histological architecture of hepatic tissue of STZ- diabetic adult male albino rats.

MATERIAL AND METHODS:

Animals and housing condition:

Seventy adult male albino rats weighing 121.33 ± 1.50 g were used in the present study and were supplied from Vacsera 51 Wezaret El Zeraa St. Agouza, Giza, Egypt. All rats were housed two weeks before the study. The animals were fed with a standard diet and allowed free access of water. All cares and procedures adopted for the present study were in accordance with the approval of the Institutional Animal Ethics Committee of Tanta University and in accordance with recommendation of the proper care and use of laboratory animals**.**

Materials:

Streptozotocin was obtained from Sigma Chemical Company (St. Louis. MO. USA) and used for induction of diabetes. Coconut oil was obtained from Albadawia Company for herbal and oil extraction Mansoura, Egypt. Vitamin D was obtained from Sigma Chemical Company (St. Louis. Mo.USA).

Experiment:

Induction of diabetes:

Animals were fasted overnight and then injected interperitoneally (i.p.) with a single dose of STZ (65 mg/kg/b.w) dissolved in freshly prepared 0.1M acetatebuffer solution

(pH 4.5) as recommended by Kanter*et al*. (2003) and Al- Amoudi and Araki (2013). Blood drawn from the tail veins of rats and blood glucose was measured by using Accu-Chek Performa apparatus according to Brăslasu *et al*. (2007) and the blood glucose level > 240 mg/dl was accepted to be diabetic.

Experimental design:

All procedures were done at the Faculty of Science, Tanta University, Egypt. The animals were housed in cages, and divided into seven groups (10 rats/ each) as follows:

Gp I: Normal control rats injected daily with 0.1 ml diluents solution. Gp II: Non-diabetic rats administered with coconut oil at a dose of (7.5ml/kg/d) for 30 days. Gp III: Non-diabetic rats received vitamin D at a dose of (500IU/kg/d) for 30 days. Gp IV: STZ-diabetic rats (served as hyperglycaemic group, positive control group). Gp V: diabetic rats received coconut oil at a dose of (7.5ml/kg/d) for 30 days. Gp VI: diabetic rats received vitamin D at a dose of (500IU/kg/d) for 30 days. Gp VI: diabetic rats received co-administered of coconut oil and vitamin D at the same doses.

At the end of 30 days of the experiment, rats were fasted for 14 hours and then sacrificed by decapitation. Blood sera were collected, and the liver tissue samples were carefully dissected out and divided into pieces for biochemical and histological studies.

Biochemical studies:

Sera were taken from all studied groups for biochemical determination. Blood glucose was estimated on day: 0, 10, 20 and 30 by using Accu-Chek Performa Apparatus (Brăslasu*et al.,* 2007). C-peptide was also determined in the laboratory by using a rat-specific C-peptide RIA kits according to Rendell (1983).

Histopathological studies:

Pieces of liver tissues were fixed in 10% buffered neutral formalin and processed to get sections of 5µm thickness for histological study. The sections were stained with Harris haematoxylin and eosin dye "H and E" according to Bancroft and Steven (1996).

RESULTS:

A) Biochemical results: -

Effect of vitamin D or/and coconut oil on blood glucose value:

Inducing of diabetes recorded a significant increase of blood glucose value at p = 0.001 to 249.50 ± 3.52 mg/L with a difference 225.4% compared with normal control rats (76.67 ± 2.08 mg/L). The rats given either coconut oil or vitamin D at a dose (7.5 mg/kg/b.w. or 500 IU/kg/b.w., respectively) for 30 days to non-diabetic rats recorded a difference (- 3.0% & - 4.3%, respectively) compared with the control normal rats. Administration of vitamin D or both vitamin D and coconut oil together to diabetic rats recorded a highly significant decrement of blood glucose values after 10 days (178.17 ± 3.37 and 169.5 ± 2.22 mg/L, respectively) with difference (- 29.9% and **-** 33.4, respectively) than those taken coconut oil alone (189.5 ± 5.04 mg/L) with difference (- 25.5%) and recorded non-significant management in comparison with the corresponding values of diabetic rats at p = 0.001.

At the experimental time end (after 30 days), the diabetic rats recorded 259.8 ± 34.74 mg/L glucose values with a difference of 231.7% compared to the control normal rats. The administration of diabetic rats with coconut oil or vitamin D or both together recorded significant decrease of blood glucose values specially the co-administration of both vitamin D and coconut oil (93.17 ± 1.97, 89.33 ± 2.08و and 79.67 ± 3.16 mg/L, respectively) with difference of (- 64.1%, - 65.7%, and - 69.3%, respectively) compared to the corresponding values of diabetic rats at p = 0.001, (Table 1 & Fig. 1).

Table 1. Effect of coconut oil or/and vitamin D daily for 30 days on blood glucose values.

GROUPS	Zero day		After 10		After 20 days		After 30 days	
	X ± SE	diff%	X ± SE	diff%	X ± SE	diff%	X ± SE	diff%
GROUP 1	76.67 ± 2.08	-	77.17 ± 1.62	-	76.33 ± 1.45	-	78.33 ± 1.2	-
GROUP 2	76.17 ± 2.39	- 0.7	74.83 ± 1.81	- 3.0	75.83 ± 1.22	- 0.7	74.83 ± 1.54	- 4.5
GROUP 3	73.17 ± 1.62	- 4.6	73.83 ± 1.7	- 4.3	75.33 ± 1.41	- 1.3	75.5 ± 1.59	- 3.6
GROUP 4	249.50 ± 3.52*	225.4	254.33 ± 5.21*	229.6	265.5 ± 4.45*	247.8	259.8 ± 34.74*	231.7
GROUP 5	249.33 ± 3.44*	225.2	189.5 ± 5.04	- 25.5	131.5 ± 4.01**	- 50.5	93.17 ± 1.97**	- 64.1
GROUP 6	252.5 ± 3.49*	223.0	178.17 ± 3.37**	- 29.9	130.67 ± 3.23**	- 50.8	89.33 ± 2.08**	- 65.7
GROUP 7	247.67 ± 1.86*	223.03	169.5 ± 2.22**	- 33.4	91.33 ± 2.06**	- 65.6	79.67 ± 3.16**	- 69.3

*Significant against group1, ** significant against group 4. All results are expressed at mean ± SE (standard error) at p < 0.001.

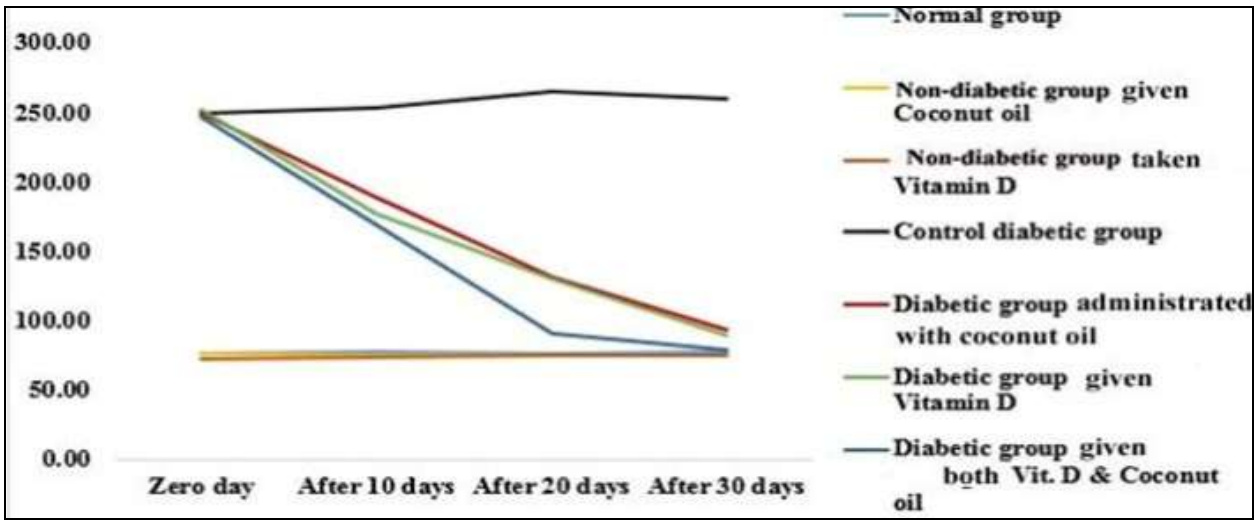

Fig 1. The effect of coconut oil or/and vitamin D on blood glucose

Effect of vitamin D or/and coconut oil on serum c-peptide:

Diabetic rats recorded significant decline in serum C-peptide (178.8 ± 1.7 pmol /L, - 36.5%) compared to the control normal rats (281.68 ± 5.7 pmol/L). Either coconut oil or vitamin D given to non-diabetic rats caused insignificant increase in serum C-peptide levels (284.36 ± 5.6 pmol /L, 1.01% and 301.52 ± 3.7 pmol /L, 7.01%, respectively) compared to control group (281.68 ± 5.7). The diabetic rats given coconut oil or vitamin D or both together recorded highly significant increase of serum C-peptide values specially both together (257.07 ± 3.9, 264.99 ± 7.37 and 275.75 ± 1.81 pmol/L, respectively) with difference of (43.8%, 48.2%, and 54.2%, respectively), compared to the corresponding values of diabetic rats at p = 0.001,(Table 2 & Fig. 2).

Table 2. Effect of coconut oil or/and vitamin D daily for 30 days on serum C-peptide.

GROUPS	C-peptide (Pmol/L)	
	X ± SE	diff%
GROUP 1	281.68 ± 5.7	-
GROUP 2	284.36 ± 5.6	1.0
GROUP 3	301.52 ± 3.7	7.0
GROUP 4	178.8 ± 1.7*	- 36.5
GROUP 5	257.07 ± 3.9**	43.8
GROUP 6	264.99 ± 7.37**	48.2
GROUP 7	275.75 ± 1.81**	54.2

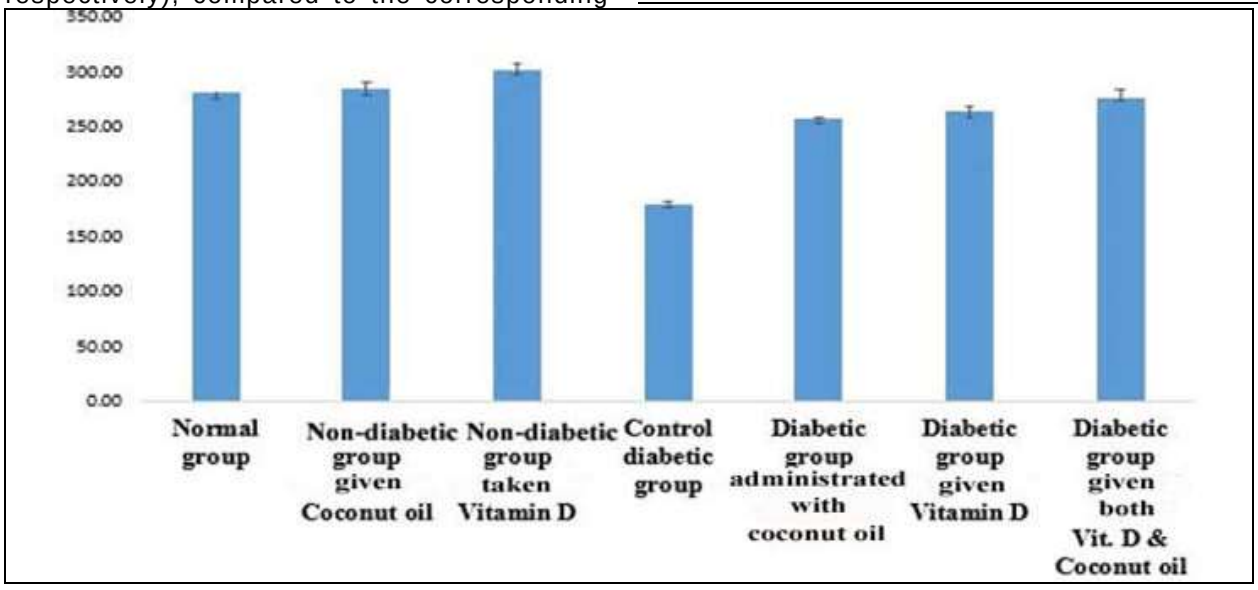

Fig 2. The effect of coconut oil or/and vitamin D on C-peptide.

B) Histological observations:

Normal control rat group (Group I):

Liver sections stained with H and E of normal control rats and examined by light microscopy showed that, each liver lobe is made of hepatic lobules. The lobules are roughly hexagonal and consist of plates of hepatocytes radiating from central veins. The central vein joins to hepatic vein to carry blood out from liver. Between the hepatocyte plates are liver blood sinusoids, which are lined with two types of cells sinusoidal endothelial cells and phagocytic Kupffer cells (Fig. 3).

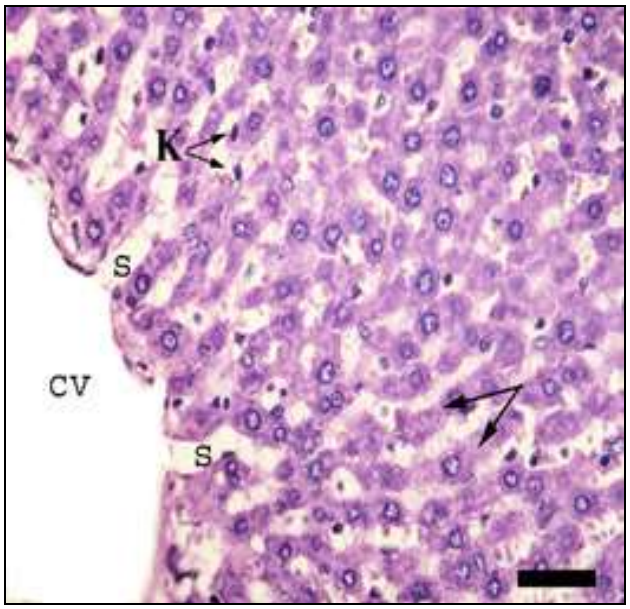

Fig. 3. A section of the liver of a normal control rat showing the normal hepatocytes (arrows), normal central vein (CV) and blood sinusoids (S), and normal appearance of Kupffer cells (K). H & E, scale bar = 6.25 µm.

Non-diabetic rats given coconut oil or vitamin D groups (Groups II & III):

Non-diabetic rats administered with either coconut oil at a dose of (7.5ml/kg/d) for 30 days or vitamin D at a dose of (500IU/kg/d) for 30 days demonstrated normal structure of liver sections with normal hepatocytes radiating from central veins and normal appearance of blood sinusoids that lined with normal endothelial and Kupffer cells (Figs 4 & 5).

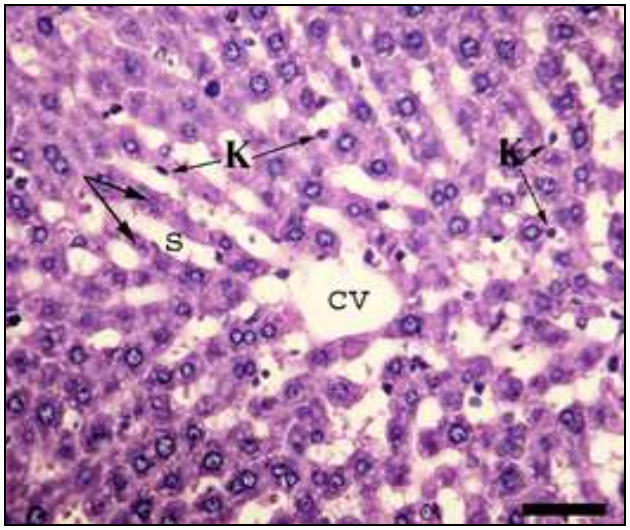

Fig. 4. A section of the liver of a non-diabetic rat given coconut oil detecting the normal hepatocytes (arrows) with normal central vein (CV)and blood sinusoids (S), and normal Kupffer cells (K). H & E, scale bar = 6.25 µm.

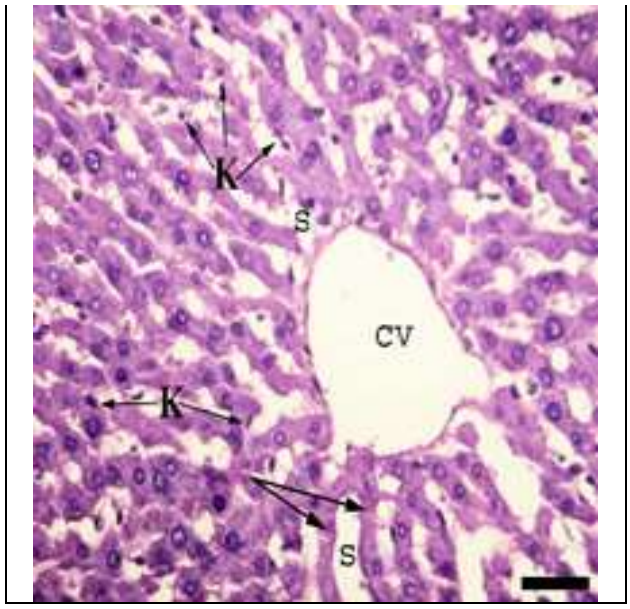

Fig. 5. A section of the liver of a non-diabetic rat administered with vitamin D illustrating the normal hepatocytes (arrows), normal blood sinusoids (S) with normal central vein (CV) and normal Kupffer cells (K). H & E, scale bar = 6.25 µm.

STZ – diabetic rat groups (Group IV):

STZ- diabetic rats illustrated loss of normal liver architecture with the appearance of degeneration of hepatocytes and loss of the normal radiating hepatic cells, widen of some blood sinusoids, dilated and congested of central veins and hepatic portal veins that surrounded by fibrosis. Kupffer cells are activated and proliferated in-between the hepatocytes, as well as the appearance of leucocytes infiltration (Figs 6 & 7).

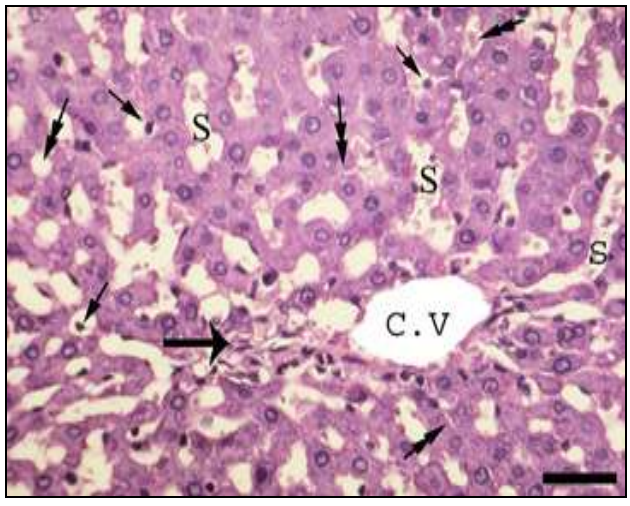

Fig. 6. A section of the liver of STZ diabetic rat illustrating loss of normal liver architecture with degeneration of hepatocytes (double arrows), infiltration of inflammatory leucocytes (thick arrow) periphery to central vein (CV), dilation of some hepatic sinusoids (S),and activation of Kupffer cells (thin arrows) in between the hepatocytes. H & E, scale bar = 6.25 µm.

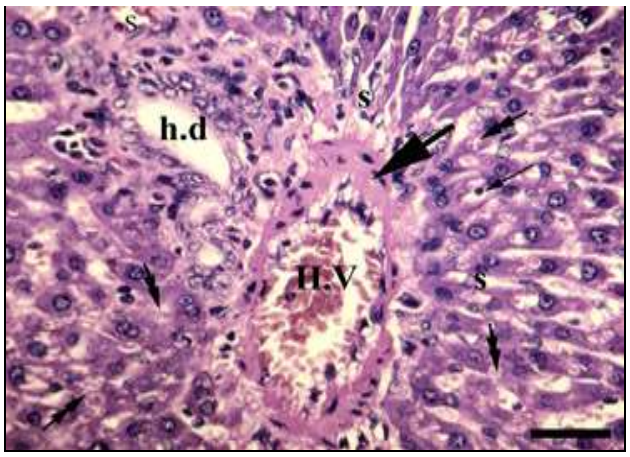

Fig. 7. A liver section of STZ diabetic rat illustrating the degeneration of hepatocytes (double arrows), dilation and congestion of hepatic portal vein (H.V) surrounded by thick fibrosis (thick arrow), dilation of hepatic duct (h.d) and blood sinusoids (S), activation of Kupffer cells (thin arrow) and the appearance of leucocytes infiltration (arrow head). H & E, scale bar =6.25 µm.

Diabetic rats given coconut oil group (Group V):

Diabetic rats taken coconut oil at a dose 7.5 ml/kg/d for 30 days demonstrated improvements of the liver histology with the recovery of most of hepatocytes, and few pyknotic nuclei are seen. Slight dilation of the blood sinusoids, as well as the decrement of inflammation were also detected (Fig. 8).

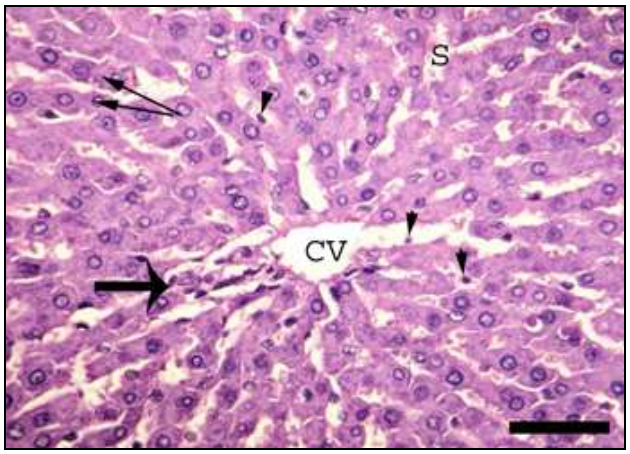

Fig. 8. A section of the liver of STZ diabetic rat given coconut oil illustrating partially improvement of hepatocytes structure (thin arrows), normal central vein (CV), no dilation in blood sinusoids (S), normal Kupffer cells (arrow heads), few infiltrations of inflammatory cells (thick arrow). H & E, scale bar = 6.25 µm.

Diabetic rats given vitamin D group (Group VI):

Diabetic rats administrated vitamin D at a dose 500 IU/kg/d for 30 days showed improvements of the liver histology with the recovery of normal hepatocytes, normal appearance of central veins, absence of pyknotic nuclei, very slight dilation in sinusoids and decrement of inflammation (Fig. 9).

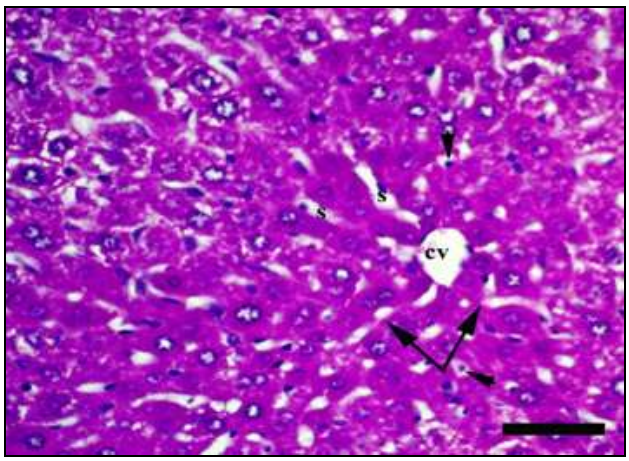

Fig. 9. A section of the liver of STZ diabetic rat administrated with vitamin D revealing improvements of hepatocytes (thin arrows), normal central vein area (CV), no dilation in blood sinusoids (S), normal Kupffer cells (arrow heads) and no inflammatory cells. H & E, scale bar = 6.25 µm.

Diabetic rats given both coconut oil and vitamin D group (Group VI):

Co-administrated of coconut oil and vitamin D to diabetic rats detected obviously improvement and recovery of the liver structure with normal appearance of central veins, normal arrangement of the hepatic cords and regeneration in the structure of hepatocytes and very slight dilation in blood sinusoids which became so close to normal appearance (Fig. 10).

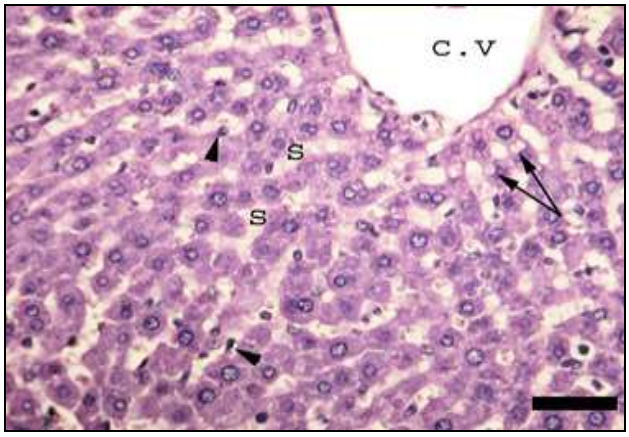

Fig. 10. A section of the liver of STZ diabetic rat administrated with both coconut oil and vitamin D detecting obviously improvement and recovery of the liver structure with normal appearance of hepatocytes (thin arrows) and central vein (CV), normal arrangement of the hepatic cords and normal Kupffer cells (arrow heads), normal blood sinusoids (S). H & E, scale bar = 6.25 µm.

DISCUSSION:

The diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both (El-Desouki, 2004; Al-Malki and El-Rabey, 2014). STZ is

used as hypoglycaemic agents because it selectively destroys the pancreatic ß-cells of rats, thus it is a useful agent for diabetes experimental model (Junod *et al*., 1969; Haligur *et al*., 2012; Al-Amoudi and Araki, 2013; Tuorkey *et al*., 2015; El-Desouki *et al*., 2018 & 2019).

The present results showed a significant increase in the blood glucose value and a highly significant decrease in C-peptide of the diabetic rats treated with STZ. The administered of diabetic rats with coconut oil at a dose 7.5 ml/kg/d for 30 days ameliorated the diabetic complications by declined the glucose levels and enhanced again C-peptide levels reflecting a restoration of the pancreatic β-cells activity to secrete insulin (Iranloye *et al*., 2013).In accordance, the hyperglycaemic response of STZ was found to be significantly reduced in animals given coconut oil (Siddalingaswamy *et al.,* 2011; El-Desouki *et al*., 2018 & 2019). The present results also illustrated a highly significant decrease in the blood glucose value after vitamin D given to diabetic rats at a dose of 500 IU/kg/d for 30 days. Similarly, the co-treatment of diabetic rats with coconut oil and vitamin D were significantly decreased blood glucose level more than each alone. In accordance, Talaei *et al*. (2013) recorded the role of vitamin D in the modulation of insulin in the diabetic patients. Moreover, the lipid metabolism and inflammation in the liver of diabetic rats are modulated by vitamin D (Ning *et al*., 2015).

Moreover, many researchers recorded a decrease in C-peptide level in STZ- diabetic rats (Saravanan and Leelavinothan, 2006; Malini *et al*., 2011). These changes are results from inhibition of insulin secretion from the pancreatic beta cells that is attributed to the induction of beta cell toxicity (Lenzen, 2008), and possibly through the mechanism of the induction of free radical species (Szkudelski, 2001) and oxidative stress that impaired insulin secretion in type 2 diabetes (Robertson, 2006). Siddalingaswamy *et al.* (2011) observed gradual decrease in blood glucose in STZ diabetic mice after been treated with coconut oil daily for 3 weeks. Moreover, Iranloyel *et al.* (2013) recorded that virgin coconut oil alleviates hyperglycaemia and improves glucose tolerance probably by its antioxidant effect which consequently leads to improvement of insulin secretion, as well as the results of El-Desouki *et al*. (2018 & 2019).

Coconut oil is a source of to cotrienols, capric acid, caproic acid, and lauric acid which are natural antioxidants. These substances act as scavengers of damaging oxygen free radicals that have been suggested to play an important role in Diabetes mellitus, aging, atherosclerosis and cancer (Kamsiah *et al.,* 2001; Schaffer *et al.,* 2005; Boateng *et al.,* 2016). Lauric acid in coconut oil has insulin-tropic properties (Nevin and Rajamohan, 2006). In diabetic patients, antioxidants may play a vital role in improving insulin response to the loaded glucose and may reduce insulin resistance (St-Onge *et al.,* 2003).

Defective insulin secretion leads to various metabolic aberrations in DM type 2, spanning from hyperglycaemia due to defective insulin-stimulated glucose uptake and up-regulated hepatic glucose production, along with dyslipidaemia, which includes impaired homeostasis of fatty acids, triglycerides and lipoproteins (Baxter and Webb, 2009; Jain and Patel, 2016). Hypovitaminosis D is associated with insulin resistance leading to DM. Vitamin D seems to affect the glucose homeostasis. Vitamin D inhibits the inflammatory responses caused by cytokines, diminishes stress in the pancreatic β cells which in turn avoids pancreatic cellular apoptosis. Along with these discoveries on a cellular level, there are possibilities that vitamin D could have a role in the prevention of the beginning of insulin resistance (Henrique *et al*., 2014; Souza *et al*., 2016).

The histological observations of liver confirmed the biochemical data in the current study. The liver tissue of diabetic rat detected loss of normal liver architecture with degeneration of hepatocytes, appearance of dilated and congested central vein and hepatic portal vein, Kupffer cells are activated and proliferated, infiltration of the inflammatory cells in-between the hepatocytes. After co- administration of both vitamin D and coconut oil to diabetic rats, the recovery of approximately normal liver architecture was demonstrated more than each alone. Al-Ani *et al*. (2017) recorded that the Diabetes mellitus is one of the most common causes of liver damage. Moreover, Ning *et al.* (2015) reported that 1, 25 (OH) 2D3 has protective effects on livers of diabetic rat by modulating inflammation and lipid metabolism. El Talees *et al.* (2019) confirmed the present histological observations, they recorded that the vitamin D administration had a hepatoprotective effect against fatty liver induced by a choline-deficient diet.

Moreover, Aisuodionoe *et al*. (2018) recorded a significant decrease in the blood glucose level of diabetic rats and also record that the diabetic rats treated with l0 mg/kg body weight of fresh coconut oil for two weeks and diabetic rats treated with 7.5 mg/kg body weight of fresh coconut oil and vitamin E (50 mg/day) for two weeks restores cellular structure and functions of the liver, pancreas and testes of diabetic rats.

In the previous our work, STZ diabetic mice demonstrated many histopathological changes in the thyroid glands included

vacuolated thyrocytes, enlargement and fusion of numerous follicles with the appearance of dilated and congested blood vessels. The diabetic mice administered with vitamin D elucidated slight improvement in the thyrocytes, while that received either coconut oil alone or co-administered with vitamin D and coconut oil illustrated a marked recovery in the architecture of follicles and thyrocytes, and appeared almost similar to the control ones (El-Desouki *et al*., 2018). Moreover, the disorders of the thyroid functions of diabetic mice returned approximately to normal level of hormones and a marked recovery of vimentin and cytokeratin immunoreactivity approximately to normal expression in the thyrocytes after administration of both vitamin D and coconut oil (El-Desouki *et al*., 2019).

In conclusion, diabetic rats given coconut oil with vitamin D or vitamin D alone demonstrated stronger anti-hyperglycaemic effects to recovery the blood glucose and C-peptide levels to normal values more than coconut oil alone and restored the histological architecture of the liver to approximately normal form.

REFERENCES:

Aebi H. 1984. Catalase *in vitro*. Methods Enzymol., 105: 121-126.

Aisuodionoe EM, Naiho AO, Okonkwo BC, Olowe GT, Esegbue PRC, Igweh JC. 2018. Mitigations in testicular, hepatic, and pancreatic histo-morphology in alloxan-induced diabetic sprague rats treated with fresh coconut oil and vitamin E. JOCAMR, 5(4): 1-11.

Al-Amoudi NS, Abu Araki HA. 2013. Evaluation of vegetable and fish oils diets for the amelioration of diabetes side effects. J. Diabetes Metab. Disord., 12(1): 13. doi: 10.1186/2251-6581-12-13.

Al-Ani IM, Abired AN, Mustafa BE, Abdel Wahab EN, Azzubaidi MS. 2017. Effect of flaxseed extract on the liver histological structure in streptozotocin induced diabetic rats. Int. Islamic. Uni. Malaysia, 16(1): 91-98.

Al-Malki AL, El- Rabey HA. 2014. The antidiabetic effect of low doses of *Moringa oleifera* Lam. seeds on streptozotocin induced diabetes and diabetic nephropathy in male rats. Biomed. Res. Int., Volume 2015, Article ID 381040, 13 pages.

Al-Shoumer KA, Al-Essa TM. 2015. Is there a relationship between vitamin D with insulin resistance and diabetes mellitus? World J. Diab., 6(8): 1057–1064.

American Diabetes Association 2010. Diagnosis and classification of diabetes mellitus. Diabetic Care, 33(Suppl 1): S62–S69.

Bancroft J, Stevens A. 1996. Theory and practice of histological techniques, 4th Edn. Churchill- Livingstone, London, pp. 766.

Baxter JD, Webb P. 2009. Thyroid hormone mimetics: potential applications in atherosclerosis, obesity and type 2 diabetes. Nat. Drug Discov., 8(4): 308-320.

Boateng L, Ansong R, Owusu E, Steiner-Asiedu M. 2016. Coconut oil and palm oil's role in nutrition, health and national development. Ghana Med. J., 50(3): 189–196.

Brăslaşu MC, Brăslaşu ED, Brădălan C, Săvulescu I, Gojmăleală R, Budai M, Tirifon E. 2007. Experimental studies regarding the Diabetes mellitus induced in white wistar rats. Lucrări Stiinłifice Med. Vet., 11: 109–116.

Cretney J, Tafunai A. 2004. Tradition, trade, and technology: Virgin coconut oil in samoa. In: "Chains of fortune: Linking women producers and workers with global markets. (Carr M. ed.)". Commonwealth Secretariat, London, pp. 45-74.

Dosumu OO, Duru FIO, Osinubi AA, Oremosu AA, Noronha CC. 2010. Influence of virgin coconut oil (VCNO) on oxidative stress, serum testosterone and gonadotropic hormones (FSH, LH) in chronic ethanol ingestion. Agric. Biol. J. North Am., 1: 1126-1132.

El Talees AE, Hussien NI, Allam MM, Mohammed DA. 2019. The potential effect of vitamin D on rats with fatty liver induced by a choline-deficient diet. Benha Med. J., 35(1): 67–73.

El-Desouki NI. 2004. Histological, immunohistochemical and ultrastructural studies on the thyroid gland of rat under alloxan induced β-cells destruction and the possible curative role of vitamin E. J. Med.Res. Inst., 25 (1): 12- 30.

El-Desouki NI, Salem ML, Afifi DF, Nasef M, Abdallah FM. 2018. The beneficial role of vitamin D and coconut oil in alleviating the glucose, insulin and histological alterations in the thyroid glands of hyperglycemic mice. Egypt. J. Zool., 70(70): 223-234.

El-Desouki NI, Salem ML, Afifi DF, Nasef M, Abdallah FM. 2019. Modulatory role of vitamin D and coconut oil on the disorders of the thyroid hormones and cytoskeletal intermediate filaments of diabetic mice. Res. J. Pharm. Biol. Chem. Sci., 10(2): 108- 1656.

Eugene R, Schiff M. 2010. Vitamin D deficiency and liver disease. Gastroenterol. Hepatol. (NY), 6(8): 491–493.

Famurewa AC, Ufebe OG, Egedigwe CA, Nwankwo OE, Obaje GS. 2017. Virgin coconut oil supplementation attenuates acute

chemotherapy hepatotoxicity induced by anticancer drug methotrexate via inhibition of oxidative stress in rats. Biomed. Pharmacother., 87: 437–442.

Girotti AW, Thomas IP. 1984. Damage effects of oxygen radicals on resealed erythrocyte ghosts. J. Biol. Chem., 259: 1744-1752.

Griz LH, Bandeira F, Gabbay MA, Dib SA, Carvalho EF. 2014. Vitamin D and diabetes mellitus: an update 2013. Arq. Bras. Endocrinol. Metab., 58(1): 1-8.

Haligur M, Topsakal S, Ozmen O. 2012. Early degenerative effects of Diabetes mellitus on pancreas, liver, and kidney in Rats. Exp. Diabetes Res., 2012: 120645. doi: 10.1155/2012/120645.

Iranloye B, Oludare G, Olubiyi M. 2013. Anti-diabetic and antioxidant effects of virgin coconut oil in alloxan induced diabetic male Sprague Dawley rats. J. Diabetes Mellitus, 3(4): 221-226.

Jain A, Patel R. 2016. A study of thyroid disorder in type 2 diabetes mellitus. Sch. J. App. Med. Sci., 4(12B): 4318-4320.

Junod A, Lambert AE, Stauffacher W, Renold AE. 1969. Diabetogenic action of streptozotocin: relationship of dose to metabolic response. J. Clin. Invest., 48(11): 2129-2139.

Kamsiah J, Aziz SN, Siew ST, Zahir IS. 2001. Changes in serum lipid profile and malondialdehyde following the consumption of fresh or heated red palm oil. Med. J. Isr. Acad. Sci., 14(2): 79–86.

Kanter M, Meral I, Yener Z, Ozbek H, Demir H. 2003. Partial regeneration/proliferation of the beta-cells in the islets of Langerhans by *Nigella sativa* L. in streptozotocin-induced diabetic rats. Tohoku J. Exp. Med.,201(4): 213-219.

Lenzen S. 2008. The mechanism of alloxan- and streptozocin-induced diabetes. Diabetologia, 51(2): 216-226.

Maestro B, Dávila N, Carranza MC, Calle C. 2003. Identification of a vitamin D response element in the human insulin receptor gene promoter. J. Steroid. Biochem. Mol. Biol., 84(2-3): 223-230.

Malini P, Kanchana A, Rajadurai M. 2011. Antidiabetic efficiency of ellagic acid in streptozotocin induced diabetes mellitus in albino Wistar rats. Asian J. Pharm. Clin. Res., 4(3): 24-29.

Mihara M, Uchiyama M. 1978. Determination of malonaldehyde precursor in tissues by thiobarbituris acid test. Anal. Biochem., 86(1): 271-278.

Nevin KG, Rajamohan T. 2006. Virgin coconut oil supplemented diet increases the antioxidant status in rats. Food Chem., 99(2): 260-266.

Ning C, Liu L, Lv L, Yang Y, Zhang U, Yu R, Wang Y, Zhu J. 2015. Lipid metabolism and inflammation modulated by Vitamin D in liver of diabetic rats. Lipids Health Dis., 14: 31. Doi: 10.1186/s12944-015-0030-5.

Refat NA. 2012. Efficacy of *N. sativa* oil and glimepiride on the histopathological changes of streptozotocin -induced diabetic rats. J. Am. Sci., 8(3): 22-33.

Rendell M. 1983. C-Peptide levels as a criterion in treatment of maturity onset diabetes. J. Clin. Endocrinol. Metab., 57(6): 1198-1206.

Robertson RP. 2006. Oxidative stress and impaired insulin secretion in type 2 diabetes. Curr. Opin. Pharmacol., 6(6): 615-619.

Saravanan G, Leelavinothan P. 2006. Effects of *Syzygium cumini* bark on blood glucose, plasma insulin and C-peptide in streptozotocin induced diabetic rats. Int. J. Endocrinol. Metab., 4: 96-105

Schaffer S, Müller WE, Eckert GP. 2005. Tocotrienols: constitutional effects in aging and disease. J. Nut., 135(2): 151–154.

Siddalingaswamy M, Rayaorth A, Khanum F. 2011. Anti-diabetic effects of cold and hot extracted virgin coconut oil. J. Diabetes Mellitus, 1(4): 118-123.

Souza CL, Cunha de Sá LBP, Rocha DRTW, Arbex AK. 2016. Vitamin D and diabetes mellitus: a review. Open J. Endocrinol. Metab. Dis., 6: 1-7.

St-Onge MP, Ross R, Parsons WD, Jones PJ. 2003. Medium chain triglycerides increase energy expenses and decreases adiposity in overweight men. Obes. Res., 11(3): 395-402.

Sun M, Zigmam S. 1978. An improved spectro-photomeric assay for superoxide dismutase based on epinephrine autooxidation. Anal. Biochem., 90(1): 81-89.

Szkudelski T. 2001. The mechanism of alloxan and streptozotocin action in β cells of the rat pancreas. Physiol. Res., 50(6): 536-546.

Takeuchi H, Sekine S, Kojima K, Aoyama T. 2008. The application of medium-chain fatty acids: edible oil with a suppressing effect on body fat accumulation. Asia Pac. J. Clin. Nutr., 17(Suppl 1): 320-324.

Talaei A, Mohamadi M, Adgi Z. 2013. The effect of vitamin D on insulin resistance in patients with type 2 diabetes. Diabetol. Metab. Syndr., 5(1): 8. doi: 10.1186/1758-5996-5-8.

Tuorkey MJ, El-Desouki NI, Kamel RA. 2015. Cytoprotective effect of silymarin against diabetes-induced apoptosis in cardiomyocytes in diabetic rats. Biomed. Environ. Sci., 28(1): 36-43.

Van Immerseel F, De Buck J, Boyen F, Bohez L, Pasmans F, Volf J, Sevcik M, Rychlik I, Haesebrouck F, Ducatelle R. 2004. Medium-chain fatty acids decrease colonization and invasion through hilA suppression shortly after infection of chickens with Salmonella enterica serovar enteritidis. Appl. Environ. Microbiol., 70(6): 3582-3587.

WHO. 2011. Diabetes Fact sheet No 312. Geneva: World Health Organization.

دور زيت جوز الهند وفيتامين "د" في الحد من تغيرات مستوي السكر والسي بيبتيد ونسيج الكبد للجرذان المصابة بداء السكري

نبيله ابراهيم الدسوقي، محمد ابو الفتوح بسيوني، غادة طبل، محمد سمير ابراهيم الأعمى

قسم علم الحيوان، كليه العلوم، جامعه طنطا، مصر

مرض السكري من اكثر الامراض المزمنة انتشارا في الوقت الحاضر، وتدل الاحصائيات على تزايد نسبة الإصابة بالنوع الثاني من مرض السكري في العالم العربي ومصر بصفه خاصة نتيجة فرط السمنة وتغير نمط الحياه وبسبب الإجهاد اليومي والأنشطة البدنية الأقل، وكذلك نتيجة لاضطرابات في عملية التمثيل الغذائي للكربوهيدرات والدهون والبروتينات الناتجة عن ضعف إفراز البنكرياس للإنسولين أو نتيجة العيوب والأمراض الوراثية في البنكرياس وعمل الأنسولين، ومرض السكري من الامراض التي تتطلب العلاج مدى الحياة، وفي اطار البحث عن العلاجات البديلة سواء من بعض الأدوية أو من مستخلصات بعض الاعشاب الطبيعية والتي تتميز بانعدام أو قلة الاعراض الجانبية وإنها في متناول الجميع فتأتى اهمية هذه الدراسة لمعرفه دورفيتامين " د" وزيت جوز الهند كمكمل غذائي لتقليل نسبة السكر. لذلك تهدف الدراسة الى دراسة الدور الايجابي لفيتامين "د" وزيت جوز الهند أو كلاهما معاضد اضطرابات مرض السكرى المستحث تجريبيا في الجرذان المهقاء البالغة باستخدام عقار الستريبتوزيتوسين، ومعرفه مدي تأثيرهما على قياس مستوي السكر والسي بيبتيد في الدم، وكذلك على تركيب نسيج الكبد المصاب بالسكري. أظهرت هذه الدراسة زيادة ملحوظة في سكر الدم في الجرذان التي حٌقنت بالأستريبتوسيتوزين، ونقص شديد في معدل السي بيبتيد، أما بعد تجريع الحيوانات بزيت جوز الهند أو فيتامين "د" أو كلاهما معاً فقد أظهرت النتائج تحسناً ملحوظاً حيث سجل نقصاً معنوياً في مستوى السكر بالدم وزيادة معنوية في كمية السي ببتيد، وكان التحسن ونقصان السكر ملحوظاً عند تجريع الجرذان بفيتامين د مع زيت جوز الهند ثم يليه فيتامين د وحده ثم زيت جوز الهند. أما الدراسة النسيجية للكبد باستخدام صبغ الهيماتوكسلين والإيوسين فقد أوضحت أن كبد الجرذان المصابة بالسكرى بها تغيرات عديدة في نسيج الكبد، وقد لوحظ فقدان الشكل الطبيعي للخلايا الكبدية وتكوين فجوات بالسيتوبلازم وانكماش لكثير من الأنوية وموت البعض الأخر واتساع في الوريد المركزي والبابي ومحاط بالتليف، ولوحظ أيضاً اتساع الجيوب الدموية للكبد وزيادة نشاط خلايا كوبفر، وكذا كارتشاح الخلايا الالتهابية بين الخلايا الكبدية. أما بعد تجريع الجرذان بزيت جوز الهند وفيتامين "د "معاً فقد تحسن نسيج الكبد بشكل ملحوظ وعاد تقريباً للطبيعي عن فيتامين "د" أو زيت جوز الهند كل على حده. ونستنتج من هذه الدراسة الدور الإيجابي لزيت جوز الهند وفيتامين "د" عند تجريعهما معاً للجرذان المصابة بالسكرى وانخفاض مستوى السكر وزيادة السي بيبتيد لمرضى السكري وكذلك قدرتهما معاً في حماية نسيج الكبد من الأثار الجانبية لزيادة السكر بالدم عن فيتامين "د" أو زيت جوز الهند كل على حده. لذلك نوصي مرضى السكرى باستخدام زيت جوز الهند مع فيتامين "د" لما لهما من تأثير إيجابي في تثبيط أعراض السكري وخفض مستوي السكر في الدم وتحسين نسيج الكبد وحمايته من الأعراض الجانبية للسكرى.