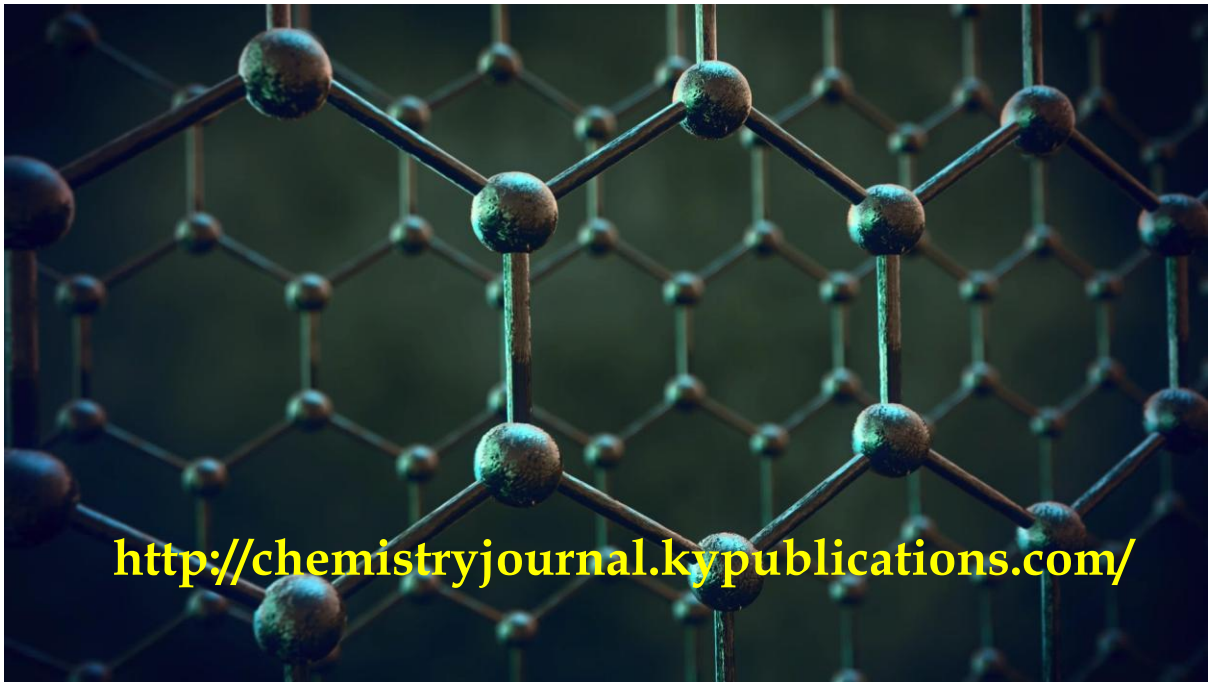

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SPIRULINA ROLE AS ANTIDIABETIC, ANTI-INFLAMMATORY AND ANTIOXIDANT AGENT IN ALLOXAN INDUCED DIABETIC MALE RABBITS

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ABSTRACT

This study was designed in order to estimate the beneficial effects of *Spirulina platensis* microalgae on alloxan induced diabetes mellitus indicated in some immunological (TNF-α) and biochemical parameters (Blood Glucose , Total Cholesterol , Triglycerides , Malondialdehyde and Glutathione) of male domestic rabbits. The study involved (21) blood samples were divided into 3 groups : group one : adult normal healthy male rabbits as control group , group two : adult male rabbits with alloxan induced diabetes mellitus , group three : adult male rabbits with alloxan induced diabetes mellitus treated with spirulina (2000 mg/kg) .The results of this study found significant increase in fasting blood glucose concentrations at levels (P≤ 0.05) of second group in comparison with control group ; while significant decrease in fasting blood glucose concentrations at levels (P≤ 0.05) of third group in comparison with diabetic group , and there is significant increase in proinflammatory cytokine TNF-α concentrations at levels (P≤ 0.05) of second group in comparison with control group , while significant decrease in TNF-α concentrations at levels (P≤ 0.05) of third group in comparison with diabetic group ; and there are significant increases in total cholesterol , triglycerides and malondialdehyde concentrations at levels (P≤ 0.05) of second group in comparison with control group, while significant decrease in total cholesterol , triglycerides and malondialdehyde concentrations at levels (P≤ 0.05) of third group in comparison with diabetic group , and there are significant decreases in glutathione concentrations at levels (P≤ 0.05) of second group in comparison with control group , while significant decrease in glutathione concentrations at levels (P≤ 0.05) of third group in comparison with diabetic group.

Keywords: Spirulina , Diabetes mellitus , Alloxan , TNF-α, Glutathione .

Introduction

Diabetes mellitus is an endocrinological disorder as group of heterogeneous metabolic disturbances resulting from deficiencies in insulin actions, insulin secretions or both which leads to chronic abnormal elevated blood sugar and glucose intolerance (1). Chronic hyperglycemia and other metabolic disturbances of diabetes mellitus lead to organs damage dna dysfunction involving the eyes, kidneys, nervous and oidracvascular systems (2).

Spirulina is a microscopic blue-green algae –cyanobacteria– from the Oscillateriaceae family naturally grows in alkaline and warm media; inthe sea and fresh water of Asia, Africa, Europe, South and North America(3); spirulina nac treat many medical conditions including diabetes mellitus because this algae has antidiabetic , anti-inflammatory ,anticancer , antibacterial , antiviral, antifungal and antioxidant properties, due to its content from active molecules such as phycocyanin, zinc, magnesium, manganese, selenium, , riboflavin, β-carotene, tocopherol, g-linolenic acid and phenolic compounds (4,5,).

Proinflammatory cytokine TNF-α is produced mainly from macrophages and from adipose tissue participated in autoimmune process of type 1 diabetes mellitus, and type 2 diabetes mellitus by which the damaged pancreatic beta cells is linked with glucotoxicity mediated through TNF-α and other proinflammatory cytokines such as IL-1β , IFN-γ(6) ; furthermore advanced glycated end products (AGEs) in diabetes mellitus stimulate the production of IL-1β by macrophages and monocytes (7) , which lead to intracellular generation of reactive oxygen species (ROS) which in turn activate NF-KB which increase the expression of a variety of proinflammatory cytokines including tumer necrosis factors (TNF-α and TNF-β) (8) ; additionally in diabetes mellitus there is hyper cholestermia condition which stimulate liver to produce proinflammatory cytokines including TNF-α (9) ; also reactive oxygen species (ROS) resulted from diabetic condition mediate proinflammatory cytokines expression including TNF-α by activating oxidant-sensitive transcription factors , such as activator protein- 1 (AP-1) , nuclear factor kappa light chain enhancer of activated B lymphocytes (NF-kB) , janus kinase signal transducers, and activators of transcription -Jak/Stat- (10).

Malondialdehyde (MDA) is a highly toxic by-product formed by lipidoxidation induced free radicals. MDA is the major metabolite of arachidonic acid reacting both irreversibly and reversibly with proteins and phospholipids (11). Malondialdehyde detaveleslevel in diabetes mellitus(12) ; indicating lipid peroxidation and oxidative stress due toincreasing of free radicals activity in diabetics this together with insulin resistancecan lead to activation of stress induced pathways, which play an important role inthe development of diabetes mellitus complications (13).Glutathione (γ-L-glutamyl-L-cysteinylglycine-GSH-) , is a water solubleendogenous tripeptide , from three amino acids glycine , cysteine , and glutamic acid (14). Glutathione (GSH) is potent antioxidant protecting the cell from the oxidative stress. Glutathione is a cofactor for Glutathione peroxidase (GPx) which is a defensemechanism against peroxides, preventing the accumulation of ROS and sopreventing cellular injury. (15).GSH is also a cofactor for the enzyme dehydroascorbate reductase, which recycles dehydro ascorbate back to reduced ascorbic acid (vitamin C) ; glutathione thereforekeeps vitamins C and E in their reduced forms by the reversible oxidation oftheir sulfhydryl group (16).

Glutathione(GSH) is reduced or depleted in diabetes mellitus condition this occur due to direct effectsof glucose and insulin on glutathione synthesis, and by consumption of a cofactorsuch as NAPDH required for GSH (reduced form) regeneration from GSSG(oxidized form) via the polyol pathway ; in addition to the effect of changes occurin GSH dependent enzyme activities, such as glutathione peroxidase, glutamyltrans peptidase, and glutathione S-transferase(17).

Material and Methods:

1.Animals :

The experiment is performed on 21 adult male domestic rabbit (*Oryctolaguscuniculus*) of weighing between (1400-1500) g and age ranges between (7 -8) months obtained from animals market dealer, the animals stayed for 2 weeks for adapted the place and to make sure they are free of disease before

began the experiment. The experiment period was from beginning of April (2017) to mid of July (2017) in Tikrit city.

2. Induction of Diabetes :

Diabetes was induced by single dose (150 mg/kg) of freshly prepared intraperitoneal injection of alloxan (British BDH company). It has dissolved by 1.5 g of alloxan in 10 ml of normal saline(18). After alloxan injection, the rabbits were allowed to drink 5% glucose solution for 24 hours to overcome the drug induced hypoglycemia. Each rabbit of the normal control group was injected with 1 ml of normal saline. The induction of diabetes was confirmed by collecting blood from the external ear vein for glucose analysis by using portable blood glucose monitor and its strips (Rossmax company) every day, for 10 days , and then rabbits with fasting blood glucose levels above 150 mg/dl were considered diabetic (19).

3. Experimental Design :

In the present experiment 21 adult male rabbit were used. The rabbits were divided randomly into three groups. ten male rabbit were included in each group, Equal weights of each group was taken into consideration as much as possible before the start of the study :

Group 1 : (control group) normal control male rabbit were given water and food for 30 days.

Group 2: (Diabetic group) : they have been injected alloxan150 mg/kg body weight intraperitoneal injection then given food and water for 30 days. .

Group 3: (Diabetic +Spirulina group) : they have been injected alloxan150 mg/kg body weight intraperitoneally then given 2000 mg/kg body weight spirulina orally concomitantly for 30 days .

4. Determination of Parameters :

The total cholesterol and triglycerides concentration was estimated in serum using kits from BIOLABO France(20).Serum malondialdehyde was measured according to modified method used by (Guidet and Shah,1989from my ph.d. ref.).Glutathione was estimated by the modified method used by (21), and TNF-α were determined by using its kit from (my bioscourse) company (USA) of ELISA technique.

Result and Discussion:

This study showed high significance increase in blood glucose concentration ($p \leq 0.05$) in diabetic group during the experiment period Figure (1) (194.00 ± 17.72 mg/dl) as compared with control group .

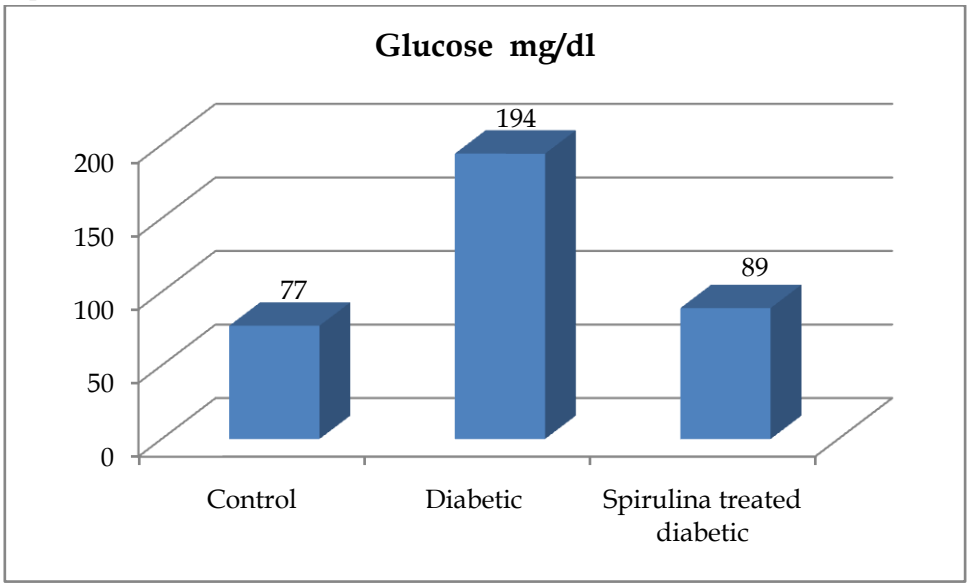

Figure (1): Concentrations of Blood Glucose (mg/dl) in the study groups.

These results coincide with the studies of Matsuura *et al.* (2017)(22); and Alamgeer*et al.* (2016) (23) ; they found significant increase of blood glucose in alloxan induced diabetic rabbits in comparison with control group.

The current study showed significance decrease in blood glucose concentration ($p \leq 0.05$) in spirulina treated diabetic group during the experiment period Figure (2) (89.00 ± 11.42 mg/dl) as compared with diabetic group , Such significant decrease in blood glucose is supported by other studies such as the study of Aissaoui *et al.* (2017) (24) , El-Desouki*et al.* (2015) (25) both revealed such significant decrease after oral administration of *Spirulina platensis* extract into alloxan induced diabetic rats.

The antidiabetic effect of *Spirulina platensis* is due to the presenceof potent antioxidant bioactive molecules (specially β-carotene and phycocyanin), which increase the insulin secretion from theislet beta cells or promotion of blood glucose transport to the peripheral tissues ;this antidiabetic effect also due to the action of peptides and polypeptides that can stimulate insulin secretion generated by the digestion of the spirulina proteins (26) ; also due to spirulina ability to decrease hexokinase activity in liver and increase glucose-6-phosphatase activity in muscles (27) ; thus spirulina improving insulin resistance and the uptake of glucose(28); additionally spirulinahigh fiber composition can reduceglucose absorption (29).This study showed significance increase in blood serum proinflammatory cytokine TNF- α concentrations ($p \leq 0.05$) in diabetic group during the experiment period Figure (3) (199.20 ± 57.81 pg/ml) as compared with control group.

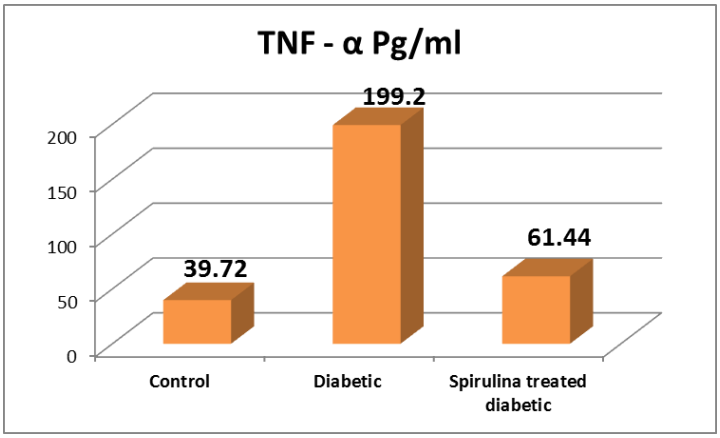

Figure (2): Concentrations of blood serum TNF- α (Pg/ml) in the study groups.

These results agree with the study of Ramadan *la te*(2017)(30);who revealed significant elvation of TNF- α in alloxan induced diabetic rats.

While this study found significant decrease in TNF-α concentrations ($p \leq 0.05$) of male rabbits in diabetic group treated with spirulina in comparison with diabetic group and this agree with the study of Hozayen *et al.* (2016) (29), who revealed such significant decrease after oral administration of spirulina into type 2 diabetic rats.

TNF-α is potent proinflammatory cytokine secreted by suoirav types of cells such as macrophages, monocytes, neutrophils and T setycohpmyl. TNF-α expression increased significantly in both types 1 and 2 of diabetus mellitus regarded as one factors of their Patho physiology (31)in type 2 diabetes TNF-α and other proinflammatory cytokines such as IL-1 beta, IL-6 and INF-gamma play an important role in insulin resistance and pathogenesis (32)ot eudseveral mechanisms including the down regulation of genes required for normal insulin action, it's negative regulation of PPARc which is an important insulin-sensitizing nuclear receptor, the direct effects on insulin signalling and the induction of elevated free fatty acids via the stimulation of lipolysis (33) , additionally TNF-α lowers the activity of 5'AMP-activated protein kinase (AMPK), *via* increased activity

of protein phosphatase 2C (PP2C), which is one of insulin resistance causes, and in type 1 diabetes TNF-a and INF-γ participate in the apoptosis process of beta cells by activating calcium channels of these cells, and this leads to the mitochondrial dysfunction and activation of caspases leading eventually to death of beta cells (34).

Spirulina contains several active ingredients, importantly phycocyanin and β-carotene that have potent antidiabetic, antioxidant and anti-inflammatory activities (25) and this explain the lowering effect of spirulina on TNF-α levels ; additionally spirulinaoral administration elevate serum adiponectin production and this adiponectin hormone in turninhibit the expression of the proinflammatory cytokine TNF-α (29)

This study showed high significance increase in total cholesterol concentrations ($p \leq 0.05$) in diabetic group during the experiment period Figure (4) (171.10 ± 53.46 mg/dl) as compared with control group.

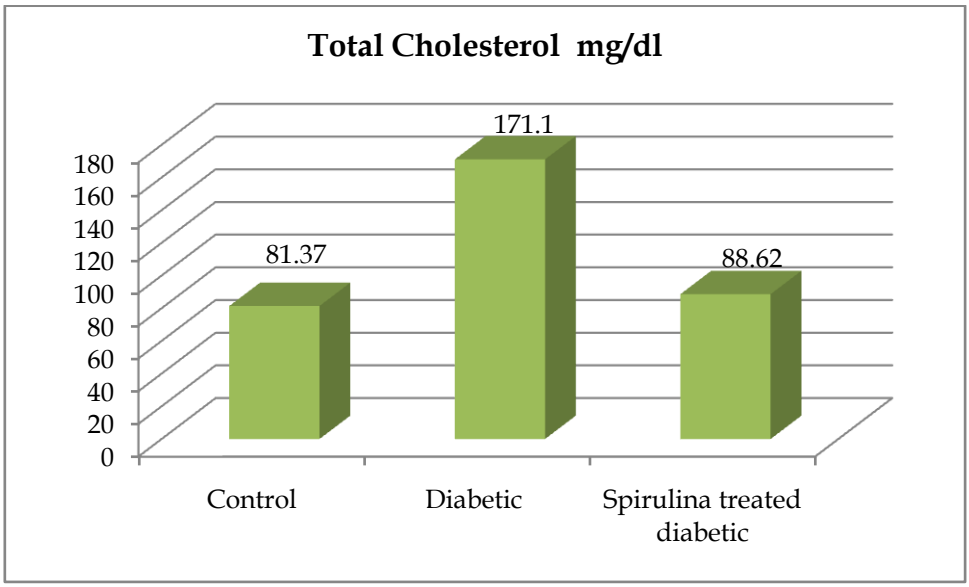

Figure (3): Concentrations of blood serum total cholesterol (mg/dl) in the study groups.

These results agree with with the study of Khulan*et al.* (2015) , who found significant increase of total cholesterol concentrations in alloxan induced diabetic rabbis in comparison with control group.(35)

This study found significant decrease in total cholesterol concentrations ($p \leq 0.05$) of male rabbits in diabetic group treated with spirulina in comparison with diabetic group and this agree with the study of Senthilkumar and John (2008) , who revealed such significant decrease after oral administration of *Spirulina platensis*.(36)

extract into alloxan induced diabetic rats ,The abnormal high concentration of serum lipids in diabetics is mainly due to increase in the mobilization of free fatty acids from the peripheral fat deposits, because insulin inhibits the hormone sensitive lipase production(37); hypocholesteremic effect of spirulina is due to the presence of γ-linoleic acid in spirulina, which prevents accumulation of cholesterol in the body ; in addition to the effect of phycocyanin which is water soluble protein as active ingredient in spirulina responsible for the hypolipidemic activity (38).

The current study showed significance increase in triglycerides concentrations ($p \leq 0.05$) in diabetic group during the experiment period Figure (4) (244.60 ± 49.32 mg/dl) as compared with control group.

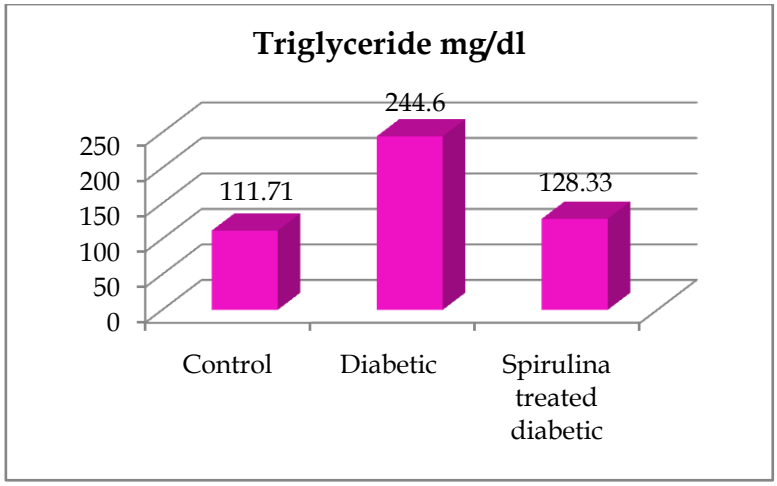

Figure (4): Concentrations of blood serum triglycerides in the study groups.

These results coincide with the study of Khulan *et al.* (2015), who noticed significant increase of blood serum triglycerides in alloxan induced diabetic rabbis in comparison with control group.(35) This study revealed significant decrease in triglycerides concentrations ($p \leq 0.05$) of male rabbits in diabetic group treated with spirulina in comparison with diabetic group and this agree with the study of El-Baz*et al.* (2013), who reported significant decrease in triglycerides concentrations after oral administration of *Spirulinaplatensis* to type 2 diabetic rats.(38)

Spirulina increase the utilization of glucose, thereby depressing the mobilization of fat; in addition spirulinais effective in normalizing the triglyceride levels through its effect on lipoprotein lipase which is a key enzyme in the metabolism of triglyceride lipoprotein , and via decreasing very low density lipoprotein (VLDL) production or increased VLDL clearance in the peripheral tissues (39).

This study showed high significance increase in blood serum malondialdehyde concentrations ($p \leq 0.05$) in diabetic group during the experiment period Figure (4) (4.17 ± 0.86 µmol / L) as compared with control group.

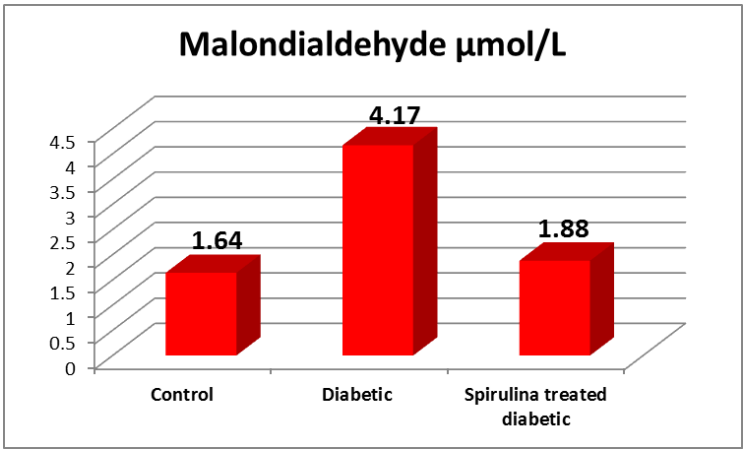

Figure (5): Concentrations of blood serum malondialdehyde in the study groups

These results agree with the study of Owolabi*et al.* (2011), who found significant increase of blood serum malondialdehyde in alloxan induced diabetic rabbis in comparison with control group.(40)This study found significant decrease in blood serum malondialdehyde concentrations ($p \leq 0.05$) of male rabbits in diabetic group treated with spirulina in comparison with diabetic group and this agree with the study of Lee*et al.* (2008)(41) , who revealed such significant decrease after oral administration of Spirulina into type 2 diabetes mellitus patients , and the study of (37) who showed such significant decrease after oral administration of spirulina intotype 2 diabetic rats.

Treatment with *Spirulinaplatensis* prevent lipid peroxidation and decrease free radicals production (24) , because spirulina protein content has high antioxidants activity by scavenging the free radicals peroxyl, hydroxyl, peroxynitrite and superoxide , and this inhibit lipid peroxidation (25).

The study showed significance decrease in blood serum glutathione concentrations ($p \leq 0.05$) in diabetic group during the experiment period Figure (4) (2.19 ± 0.88 µmol/L) as compared with control group.

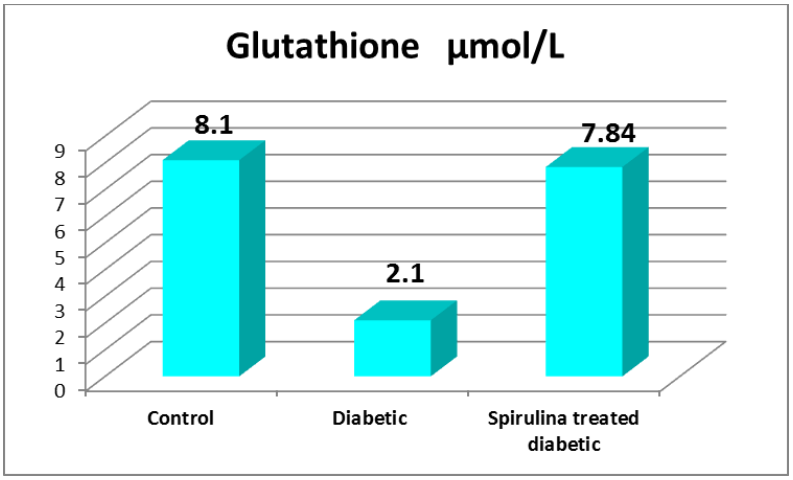

Figure (6): Concentrations of blood serum glutathione in the study groups

These results agree with the study of Ahmadvand and Khosrow beygi (2015) (42) , who found significant decrease of blood serum glutathione in alloxan induced diabetic rabbits in comparison with control group this occur due to oxidative stress resulted from diabetes mellitus which cause consumption of most glutathione used here as an antioxidant agent against diabetic harmful effects (17).

This study found significant decrease in blood serum glutathione concentrations ($p \leq 0.05$) of male rabbits in diabetic group treated with spirulina in comparison with diabetic group and this agree with the study of Senthil *et al*. (2013) (27) who revealed such significant decrease after oral administration of spirulina extract into in streptozotocin induced diabetic rats and the study of El-Baz *et al* (2013) (37) who showed such significant decrease after oral administration of spirulina into type 2 diabetic rats, Oral administration of *Spirulinaplatensis* cause decreasing of free radicals production leading to normalization of glutathione and this occurdue to spirulinahigh contents from protein, essential amino acids, essential fatty acids, minerals,vitamins, carotenoids and other antioxidant active components in addition to spirulina antidiabetic effects (26).

References:

[1]. Deepthi , B ; Sowjanya , K ; Lidiya , B ; Bhargavi , RS. and Babu , PS (2017). A Modern Review of Diabetes Mellitus: An Annihilatory Metabolic Disorder. Journal of In Silico & In Vitro Pharmacology ; Vol. 3, No.1:14 .

[2]. Harikumar , K. ; Kishore , K. B.; Hemalatha G.J. ; Bharath ,K. M. ; Lado , S.F.S. (2015). A Review on Diabetes Mellitus. International Journal Of Novel Trends In Pharmaceutical Sciences ; Vol. 5 , No. 3 : 201-217.

[3]. Gutiérrez-Salmean , G.; Fabila-Castillo , L. and Chamorro-Cevallos , G. (2015). Nutritional and toxicological aspects of *Spirulina (Arthrospira).Nutr* Hosp. 2015;32(1):34-40.

[4]. Nuhu , A.A. (2013). *Spirulina (Arthrospira)*: An Important Source of Nutritional and Medicinal Compounds . Journal of Marine Biology , Volume 2013, Article ID 325636.

[5]. PANKAJ , P. P. and VARMA , M. C. (2013). Potential Role Of Spirulina Platensis In Maintaining Blood Parameters In Alloxan Induced Diabetic Mice . Int J Pharm Pharm Sci, Vol 5, Suppl 4, 450-456.

[6]. Cieślak ,M.; Wojtczak , A. and Cieślak , M. (2015). Role of pro-inflammatorycytokines of pancreatic isletsandprospects ofelaboration of newmethods for the diabetestreatment.Biochimica Polonica , Vol. 62, No 1: 15-21.

[7]. Byun , K.; Yoo , Y.C.; Son , M.; Lee , J.; Jeong , G.-B.; Park , Y. M.; Salekdeh ,G. H. and Lee , B. (2017). Advanced glycation end-productsproduced systemically and bymacrophages: A common contributorto inflammationanddegenerative diseases.Pharmacology & Therapeutics 177 : 44–55.

[8]. Zhang ,J. ; Wang, X.; Vikash , V.; Ye, Q. ; Wu ,D.; Liu , Y. and Dong , W. (2016). ROS and ROS-Mediated Cellular Signaling . Oxidative Medicine and Cellular Longevity , Volume 2016, Article ID 4350965.

[9]. González-Pérez, B.; Salas-Flores, R.; Echegollen-Guzmán, A.; Pizarro-Chávez, S. and Guillén-Mata, G. A. (2011). Elevated liver enzymes,impaired fasting glucose and undiagnosed diabetes. Rev Med Inst Mex Seguro; 49 (3) : 247-252.

[10]. Padgett,L. E. ; Broniowska,K. A. ; Hansen, P. A.; Corbett,J. A. and Tse , H. M.(2013). The role of reactive oxygen species and proinflammatorycytokines in type 1 diabetes pathogenesis. Ann. N.Y. Acad. Sci. 1281 : 16–35.

[11]. Ayala,A. ; Muñoz, M. F.and Argüelles, S.(2014). Lipid Peroxidation: Production, Metabolism,and SignalingMechanisms of Malondialdehyde and 4-Hydroxy-2-Nonenal. Oxidative Medicine and Cellular Longevity ; Volume 2014, Article ID 360438.

[12]. Jalees1, S. S. and Rosaline ,M.(2017). Study of malondialdehyde and estimation of blood glucose levels in patients with diabetes mellitus with cataract. International Journal of Clinical Biochemistry and Research;4(3):319-323.

[13]. Rahimi-Madiseh , M.; Malekpour-Tehrani , A.; Bahmani, M. and Rafieian-Kopaei , M. (2016). The research and development on the antioxidants in prevention of diabetic complications. Asian Pacific Journal of Tropical Medicine; 9(9): 825–831.

[14]. Ren , X. (2017). Thioredoxin and Glutaredoxin Systems under Oxidative and Nitrosative Stress. Ph.D. Thesis.Karolinska Institutet , Department of Medical Biochemistry and Biophysics in Stockholm (Sweden).

[15]. Ribas , V. ; García-Ruiz1, C. and Fernández-Checa , J. C. (2014). Glutathione and mitochondria. FrontiersinPharmacology , ExperimentalPharmacologyandDrugDiscovery ; Volume5 , Article 151.

[16]. Jozefczak, M. ; Bohler, S. ; Schat, H. ; Horemans, N. ; Guisez, Y. ; Remans,T. ; Vangronsveld ,J. and CuypersA. (2015). Both the concentration and redox state of glutathione and ascorbate influencethe sensitivity of arabidopsis to cadmium. Annals of Botany ; 116: 601–612.

[17]. Rosales-Corral, S. ; Tan, D.-X. ; Manchester ,L. ; and Reiter , R. J. (2015). Diabetes and Alzheimer Disease, Two OverlappingPathologies with the Same Background: Oxidative Stress. Oxidative Medicine and Cellular Longevity ; Volume 2015, Article ID 985845.

[18]. Al-Nuaimy , S. B. H. (2013). Effect of CoQ10 and L-Carnitine in The Level Of Oxidative Stress and Number of Physiological and Biochemical Parameters in Normal and alloxan inducedDiabetic albino Rats. Master Thesis. College of Science , University of Tikrit , Department of Biology (Iraq).

[19]. Ikram , F. and Hussain , F. (2014). Antidiabetic Efficacy of Nigella sativa Linn. In Alloxan-induced Diabetic Rabbits. The International Medical Journal Malaysia ; Vol.13 , No.1 : 13-18.

[20]. Fossati , P. and Prencipe , L. (1982). Serum Triglyceride DeterminedColorimetrically with an Enzyme That Produce Hydrogen Per-Oxide. Clin.Chem ;28(16) : 2077-2080.

[21]. Tietz , N. W. (1999). Textbook of clinical chemistry. 3 rd ed. C.A.Burtis,E.R.Ashwood,W.B.Saunders. pp: 819-861 , 1245-1250.

[22]. Matsuura , Y. ; Yamashita , A. ; Zhao , Y. ; Iwakiri , T. ; Yamasaki , K. ; Sugita , C. ; Koshimoto, C. ; Kitamura,K.; Kawai, K. ; Tamaki, N. ; S. Zhao, Kuge , Y. ; Asada ,Y. (2017).Altered glucose metabolism and hypoxicresponse in alloxan-induced diabeticatherosclerosis in rabbits. PLoS ONE 12(4): e0175976.

[23]. Alamgeer, M. N., Raza,S. A. ; Mushtaq, M. N. ; Raza, S. A., Z. Khan, Z. ; Ahmad,T. ; Ahsan, H. ; Asif, H. ; Noor, N. ; Uttra A. M. and ArshadL. (2016). Evaluation Of Anti-Diabetic Effects Of Poly-Herbal ProductÌdiabetic Balî In Alloxan-Induced Diabetic Rabbits. Acta Poloniae Pharmaceutica - Drug Research, Vol. 73, No. 4 : 967-974.

[24]. Aissaoui , O. ; Amiali , M. ; Bouzid , N. ; Belkacemi , K. and Bitam , A. (2017). Effect of Spirulina platensis ingestion on the abnormal biochemical and oxidative stress parameters in the pancreas and liver of alloxan-induced diabetic rats. Journal of Pharmaceutical Biology ; Vol. 55, No.1: 1304–1312.

[25]. El-Desouki , N.I. ; Tabl , G.A. ; K.K. Abdel-Aziz , Salim , E.I. ; Nazeeh , N. (2015). Improvement in beta-islets of Langerhans in alloxan-induced diabetic rats by erythropoietin and spirulina. The Journal of Basic & Applied Zoology , 71: 20–31.

[26]. Anwer , R. ; Alam , A. ; Khursheed S. ; Kashif , S. M.; Kabir , H. and Fatma , T. (2012). Spirulina: possible pharmacological evaluation for insulin-like protein. J Appl Phycol ; DOI 10.1007/s10811-012-9924-z.

[27]. Senthil , N. ; Balu , P.M. and Murugesan ,K. (2013). AntiHyperglycemic effect of Spirulina, Insulin and Morinda citrifolia against Streptozotocin induced diabetic rats. Int.J.Curr.Microbiol.App.Sci.; 2(10): 537-559.

[28]. Andrica ,F. M. ; Albai , O. ; Vaduva , D. B. ; Popescu , R. ; Nica , D. ; Bucuras , P. ; Pah , A.M. ; Dragan , S. (2016). Evaluation of Hypoglycemic Effect of Spirulina in AlloxanInduced Diabetic Mice.Rev.Chim (Bucharest);67,No. 5 : 984-986.

[29]. Hozayen , W. G. ; Mahmoud , A. M. ; Soliman , H. A. and Mostafa , S. R. (2016). Spirulina versicolor improvesinsulin sensitivity and attenuateshyperglycemia-mediated oxidativestress in fructose-fed rats. Journal of Intercultural Ethnopharmacology ; J. Intercult Ethnopharmacol , Vol 5 , Issue 1 : 57-64.

[30]. Ramadan , B. K. ; Schaalan ,M. F. and Tolba , A. M. (2017).Hypoglycemic and pancreatic protective effects of Portulaca oleracea extract in alloxan induced diabetic rats.BMC Complementary and Alternative Medicine ; 17 (37).

[31]. Goya ,R. ; Faizy ,A. F. ; Siddiqui , S. S. and Singhai , M. (2012). Evaluation of TNF-α and IL-6 Levels in Obese andNon-obese Diabetics: Pre- and Postinsulin Effects. North American Journal of Medical Sciences ; Vol. 4 , Issue 4 : 180-184.

[32]. Qiao , Y.-C. ; Chen ,Y.-L. ; Pan , Y.-H. ; Tian , F. ; Xu ,Y. ; Zhang ,X. ; Zhao , H.-L. (2017).The change of serum tumor necrosis factoralpha in patients with type 1 diabetes mellitus:A systematic review and meta-analysis. PLoS ONE 12(4): e0176157.

[33]. Hossain ,M. , Faruque ,M. O. ; Kabir , G. ; N. Hassan , D. Sikdar , Q. Nahar , L. Ali (2010).International Journal of Diabetes Mellitus 2 : 165–168.

[34]. Cieślak , M. and Cieślak , M. (2017). Role of purinergic signalling and proinflammatory cytokines in diabetes.Clinical Diabetology ; Vol. 6, No. 3 : 90-100.

[35]. Khulan , T.S. ; Ambaga , M and Chimedragcha , C. H. (2015).Effect of Honey Bee Venom (Apis mellifera) on Hyperglycemia and Hyperlipidemia in Alloxan Induced Diabetic Rabbits. J. Diabetes Metab. ; Vol. 6, No. 3.

[36]. Senthilkumar , R. and John , S. A. (2008). Hypoglycaemic Activity Of Marine Cyanobacteria In Alloxan Induced Diabetic Rats. Pharmacologyonline 2: 704-714.

[37]. El-Baz, F. K. ; Aly , H. F. ; El-Sayed, A.B and MohamedA. A.(2013). Role Of Spirulina Platensis In The Control Of Glycemia In DM2 Rats. International Journal of Scientific & Engineering Research, Volume 4, Issue 12 : 1731-1740.

[38]. Metwally , N. S. ; Maghraby , A. S. ; Farrag, E. K. ; Abd El Baky, H. H. ; Farrag , A.- R. H. ; Foda, D. S. and Rawi, S. M. (2015).Efficiency Of The Algae Spirulina Platensis As Antidiabetic Agent. World Journal of Pharmaceutical Research; Vol. 4, Issue 11 : 18-54.

[39]. El-Sheekh , M. M. ; Hamad , S. M. and Gomaa , M. (2014). Protective Effects of Spirulina on the Liver Function and Hyperlipidemia of Rats and Human. Braz. Arch. Biol. Technol. Vol.57 , No.1: 77-86.

[40]. Owolabi , M.A. ; Jaja , S.I. ; Olatunji , O.J. ; Oyekanmi , O.O. and Adepoju , S. (2011). Attenuation of Oxidative Damage in Alloxan Induced Diabetic Rabbits Following Administration of the Extract of the Leaves of Vernonia amygdalina.Free Radicals and Antioxidants ; Vol. 1, Issue 3 : 94-101.

[41]. Lee , E. H. ; Park , J.-E. ; Choi , Y.-J. ; Huh , K.-B. and Kim,W.-Y. (2008). A randomized study to establish the effects of spirulina in type 2 diabetes mellitus patients. Nutrition Research and Practice , 2(4) : 295-300.

[42]. Ahmadvand , H. andKhosrowbeygi, A.(2015). Effect of Sodium Selenite on Lipid Peroxidation and Glutathione in Alloxan Induced Diabetic Rats. Zahedan J Res Med Sci.;17(3):e1105.

دور طحلب السبريولينا كعامل مضاد للسكر ومضاد للالتهاب ومضاد للأكسدة في ذكور الارانب المصابة بداء السكر المستحدث بالالوكسان

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الملخص

جرى تصميم هذا البحث لمعرفة التأثيرات الايجابية لطحلب السبريولينا على عدد من المتغيرات المناعية (الحركي الخلويTNF-α) والكيموحيوية (سكر الدم , الكوليستيرول الكلي , الكليسيريدات الثلاثية , المالونديالديهايد , الغلوتاثايون) في ذكور الارانب المحلية , وشملت الدراسة (21) عينة دم قسمت الى 3 مجاميع : المجموعة الاولى : ذكور ارانب بالغة سليمة كمجموعة سيطرة , المجموعة الثانية : ذكور ارانب بالغة مصابة بداء السكر المستحدث بالالوكسان, المجموعة الثالثة : ذكور ارانب بالغة مصابة بداء السكر المستحدث بالالوكسان ومعالجة بطحلب السبريولينا (2000 ملغم/كغم) , ولقد اظهرت نتائج الدراسة الحالية ارتفاع تركيز الحركي الخلويTNF-α معنويا عند مستوى ($P\leq0.05$) في المجموعة الثانية (مجموعة داء السكر) مقارنة مع مجموعة السيطرة , بينما كان انخفاض معنوي عند مستوى($P\leq0.05$) بتركيز الحركي الخلوي FNT-α في المجموعة الثالثة (المصابة بداء السكر والمعالجة بالسبريولينا) مقارنة مع مجموعة داء السكر , كما وجدت هذه الدراسة ارتفاعات معنوية عند مستوى($P\leq0.05$) لتراكيز مكوني مرتسم الدهون (الكوليستيرول الكلي و الكليسيريدات الثلاثية) وكذلك للمتغير الكيموحيوي المالونداليديهايد في المجموعة الثانية (مجموعة داء السكر) مقارنة مع مجموعة السيطرة , فيما كانت هناك انخفاضات معنويةعند مستوى($P\leq0.05$) لهذه المتغيرات الكيموحيوية (الكوليستيرول الكلي , الكليسيريدات الثلاثية , و المالونداليديهايد) في المجموعة الثالثة (المصابة بداء السكر والمعالجة بالسبريولينا) مقارنة مع مجموعة داء السكر, بينما لوحظ انخفاض معنوي عند مستوى($P\leq0.05$) لتركيز الغلوتاثايون في المجموعة الثانية (مجموعة داء السكر) مقارنة مع مجموعة السيطرة , ووجد ارتفاع معنوي عند مستوى($P\leq0.05$)لتركيز الغلوتاثايونفي المجموعة الثالثة (المصابة بداء السكر والمعالجة بالسبريولينا) مقارنة مع مجموعة داء السكر.