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# MICROSCOPICAL OBSERVATION OF TESTES FOR AMELIORATIVE EFFECTS OF VITAMIN - E & C IN STREPTOZOTOCIN INDUCED DIABETIC RATS

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## Abstract

Oxidative stress induces many serious reproductive tissue damages in male and female gonads and thus poses a serious threat to reproductive health. Lipid peroxidation is an important biological consequence of oxidative cellular damage in patients with DM. Serum lipo-peroxidation products such as malondialdehyde (MDA) reflects oxidative stress. The purpose of this study is to evaluate the effects of Vitamins E and C (VEC) on diabetic rat in prevention of Streptozotocin induced damages on testis. The experiments were performed on twenty four (n = 8) male Albino rats (approx 200-250 g) obtained from Animal house, National Medical College, Birgunj, Parsa, Nepal. The twenty four male albino rats were divided into three groups (n = 8) as Group-A: Control group with normal diet (Saline solution, i.p.); Group-B: Diabetic group with Streptozotocin; The rats developed diabetes after injection was evidenced by sustained hyperglycemia and glycosuria seven days after the induction; Group-C: (Diabetic + VEC) Albino rats were induced diabetes mellitus with Streptozotocin are evidenced by sustained hyperglycemia and glycosuria after seven days, and then it was treated with VEC supplementation for seven days. The experiment was conducted for a period of five weeks. After the experimental period the serum testosterone and tissue malondialdehyde (MDA), superoxide dismutase (SOD), glutathione (GSH) levels were measured, and testis tissue was examined histopathologically. Elevated malondialdehyde and reduced superoxide dismutase, glutathione, and serum testosterone levels were detected. Histopathological observation detected that marked changes in the testis tissue in all the groups. Our results provide additional evidence for the concept of increase in oxidative stress by diabetes mellitus causes free radical damage in testis tissue. An improvement in this damage can be achieved by vitamin E & C treatment.

**Keywords:** Diabetes mellitus, Vitamin E & C, Testosterone, Oxidative stress, Testes.

## Introduction

Oxidative stress induces many serious reproductive tissue damages in male and female gonads and thus poses a serious threat to reproductive health. Research over recent years has greatly improved the understanding of the important roles that reactive oxygen species (ROS) and oxidative stress play in mammalian reproduction. Diabetes mellitus (DM) is the most common metabolic disease. It is more likely that long-term, uncontrolled DM with sustained high blood glucose levels is the cause of glucose auto-oxidation with increased oxidative stress.[1] Over-production of reactive oxygen species

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(ROS) through the electron transport chain has been demonstrated in DM. Lipid peroxidation is an important biological consequence of oxidative cellular damage in patients with DM. Serum lipo-peroxidation products such as malondialdehyde (MDA) reflect oxidative stress. The increase in ROS causes nonspecific modification of nucleic acids, proteins, and phospholipids leading to DNA, RNA, and protein damage and alterations in antioxidant enzyme levels. All these events result in cellular and tissue damage.

Tissue damage induced by free radicals is thought to be an important factor in the pathogenesis of DM and its complications.[2] Experimentally, streptozotocin (STZ) induces DM, probably through the generation of ROS, leading to islet cell destruction.[3] In accordance with theories on the aging process put forward in recent years, it is well accepted that the balance between antioxidants and prooxidants is one of the important factors in aging. It was also well documented that, as a result of impairment in the mitochondrial respiratory chain, an organism comes under enhanced oxidative stress with age.[4–6] The balance between oxidant and antioxidant species has been proposed to have an important role in retarding the aging process and preventing diabetic complications. Dietary antioxidants play a major role in the maintenance of the oxidative balance. Vitamin E, Vitamin C, and other micronutrients protect humans from several diseases, including aging and DM.[7]

## Materials and Methods

### Chemical Agents

Streptozotocin was purchased from Sigma-Aldrich Chemical Company. It was freshly dissolved in ice-cold 0.05 M citrate buffer (pH 4) and given i.p. in a dose of 60mg/kg body weight for 3 consecutive days for induction of diabetes.[8, 9] The Vitamins-E and C–supplemented diabetic rats that were given the vitamins daily by intraperitoneal injection, 100 mg/kg vitamin E and 200 mg/kg vitamin C.[10]

### Animals

The experiments were performed on twenty four (n = 8) male Albino rats (approx 200-250 g) obtained from Animal house, National Medical College, Birgunj, Parsa, Nepal. All aspects of animal care complied with the ethical guidelines and technical requirements approved by the Institutional Animal Ethics Committee. Animals were housed individually in cages in an environmentally controlled animal facility (room temperature, 12 h light: 12 h dark cycle) with free access to a standard commercial diet and water ad libitum. The experiment was conducted for a period of five weeks. All animals were fed on normal diet for seven days of acclimatization. Diabetes was induced by an intraperitoneal (IP) injection of freshly prepared dissolved mixture of Streptozotocin with ice-cold 0.05 M citrate buffer (pH 4) and given in a dose of 60mg/kg body weight for three consecutive days.

Blood glucose levels were measured daily three days prior and seven days after Streptozotocin administration. Development of diabetes mellitus was proven by sustained hyperglycemia and glycosuria. Diabetic rats that had a fasting glucose greater than 200 mg/dL would be included in the study.[11] No deaths occurred during the study in any of the groups.

### Experimental Design

The twenty four male albino rats were divided into three groups (n = 8) as follows:

Group-A: Control group with normal diet (Saline solution, i.p.);

Group-B: Diabetic group with Streptozotocin; The rats developed diabetes after injection was evidenced by sustained hyperglycemia and glycosuria seven days after the induction;

Group-C: (Diabetic + VEC) Albino rats were induced diabetes mellitus with Streptozotocin are evidenced by sustained hyperglycemia and glycosuria after seven days, and then it was treated with VEC supplementation for seven days.

Animals were starved for 16 h before blood collection. Fasting blood glucose was estimated by glucose oxidase method according manufacturer's procedure (Randox laboratories Ltd. Ardmore, United Kingdom). Urine was collected in cage urine separator bottle containing 1 mL of 10% thymol and glucose determined using Combosik (DFI Co. Ltd., Gimhae, Gyuang-Nam, Korea). Diabetic rats that had a fasting glucose greater than 200 mg/dL would be included in the study.[11]

### Serum and Tissue Preparation

Sacrificing procedure; the rats were made unconscious with carbon (IV) chloride before sacrificed by euthanasia. The Testes of the rats

were removed, dissected free of surrounding connective tissue, and rinsed several times in ice-cold 0.9% NaCl then immediately frozen in liquid nitrogen and stored at -20°C until processed for malondialdehyde (MDA), reduced glutathione (GSH), and superoxide dismutase (SOD) assays. The dissected testis tissues were fixed with the 10% neutral buffered formalin for microscopical study.

The blood collected via cardiac puncture was allowed to clot, and the serum was obtained by centrifugation at 1500/g for 15 minutes. Aliquots of serum samples were stored at -20°C until analyzed.

**Methods of Analysis**

The tissues MDA levels were determined using the procedure of Ohkawa et al.[12] GSH levels were measured using the method of Moron et al.[13] and SOD activity in tissues was determined using the method of Sun et al.[14] Microscopical analysis was done according to Bancroft and Stevens.[15] The serum testosterone levels in male rats were determined by IMMULITE total testosterone commercial kit (solid-phase, competitive chemi-luminescent enzyme immunoassay) with an Immulite One immunoassay analyzer (DPC Cirrus Inc., Flanders, NJ).

**Statistical Analysis**

Statistical analysis of the values in the testis MDA, SOD, GSH, and serum testosterone levels of the groups were compared with each other by Mann-Whitney U-test with a Bonferroni correction for multiple comparisons. If necessary, the results were expressed as median (minimum –maximum) and mean ± standard deviation. The correlation among total testosterone and MDA, SOD, GSH levels were evaluated by Spearsman's rank test.

## Result

**Biochemical Analysis**

The serum total testosterone level of all the Groups rats are analysed, compared and presented in Table 1. Among the groups, there was statistically less significant difference in the total serum testosterone levels (Mann-Whitney U-test; P = 0.002)

**Table No. 01: Comparison of Serum total testosterone level**

| | Group - A | Group - B | Group - C |
|---|---|---|---|
| Testosterone (ng/dL) | 273 ± 67 | 71 ± 22[a] | 204 ± 12 |

**[a]Group - B compared with Group-A (Mann-Whitney U-test; P = 0.002)**

The serum malondialdehyde (MDA), reduced glutathione (GSH), and superoxide dismutase (SOD) are analysed, compared and presented in Table 2. Among the groups, there was statistically less significant difference in the serum malondialdehyde (MDA) levels (Mann-Whitney U-test; P = 0.002). But, there was a significant statistical difference in the serum reduced glutathione (GSH) levels (Mann-Whitney U-test; P = 0.001). The serum superoxide dismutase (SOD) levels are shows statistically not significant difference (Mann-Whitney U-test; P = 0.001) among the Group-B and Group-A.

**Table No. 02: Comparison of Serum MDA, SOD and GSH levels**

| | Group - A | Group - B | Group - C |
|---|---|---|---|
| MDA (nmol/mg) | 92 (58 - 106) | 179 (133 - 267)[a] | 97 (65 - 118) |
| SOD (U/g) | 46.9 (37 - 76) | 25.3 ± 3.2 (17 - 37)[b] | 37.5 (15 - 67) |
| GSH (nmol/g) | 132 (120 - 153) | 111 (103 - 119)[c] | 132 (102 - 141) |

**[a]Group- B compared with Group-A (Mann-Whitney U-test; P = 0.002)**
**[b]Group- B compared with Group-A (Mann-Whitney U-test; P = 0.001)**
**[c]Group- B compared with Group-A (Mann-Whitney U-test; P = 0.005)**

**Microscopical Observation**

Microscopical features of testis from control group (Group-A) (Figure: 1) shows normal seminiferous tubule lined with Stratified epithelium, composed of two major cells (Supporting (sertoli) cells & Spermatogenic series of cells). The spermatozoa are arranged in rows between and around the cells of sertoli.

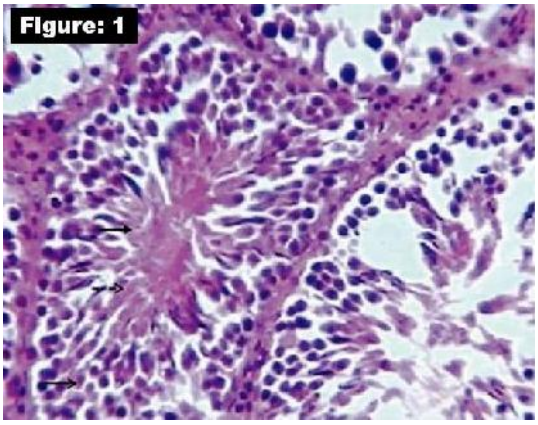


**Fig. No. 01: Microscopical features of testis from control group (Group-A)**

Microscopical features of testis from diabetic group (Group-B) (Figure: 2) shows degeneration of the Spermatogenic cells, occlusion of the lumen and hypertrophied seminiferous tubules.

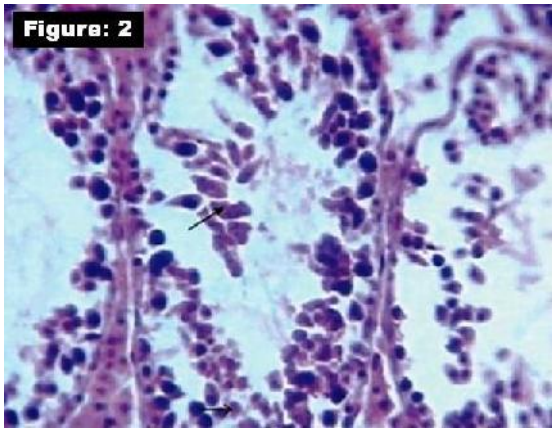


**Fig. No. 02: Microscopical features of testis from diabetic group (Group-B)**

Microscopical features of testis from diabetic + VEC group (Group-C) (Figure: 3) shows increase in the number of Spermatogenic series cells also showing matured spermatozoa in the seminiferous tubules.

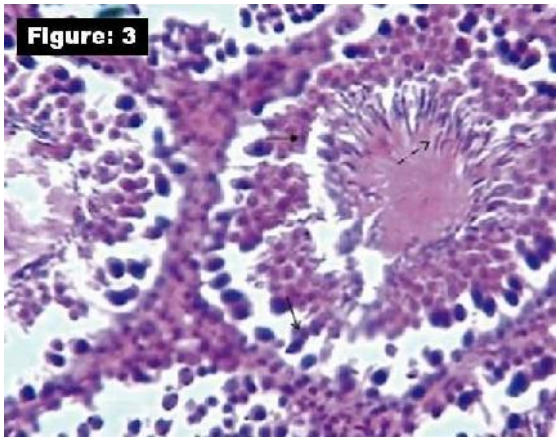


**Fig. No. 03: Microscopical features of testis from diabetic + VEC group (Group-C)**

## Discussion

Our study demonstrated that DM caused oxidative imbalance resulting in an impairment of the steroidogenic function of the testis. The results also suggest that Vitamin E & C prevents the free radical damage in DM resulting in an improvement

in the steroidogenic function of the testis. The function and life cycle of the cells can be impaired by ROS. Living organisms possess antioxidant defense systems against ROS. These defence systems include endogenous antioxidants, which can be classified as enzymatic (SOD, GSH) and non-enzymatic (vitamin E, uric acid, bilirubin) defense systems. In the reproductive system, there is a balance among ROS production and antioxidant defense systems. This balance minimizes the ROS levels, which is required to maintain the regulation of normal sperm function.[16] Increased ROS production or a decreased antioxidant defense system is associated with lipid peroxidation in the sperm plasma membrane.[17] Studies have detected increased semen ROS levels in 25% to 40% of infertile men.[18, 19, 20]

In our study, the antioxidant enzymes MDA and SOD levels are not statistically significant in between Diabetic (Group-B) and Control group (Group-A). The results of this study reveal microscopical changes in the testis tissues in all of the groups. However, in diabetic groups the elevated testis MDA levels correlates with reduced serum testosterone levels; after antioxidant administration, the serum testosterone levels increased to control levels. These observations can be attributed to a relationship between steroidogenesis and ROS in testis of diabetic rat. Several previous studies support our results.[21, 22]

## Conclusion

Our results provide additional evidence for the concept of increase in oxidative stress by diabetes mellitus causes free radical damage in testis tissue. An improvement in this damage can be achieved by vitamin E & C treatment. However, the increased oxidative stress in DM possibly inhibits steroidogenesis with marked changes in the microscopical features.

## References

1. Sozmen EY, Sozmen B, Delen Y, Onat T. Catalase/superoxide dismutase (SOD) and catalase / paraoxonase (PON) ratios may implicate poor glycemic control. Arch Med Res 2001;4:283 – 7.
2. Annunziata L, Domenico F, Pietro T. Glyco-oxidation in diabetes and related diseases. Clin Chim Acta 2005;2:236–50.
3. Tavridou A, Unwin NC, Laker MF, White M, Alberti GK. Serum concentrations of vitamin A and E in impaired glucose tolerance. Clin ChimActa 1997;266:129–40.
4. Harman D. Free radical theory of ageing: effect of free radical reaction inhibitors on the mortality rate of male LAF mice. J Gerontol 1968;23:476–82.
5. Harman D. Free radical involvement in aging: pathophysiology and therapeutic implications. Drugs Aging 1993;3:60–80.
6. Ashok BT, Ali R. The aging paradox: free radical theory of aging. Exp Gerontol 1999;3:293–303.
7. Schwedhelm E, Maas R, Troost R, Boger RH. Clinical pharmacokinetics of antioxidants and their impact on systemic oxidative stress. Clin Pharmaco kinet 2003;42:437–59.
8. Abdel-Wahab MH and Abd-Allah AR. Possible protective effect of melatonin and/or desferrioxamine against streptozotocin-induced hyperglycaemia in mice. Pharmacol. Res, 41(5), 2000, 533-537.
9. Yavuz O, Cam M, Bukan N, Guven A and Silan F. Protective effect of melatonin on beta-cell damage in streptozotocin-induced diabetes in rats. Acta Histochem, 105, 2003, 261-266.
10. Nurten Aksoy,T, Huseyin Vural, Tevfik Sabuncu,Oktay Arslan, Sahin Aksoy. Beneficial effects of vitamins C and E against oxidative stress in diabetic rats. Nutrition Research, 25, 2005, 625–630.
11. Stanley, MP. Venogopal, M.P. Antioxidant action of Tinospora-Cordiofolia root extract in alloxan-induced diabeic rats. Phytother. Res , 15, 2001, 213-218.
12. Ohkawa H, Ohishi N, Yagi K. Assay for lipid peroxides in animal tissue by thiobarbituric acid reaction. Anal Biochem 1979;95:351–8.
13. Moron MS, Depierre JW, Mannervik B. Levels of glutathione, glutathione reductase and glutathione S-transferase activities in rat lung and liver. Biochim Biophys Acta 1979;582:67–78.
14. Sun Y, Oberley LW, Li Y. A simple method for clinical assay of superoxide dismutase. Clin Chem 1988;34:497–500.
15. John D. Bancroft, Alan. Stevens. Histochemical techniques: Theory and practice of histological techniques. Churchill Livingstone (Edinburgh and New York), 1982.

16. Aitken RJ. The Amoroso Lecture. The human spermatozoon—a cell in crisis? J Reprod Fertil 1999;115:1–7.
17. Smith R, Vantman D, Ponce J, Escobar J, Lissi E. Total antioxidant capacity of human seminal plasma. Hum Reprod 1996; 11:1655–60.
18. Koksal IT, Usta M, Orhan I, Abbasoglu S, Kadioglu A. Potential role of reactive oxygen species on testicular pathology associated with infertil-ity. Asian J Androl 2003;5:95–9.
19. De Lamirande E, Gagnon C. Impact of reactive oxygen species on spermatozoa: a balancing act between beneficial and detrimental effects. Hum Reprod 1995;10(Suppl 1):15–21.
20. Padron OF, Brackett NL, Sharma RK, Lynne CM, Thomas AJ Jr, Agarwal A. Seminal reactive oxygen species and sperm motility and morphology in men with spinal cord injury. Fertil Steril 1997;67: 1115–20.
21. Luo L, Chen H, Trush MA, Show MD, Anway MD, Zirkin BR. Aging and the brown Norway rat Leydig cell antioxidant defense system. J An-drol 2006;27:240–7.
22. Ballester J, Carmen Muno˜z M, Domı´nguez J, Rıgau T, Guınovart JJ, Rodrı´guez-Gıl JE. Insulin-dependent diabetes affects testicular function by fsh- and lh-linked mechanisms. J Androl 2004;25:706–19.