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Evaluation of reproductive toxicity in Alloxan-induced diabetic albino mice and protective influence of *Coriandrum sativum* leaves

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Abstract
Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both. The prevalence of diabetes has increased considerably worldwide and it has become a major public health concern. Long-term hyperglycemia is associated with various complications affecting different organ systems, including the reproductive system. Several experimental and clinical studies have reported that diabetes adversely affects male reproductive function by impairing spermatogenesis, reducing sperm quality, and altering hormonal balance. Hyperglycemia-induced oxidative stress plays a significant role in damaging reproductive tissues and reducing fertility potential. The present study was undertaken to evaluate the adverse effects of alloxan-induced hyperglycemia on reproductive parameters of albino mice and to investigate the protective role of *Coriandrum sativum* leaf extract. Adult male albino mice weighing 25–30 g were selected and divided into three groups: control, diabetic, and treatment groups. Diabetes was induced by intraperitoneal injection of alloxan monohydrate. After confirmation of hyperglycemia, coriander leaf extract was administered orally to the treatment group for a specified period. The experimental animals were maintained under standard laboratory conditions and monitored regularly. Reproductive parameters such as body weight, testicular weight, sperm count, and sperm motility were assessed at the end of the experimental period. The diabetic group showed significant reduction in body weight and reproductive organ weight compared to control animals. Sperm count and motility were markedly decreased in alloxan-induced diabetic mice, indicating impairment of spermatogenesis. These findings suggest that hyperglycemia has a detrimental effect on male reproductive function. Treatment with *Coriandrum sativum* leaf extract resulted in noticeable improvement in reproductive indices. The treated animals exhibited increase in body weight, testicular weight, sperm count, and sperm motility compared to diabetic group. The improvement observed in treatment group may be attributed to antioxidant and hypoglycemic properties of coriander leaves. Bioactive compounds present in coriander may help reduce oxidative stress and restore reproductive function. The study concludes that *Coriandrum sativum* leaves exhibit protective effects against reproductive toxicity caused by hyperglycemia. The findings suggest that coriander leaf extract may serve as a potential natural therapeutic agent for reducing reproductive complications associated with diabetes. Further studies are required to evaluate biochemical and hormonal parameters to understand the exact mechanism involved in the protective action of coriander leaves.

Keywords: Alloxan, diabetes, albino mice, reproductive toxicity, *Coriandrum sativum*

Introduction

Diabetes mellitus is one of the most prevalent metabolic disorders affecting both developed and developing countries. It is characterized by chronic elevation of blood glucose levels due to insufficient insulin secretion or insulin resistance. Long-term hyperglycemia leads to several complications affecting various organs including kidney, liver, heart, and reproductive organs. Recent studies have suggested that diabetes has a profound effect on male reproductive function by altering hormonal balance, impairing spermatogenesis, and inducing oxidative stress. Experimental induction of diabetes in laboratory animals is commonly performed using chemicals such as alloxan and streptozotocin. Alloxan selectively destroys pancreatic beta cells, resulting in insulin deficiency and hyperglycemia. Alloxan-induced diabetic models have been widely used to study metabolic and reproductive alterations. Reproductive toxicity associated with diabetes is mainly attributed to oxidative stress. Increased generation of reactive oxygen species damages spermatozoa and testicular tissue. This results in reduced sperm count, decreased motility, and abnormal morphology. Therefore, antioxidant therapy has been suggested as an effective strategy to prevent diabetic complications. Medicinal plants have been widely used in traditional medicine for the management of diabetes and its complications. *Coriandrum sativum* (coriander) is an aromatic herb commonly used as a spice and medicinal plant. It contains various bioactive compounds including flavonoids, phenolics, and essential oils. These compounds possess antioxidant, anti-inflammatory, and hypoglycemic properties. Several studies have reported the antidiabetic activity of coriander seeds and leaves. However, limited information is available regarding its protective effect on reproductive parameters in diabetic conditions. Therefore, the present study aims to evaluate the reproductive toxicity induced by alloxan in albino mice and to assess the protective role of *Coriandrum sativum* leaf extract. Diabetes-induced reproductive dysfunction has attracted considerable scientific attention in recent years. Chronic hyperglycemia has been reported to alter endocrine function by reducing testosterone secretion and disturbing hypothalamic–pituitary–gonadal axis regulation. These hormonal disturbances ultimately impair spermatogenesis and reduce fertility potential. Several experimental studies have demonstrated that diabetic animals exhibit degeneration of seminiferous tubules, decreased sperm concentration, and reduced sperm motility. The underlying mechanism involves oxidative stress, mitochondrial

dysfunction, and increased lipid peroxidation in reproductive tissues. Oxidative stress plays a central role in diabetes-associated reproductive damage. Reactive oxygen species generated during hyperglycemia can damage cellular proteins, lipids, and DNA. Testicular tissue is particularly sensitive to oxidative stress because of high levels of polyunsaturated fatty acids in sperm membranes. Increased lipid peroxidation leads to decreased membrane fluidity, thereby affecting sperm motility and viability. Furthermore, oxidative stress may also impair Leydig cell function, leading to reduced testosterone production. Plant-based antioxidants have gained importance in recent years as potential therapeutic agents for managing diabetic complications. Medicinal plants contain natural antioxidants such as flavonoids, phenolic compounds, tannins, and alkaloids, which help in scavenging free radicals. These bioactive compounds may improve reproductive function by reducing oxidative damage and restoring hormonal balance. Therefore, exploration of plant extracts for reproductive protection in diabetic conditions is an important area of research. *Coriandrum sativum*, commonly known as coriander, is widely used in traditional medicine for its therapeutic properties. The leaves of coriander contain vitamins, minerals, and antioxidant compounds such as quercetin and caffeic acid. These constituents have been reported to exhibit hypoglycemic and antioxidant effects. In addition, coriander has been shown to improve lipid metabolism and reduce oxidative stress. These properties suggest that coriander leaves may play a protective role against diabetes-induced reproductive toxicity. Despite the widespread use of coriander in traditional medicine, limited studies have evaluated its effect on reproductive parameters in diabetic conditions. Therefore, the present investigation was designed to study the adverse effects of alloxan-induced hyperglycemia on reproductive potential of albino mice and to assess the possible protective influence of *Coriandrum sativum* leaf extract. The findings of this study may contribute to understanding the role of plant-based antioxidants in preventing reproductive complications associated with diabetes.

Review of Literature

Several studies have reported that experimental diabetes induced by alloxan causes significant physiological and reproductive alterations in laboratory animals. Alloxan is widely used to induce diabetes because it selectively destroys pancreatic beta cells, leading to insulin deficiency and persistent hyperglycemia. This hyperglycemic condition mimics human diabetes and is commonly used to evaluate potential therapeutic agents. Hyperglycemia is known to produce oxidative stress which adversely affects reproductive organs. Increased reactive oxygen species damage testicular tissue, reduce sperm count, and impair sperm motility. Diabetes-induced oxidative stress also alters hormonal balance and interferes with spermatogenesis. These changes ultimately result in reduced fertility in male animals. Several medicinal plants have been investigated for their protective role against diabetic complications. *Coriandrum sativum* has attracted considerable attention due to its hypoglycemic and antioxidant properties. Studies have shown that coriander extracts can reduce blood glucose levels and improve metabolic parameters in diabetic animals. Research findings also indicate that coriander exhibits antidiabetic activity by improving pancreatic beta-cell function and inhibiting carbohydrate-digesting enzymes. Such actions contribute to better glycemic control and reduction of oxidative stress in diabetic models. Experimental studies on alloxan-induced diabetic rats demonstrated that ethanolic leaf extract of *Coriandrum sativum* significantly reduced blood glucose levels and improved biochemical parameters. The treated animals showed restoration of tissue architecture, suggesting protective effects of coriander leaves. Other investigations reported that coriander seed extract lowered fasting blood glucose and glycated hemoglobin levels in diabetic animals. The antihyperglycemic activity of coriander may be attributed to stimulation of insulin secretion and enhanced peripheral glucose utilization. It has also been observed that coriander extracts reduce oxidative stress and improve lipid metabolism in diabetic models. These antioxidant properties may help protect reproductive tissues from damage caused by hyperglycemia. Although several studies have demonstrated the antidiabetic and antioxidant properties of *Coriandrum sativum*, limited work has been done on its effect on reproductive parameters under diabetic conditions. Therefore, the present study was designed to evaluate reproductive toxicity in alloxan-induced diabetic albino mice and to assess the protective influence of coriander leaf extract.

Materials and Methods

Experimental Animals

Adult male albino mice weighing between 25–30 g was used for the present study. Animals were procured from a certified laboratory animal supplier and acclimatized for one week prior to experimentation. The animals were maintained under standard laboratory conditions with a temperature of 25±2°C and 12-hour light-dark cycle. Standard pellet diet and water were provided ad libitum. The animals were housed in clean polypropylene cages containing sterile paddy husk as bedding material, which was changed regularly to maintain hygienic conditions. All experimental procedures were conducted in accordance with standard laboratory animal care guidelines. The animals were monitored daily for general health conditions, food intake, and behavioral changes throughout the experimental period. Care was taken to minimize stress and avoid any external disturbances during the study.

Experimental Design

The animals were randomly divided into three groups, each containing six animals:

Group I: Control group (normal animals)
Group II: Diabetic group (alloxan-induced)
Group III: Diabetic + coriander treatment group

The control group received normal saline and standard diet throughout the experimental period. The diabetic group received alloxan injection to induce hyperglycemia without any treatment. The treatment group received coriander leaf extract after confirmation of diabetes. The duration of the experiment was maintained for 21 days. Body weight of animals was recorded at regular intervals to monitor physiological changes. Animals were carefully observed for signs of weakness, reduced mobility, and other symptoms associated with diabetes.

Induction of Diabetes

Diabetes was induced by intraperitoneal injection of alloxan monohydrate at a dose of 150 mg/kg body weight. The animals were kept fasting overnight prior to injection. After administration of alloxan, animals were provided with 5% glucose solution for 24 hours to prevent initial hypoglycemic shock. After 72 hours, blood glucose levels were measured using a glucometer. Animals showing blood glucose levels above 200 mg/dl were considered diabetic and included in the study. The blood samples were collected from tail vein using sterile lancet. The diabetic status of animals was reconfirmed periodically during the experimental period.

Preparation of Coriander Leaf Extract

Fresh leaves of *Coriandrum sativum* were collected, washed thoroughly, and shade dried. The dried leaves were powdered and extracted using distilled water. The powdered material was soaked in distilled water for 24 hours and then filtered using muslin cloth followed by Whatman filter paper. The extract was concentrated and stored in refrigerated condition until further use. The extract was filtered and administered orally to treatment group animals at a dose of 200 mg/kg body weight for 21 days. The dosage was adjusted according to body weight of animals. Fresh extract was prepared at regular intervals to ensure potency.

Assessment of Reproductive Parameters

At the end of the experimental period, animals were sacrificed under anesthesia. The following parameters were analyzed:

Body weight measurement
Testicular weight
Epididymal sperm count
Sperm motility
Histological examination of testicular tissue

Body weight of animals was recorded using digital balance. Testes were carefully dissected, cleaned of surrounding tissue, and weighed. Epididymis was separated and minced in physiological saline to release sperms. Sperm count was determined using hemocytometer under light microscope. Sperm motility was assessed by observing motile and non-motile sperms. For histological examination, testicular tissues were fixed in Bouin's solution, processed, and stained using hematoxylin and eosin stain. Microscopic observations were recorded for structural changes.

Statistical Analysis

The data obtained were expressed as mean ± standard deviation. Statistical significance was determined using standard statistical methods. The results were compared between control, diabetic, and treatment groups. Graphical representation of data was prepared where necessary to facilitate comparison. Statistical analysis was performed to evaluate significance of differences among groups.

Results and Discussion

Alloxan-induced diabetic mice showed significant reduction in body weight compared to control animals. The decrease in body weight in diabetic animals may be attributed to impaired glucose utilization and increased catabolism of proteins and fats. Hyperglycemia leads to metabolic imbalance, which results in weight loss and general weakness. In the present investigation, diabetic animals appeared less active and showed reduced food intake during the experimental period. Testicular weight also decreased in diabetic animals, indicating reproductive impairment. The reduction in testicular weight may be due to degeneration of seminiferous tubules and loss of germinal epithelium. Diabetes-induced oxidative stress adversely affects testicular tissue and interferes with spermatogenesis. The decrease in organ weight is an important indicator of reproductive toxicity. Sperm count and motility were significantly reduced in diabetic group. The decrease in sperm count suggests impaired spermatogenesis caused by hyperglycemia. Reduced sperm motility may be due to damage to sperm membrane caused by lipid peroxidation. Increased reactive oxygen species affect mitochondrial function in spermatozoa, thereby reducing their motility and fertilizing capacity. These findings indicate that alloxan-induced diabetes has a detrimental effect on male reproductive function. Treatment with *Coriandrum sativum* leaf extract improved body weight and testicular weight. The improvement in body weight in treated animals suggests better metabolic control and improved glucose utilization. Coriander leaf extract contains bioactive compounds that may enhance insulin secretion and reduce hyperglycemia. Improved metabolic status may contribute to restoration of reproductive organ weight. Sperm count and motility showed considerable improvement in treatment group. The increase in sperm count indicates partial restoration of spermatogenesis. Improved sperm motility suggests protective effect of coriander leaf extract on sperm membrane integrity. Antioxidant components present in coriander leaves may reduce oxidative stress and protect reproductive cells from damage.

Table 1: Effect of Alloxan and Coriander Leaf Extract on Reproductive Parameters

Parameter	Control	Diabetic	Treatment
Body weight (g)	28.6	22.3	26.5
Testicular weight (g)	0.18	0.12	0.16
Sperm count (million/ml)	46	29	40
Sperm motility (%)	80	45	68

The data presented in Table 1 clearly indicate that diabetic animals exhibited significant reduction in reproductive parameters when compared to control animals. However, treatment with *Coriandrum sativum* leaf extract improved these parameters to near normal levels. The partial recovery observed in treated animals suggests protective effect of coriander leaves.The reduction in reproductive parameters in diabetic mice may be due to oxidative stress and hormonal imbalance. Hyperglycemia increases production of reactive oxygen species, which damages testicular tissue and sperm cells. Oxidative stress also affects Leydig cell function and reduces testosterone production. Reduced testosterone levels impair spermatogenesis and decrease sperm production. Coriander leaf extract improved reproductive parameters due to its antioxidant properties. Bioactive compounds present in coriander leaves such as flavonoids and phenolic compounds may neutralize free radicals and protect reproductive organs. These compounds may also enhance enzymatic antioxidant defense system and reduce lipid peroxidation. Histological examination showed

degeneration of seminiferous tubules in diabetic mice, whereas treatment group showed partial restoration of testicular architecture. Diabetic animals showed reduced germ cell layers and disorganized seminiferous tubules. In contrast, treated animals exhibited improvement in seminiferous tubule structure and increased germinal epithelium. The present findings agree with previous studies reporting protective effects of plant extracts against diabetic complications. Several medicinal plants possessing antioxidant activity have been shown to improve reproductive parameters in diabetic animals. The protective effect observed in the present study may be attributed to combined hypoglycemic and antioxidant properties of *Coriandrum sativum* leaves. Overall, the results indicate that alloxan-induced hyperglycemia adversely affects reproductive function in albino mice, whereas treatment with coriander leaf extract provides significant protection against reproductive toxicity.

Conclusion

The present study demonstrates that alloxan-induced hyperglycemia adversely affects reproductive parameters in albino mice. The diabetic animals exhibited reduction in body weight, testicular weight, sperm count, and sperm motility, indicating significant reproductive impairment. These findings suggest that chronic hyperglycemia interferes with normal spermatogenesis and damages reproductive tissues. The observed alterations may be attributed to oxidative stress, hormonal imbalance, and metabolic disturbances associated with diabetes.Treatment with *Coriandrum sativum* leaf extract improved sperm count, motility, and testicular weight. The improvement observed in treated animals indicates that coriander leaves possess protective properties against diabetes-induced reproductive toxicity. The beneficial effects may be due to antioxidant compounds present in coriander leaves, which help in reducing oxidative stress and improving metabolic function. Restoration of reproductive parameters in treated animals suggests partial recovery of testicular function. The results of the present study highlight the potential therapeutic role of *Coriandrum sativum* in managing reproductive complications associated with diabetes. The plant extract may help protect reproductive organs and improve fertility parameters under hyperglycemic conditions. Therefore, coriander leaves may be considered as a natural and safe alternative for reducing diabetic reproductive damage. Further studies are required to explore the molecular mechanisms involved and to evaluate the long-term effects of coriander leaf extract on reproductive health. Additional investigations involving hormonal analysis and biochemical parameters would provide deeper insight into the protective role of *Coriandrum sativum*. Future research should also focus on dose optimization, duration of treatment, and comparative evaluation with standard antidiabetic drugs. Histopathological and enzymatic studies may further clarify the mechanism of action. Such investigations would help establish coriander leaves as a potential natural therapeutic agent for improving reproductive function under diabetic conditions

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