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Original Article

# Effect of Garlic on Antioxidant Enzymes in STZ Induced Diabetes: Studies on the Glucose Levels and Oxidative Markers

**Priyanka Surajan[1], Dronadula Veenamadhuri[2], Erla Komali[3], Ramavath Kambli Naik[4], Bollapalli Ashok Kumar[5], Meesala Guru Sekhar[6,*]**

[1]Department of Biotechnology, DK Govt. Degree College (W), Nellore, Andhra Pradesh, INDIA.
[2]Information Science and Technology, University of Nebraska Omaha, Dodge St, Omaha, Nebraska, UNITED STATES OF AMERICA.
[3]Department of Zoology, S. V. University, Tirupati, Andhra Pradesh, INDIA.
[4]Department of Zoology, Lecturer in Zoology, Government Degree College for Men, Kurnool, Cluster University Kurnool, Andhra Pradesh, INDIA.
[5]Department of Zoology, Government Degree College, Addanki, Prakasam, Andhra Pradesh, INDIA.
[6]Department of Zoology, Government Degree College, Cumbum, Markapur, Andhra Pradesh, INDIA.

## ABSTRACT

**Background:** Diabetes is a serious health problem and is rapidly increasing worldwide. It is characterized by insulin resistance and abnormalities in insulin production.**Objectives:** The current study was planned to know the antidiabetic and antioxidant effect of garlic in diabetic rats. **Materials and Methods:** In the present study, oral administration of garlic extract was given for 30 days. Later the level of serum glucose, antioxidant enzymes SGOT, SGPT are assayed in all the experimental groups. **Results:** In diabetic rats, serum glucose levels are increased, while body weight was decreased. All the antioxidant enzymes are decreased in the diabetic rats. However, with garlic supplementation all these antioxidant enzymes are upregulated in diabetic rats and serum glucose levels decreased, body weight are elevated. A comparison was made between the action of garlic extract and Vitamin C the known antidiabetic drug. The antidiabetic effect of the extract was more effective than Vitamin C. **Conclusion:** Our study reported that garlic possesses antioxidant and antidiabetic effect in diabetic rats. So, consumption of garlic helpful to diabetic patients. Therefore, garlic could be of great value in managing the effects and complications of diabetes in affected individuals.

**Keywords:** Diabetes, Garlic, Glucose, Antioxidant enzymes, Rats.

**Correspondence:**
**Dr. Meesala Guru Sekhar**
Associate Professor, Department of Zoology, Government Degree College, Cumbum-523333, Markapur, Andhra Pradesh, INDIA.
Email: meesala1980@gmail.com

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## INTRODUCTION

Diabetes affects many parts of the body, due to over production of free radicals. Free radicals are produced during diabetic condition. Which cause oxidative stress thus leads to organ damage. By 2040 the diabetic patients will be around 660 million. There are many factors which leads to diabetes like sedentary lifestyle, intake of carbohydrate rich diets, obesity, hypertension, family history, and genetic makeup, physical inactivity (Shanmugam *et al*., 2011).

Garlic, scientifically known as *Allium sativum*, is an herbaceous plant belongs to Amaryllidaceae family. Garlic contains many important water-soluble organo-sulfur compounds with potent antioxidant and free radical scavenging activities. Garlic contains around 2000 biologically active components and sulfur-containing compounds which are found to play a great pharmacological role. Garlic has anti-diabetic, anti-oxidant, anti-lipidemic, anti-cancer, anti-bacterial, anti-viral properties, antiallergic and anti-inflammatory properties (Dini *et al*., 2011, Sahidur *et al*., 2023).

Garlic is rich in Vitamins C, selenium, which support the immune system by enhancing various cellular functions. Selenium plays a vital role in the antioxidant enzyme system and immune response (Shagun *et al*., 2024). It is significant in managing metabolic disorders by improving insulin sensitivity and reducing blood glucose levels, making it crucial for individuals with diabetes.

The objective of the present study was to investigate the antidiabetic and antioxidant effect of garlic ethanolic extract in normal and streptozotocin-induced diabetic rats.

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## MATERIALS AND METHODS

### Collection of Plant Material

Garlic was collected locally and was dried in the shade, coarsely powered and soaked in 70% ethanol for three days at room temperature. The extract was filtered and the solvent was removed using rotary evaporator at 65ºC. The yield was 12% (w/w).

### Chemicals

All the chemicals used in this study are obtained from Sigma-Aldrich (St. Louis, USA), Qualigens Merck etc.

### Animals

Thirty male albino rats weighing 200±10 g were obtained from the animal house of the faculty of National Institute of Nutrition, Hyderabad. Rats were housed in a temperature-controlled environment (22±3ºC), 45%-55% humidity, and a 12-hr light/darkcycle. After baseline behavioural assessment, the animals were allowed to acclimatize for two weeks before the experiment. Throughout the experiment, rats are weighed and regularly monitored for any indications of distress.

### Diabetes Induction in rats

The rats are given a single intraperitoneal Injection (ip) of STZ (50 mg/kg) for the introduction of diabetes. All the STZ-induced rats are given 20% glucose solution for 24 hours to prevent hypoglycemic shock. Accucheck glucometer (Roche-Germany) was used to test the blood glucose levels. After 3 days of STZ injection, the rats with the blood glucose levels more than 250 mg/dL are used for the study. All the experiments in this study are approved and accepted by the institutional Animal Ethics Committee (The Institutional Animal Ethical Committee, S. V. University (No.01/2011-2012/(i)/a/CPCSEA/IAEC/SVU/MBSR/Dt20/06/2011), Tirupati).

### Grouping of Animals

Rats are separated in to five groups, each group containing six rats.

- **I - Normal Control (NC):** rats receive saline for 30 days.
- **II - Garlic treatment (Gt):** rats receive the garlic ethanolic extract (200 mg/bodyweight) for 30 days.
- **III - Diabetic Control (DC):** streptozotocin (STZ-50 mg/kg), was used for induction of diabetes.
- **IV - Diabetic + Garlic Treatment (D+Gt):** diabetic rats receive garlic for a period of 30 days.
- **V - Diabetic + Vitamin C (D+Vit C):** Diabetic rats receive Vitamin C for 30 days.

Treatment was given for 30 days and after 24 hr of the last treatment the rats are decapitated by cervical dislocation. Serum was collected at 4ºC and used for estimation of biochemical parameters.

### A estimation of serum glucose and body weight

Serum glucose and body weight changes are observed in all the experimental groups.

### Estimation of Antioxidant enzymes in Kidney

SOD (Misra and Fridovich,1972), CAT (Aebi, 1984), GR (Flohe and Gunzler,1984), GPx (Carlberg and Mannervik,1985) and GSH (Akerboom and Sies, 1981) antioxidant enzymes are estimated in the kidney of all groups by standard protocols (Figure 1).

### Estimation of serum markers in serum

The serum markers like SGOT, SGPT, and ALP are also estimated in the serum of all the samples (Table 1).

### Statistical analysis

The data are expressed as mean±SD and were analysed by one-way analysis of variance. Student's t-test was used to detect differences in means between the control group and the group of diabetic rats. Duncan's multiple-comparison test was used to detect differences among the means of the STZ-injected groups. $p$ values <0.05 were considered significant. All analysis were performed with commercially available software (SPSS 12 for WINDOWS; SPSS Inc., Chicago, IL). M.S. Office, excel softwares are also used for analysis of the data. Differences were considered significant at $p<0.001$.

## RESULTS

In diabetic rats the serum glucose levels are elevated and body weigh was depleted in diabetic rats. But with garlic administration the serum glucose levels are decreased and body weight was elevated in diabetic rats (Table 1).

The antioxidant enzymes SOD, CAT, GPx, GR and GSH downregulated in diabetic rats. However, with garlic treatment in diabetic rats, restored all antioxidant enzymes near to normal levels (Figure 1).

The liver markers SGOT, SGPT and ALP levels are elevated in diabetic rats. But with garlic administration all these parameters are depleted in diabetic rats (Table 1).

## DISCUSSION

The present study was investigated in *in vivo* condition to know the antioxidant and anti-diabetic activities and renal protective effect of garlic in diabetic rats. It has been reported that the oral administration garlic to diabetic rats depleted serum glucose levels. Bioactive compounds of garlic are capable of modulating the oxidative stress and depleted the production of free radicals. The World Health Organization (WHO) has reported that about

80% of the world population depend on herbal remedies for their healthcare problems (Ekor, 2014).

The plant derived phytochemicals such as flavonoids, polyphenols, unsaturated fatty acids, glycosides, tannins, saponins and alkaloids having wide range of biological activities and found useful in the treatment of diabetes (Pang *et al.*, 2019). In recent years, there has been a growing focus on the potential of natural compounds in preventing diabetes. In this study we observed elevated levels of serum glucose and depleted levels of body weight in diabetes rats. But with garlic supplementation serum glucose levels and body weight was come back to near to normal levels (Capasso, 2013). Our study proved that garlic have anti-diabetic effect in diabetic subjects. Besides, another previous study has confirmed the anti-diabetic activity (Shanmugam *et al.*, 2011) (Table 1).

Oxidative stress is an imbalance between production and removal of ROS due to the decrease in the antioxidant defence mechanisms. It is very evident that free radicals adversely affect various types of biomolecules and can cause lipid peroxidation, thereby damaging several organelles (Darenskaya *et al.*, 2021). Hyperglycemia and hyperlipidemia induce oxidative stress in diabetes. During hyperglycemia, increased mitochondrial pyruvate oxidation promotes the TCA cycle, which in turn promotes lipid synthesis

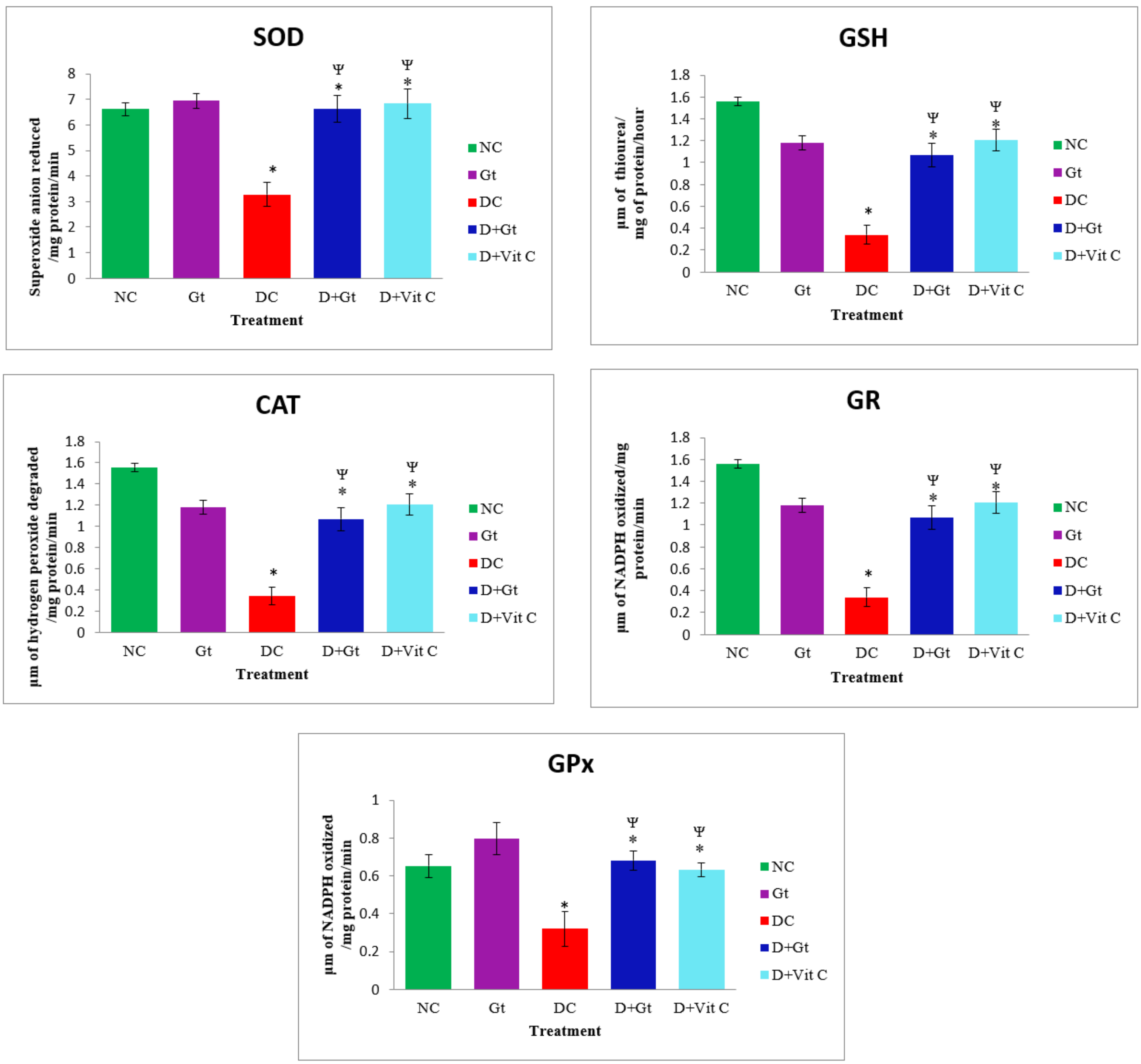


**Figure 1:** Effect of garlic on Antioxidant Enzymes in Diabetic Rats.

**Table 1: Effect of garlic on serum glucose, body weight and liver markers in diabetic rats.**

| Groups | Serum Glucose (0 Day) | Serum Glucose (30 Day) | Body Weight (0 Day) | Body Weight (30 Day) | SGOT (IU/L) | SGPT (IU/L) | ALP (IU/L) |
|---|---|---|---|---|---|---|---|
| NC | 82±16 | 84±14 | 220±12 | 210±18 | 62±6.2 | 72±12 | 96±12 |
| Gt | 82±12 | 84±16 | 234±16 | 220±12 | 64±10.4 | 74±12* | 94±16 |
| DC | 286±14* | 290±18* | 226±12 | 148±12 | 126±12.4* | 156±16* | 204±14 |
| D+Gt | 242±18* | 142±12* | 220±18 | 180±18 | 96±12.4 | 78±18* | 142±16 |
| D+Vit C | 234±16* | 162±14 | 228±10 | 184±16 | 108±14.4* | 82±16* | 156±12 |

All the values are Means±SD of six individual observations. * Significant at $p<0.001$ with respect to normal control.

and Reactive Oxygen Species (ROS) production. A high glucose level can also enhance the generation of ROS from pro-oxidative pathways. Garlic has been known for its antioxidant effects in a variety of pathophysiological conditions (Liu *et al*., 2007), however, these effects of garlic have been demonstrated to differ in different tissues and organs. For example, in STZ-induced diabetic rats, although garlic oil elevates the level of total thiols and ameliorates lipid peroxidation in plasma and erythrocyte, these two indexes of oxidative stress are not affected in the kidneys of these animals (Anwar and Meki, 2003) (Table 1).

Garlic exerts antioxidant effects by scavenging free radicals, enhancing superoxide dismutase, catalase and glutathione peroxidase, and increasing cellular glutathione. These effects of garlic may be due to the bioactive compounds and phytochemicals of garlic. Garlic has been shown *in vitro a*nd animal studies to protect against renal toxicity from environmental substances, like this garlic also protect renal tissue from oxidative damage in diabetic condition.

SOD, CAT and GPx activities are depleted in diabetic rats. The stronger induction of the antioxidant enzyme activities are more susceptible to ROS generation, particularly superoxide, hydrogen peroxide, and therefore require more effective scavenging systems, which is responsible for down regulation of the antioxidant enzymes in diabetic rats (Shanmugam *et al*., 2011). But with garlic administration these antioxidant enzymes are elevated in diabetic rats. This may be due to the bioactive compounds and phytochemicals in garlic. These compounds may inhibit the release of free radicals in diabetic rats. Hence SOD, CAT and GPx activities are upregulated in diabetic rats. GR and GSH activities are also decreased in diabetic rats. This condition may be due to oxidative stress and oxidative damage in diabetic rats. But with garlic supplementation GR and GSH levels are increased (Figure 1).

The elevated levels of SGOT, SGPT and ALP liver function enzymes in the serum are associated with hepatocellular damage because damage in the liver cell plasma membrane results in the release of these enzymes into circulation. SGOT, SGPT and ALP are liver markers, when liver tissue is damaged these markers will leakage in to blood stream. Therefore, serum levels of SGOT, SGPT and ALP can be considered as the most sensitive indicators of liver injury. Our studies reported in diabetic rats these levels are increased. However, garlic treatment these serum markers are down regulated. Our study showed that garlic have hepato protective effect in diabetic subjects (Table 1).

Investigation of diabetic subjects has found increased protein oxidation, lipid peroxidation, and NO levels and decreased levels of enzymatic and nonenzymatic antioxidants in kidney. Similarly, in STZ-induced diabetic rats, increased oxidative stress is accompanied by decreased antioxidant power in kidney (Chugh *et al*., 2023). Furthermore, it was recently demonstrated that ethanolic-garlic extract attenuates oxidative stress in renal tissues of STZ-induced diabetic rats and that fresh garlic homogenate ameliorates renal oxidative stress and nitric oxide production in STZ-induced diabetic rats.

## CONCLUSION

The finding of this study advocates that the anti-diabetic, antioxidant and renal protective effect of garlic in diabetic subjects. So, garlic may be used to treat diabetes.

## ABBREVIATIONS

**STZ:** Streptozotocin; **SGOT:** Serum Glutamic Oxaloacetic Transaminase; **SGPT:** Serum Glutamic Pyruvic Transaminase; **SOD:** Superoxide Dismutase; **CAT:** Catalase; **GR:** Glutathione Reductase; **GPx:** Glutathione Peroxidase; **GSH:** Glutathione; **ALP:** Alkaline Phosphatase; **SD:** Standard Deviation; **WHO:** World Health Organization; **TCA:** Tricarboxylic Acid; **ROS:** Reactive Oxygen Species; **NO:** Nitric Oxide; **NC:** Normal Control; **Gt:** Garlic Treatment; **DC:** Diabetic Control; **D+Gt:** Diabetic + Garlic Treatment; **D+Vit C:** Diabetic + Vitamin C; **ip:** Intraperitoneal.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Nil

## AUTHOR CONTRIBUTIONS

A - Research concept and design, B - Collection and/or assembly of data, C - Data analysis and interpretation, D - Writing the article, E - Critical revision of the article, F - Final approval of the article Corresponding author Meesala Gurusekhar ZOOLOGY, Department of Zoology, Government Degree College, Cumbum - 523333, Andhra Pradesh, India.

## SUMMARY

Our study will provide the basis for future studies to study the effect of bioactive compounds of garlic in diabetic subjects.

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