


# Antioxidant Effects Following Oral Administration of *Foeniculum vulgare* in Male Rats

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**Abstract:** Fennel (*Foeniculum vulgare*), a perennial herb belongs to the carrot family and comprises of yellow flowers and feathery leaves. Due to highly fragrance, it is widely used in cooking and is one of the primary components of absinthe. Fennel has become established along roadsides, in pastures, and in various open areas around the world. Present study was carried out to evaluate the antioxidant effects following fennel seeds administration in male albino rats. Twelve albino rats were divided into control and tests. Control was treated with normal saline while treatment was given at concentration of 200 mg/kg/ml of fennel seeds aqueous solution in oral form for three weeks. Antioxidant activities were evaluated by measuring the levels of Malondialdehyde, Catalase, Glutathione peroxidase and Glutathione reductase levels in blood. The administration of fennel seeds significantly enhanced the antioxidant activity showing active action against free radicals in body. It is suggested that fennel seeds can be used as a functional health boosting meal. Further neurochemical research is needed to confirm the mechanism at molecular level.

**Keywords:** Fennel seeds, Catalase, Malondialdehyde, Glutathione peroxidase and Glutathione reductase

## Introduction

Herbs have been used as medicine for a long time; either parts or seeds of plants as phyto-constituents, specifically as medications and other pharmaceutical products. Different herbs like fennel, curcumin, black seeds and cardamom are widely used as medicinal substances (Yang and Shin, 2015). Cytokines involved in inflammatory reactions are produced in a sequential order of events. Additionally, its antioxidant characteristics might reduce stress and stress-related disorders (Koppula & Kumar, 2013). Fennel, *Foeniculum vulgare* is a medicinal plant which has a significant smell, belongs to the Apiaceae family. It shows properties such as liver protection, blood clot prevention, antioxidant defense, bacterial fighting, inflammation reduction, and fungus inhibition (Rather *et al* 2016). Several macromolecules like carbohydrates, protein, fats, vitamins and minerals are rich in fennel seeds (Bukhari *et al* 2014).

Fennel seeds are found to help reduce neuronal damage by maintaining stable levels of amyloid precursor proteins isoforms and oxidative stress markers (Bhatti *et al* 2018). It has been observed that fennel extract has an anti-cholinesterase property and may help improve memory impairments in Alzheimer's disease and dementia (Joshi & Parle, 2006). Fennel in the diet, along with other dietary spices, can lead to a notable decrease in food transit time, and promote a healthy appetite and digestion. It contains high levels of anethole spread evenly throughout the plant, but mainly concentrated in the seeds (Patel and Srinivasan 2001). The reason for fennel's digestive and carminative effects is due to this compound, while its delightful flavor and unique scent make fennel a tasty vegetable to incorporate into dishes. Vegetable charcoal has been known for its capacity to easily absorb liquid and gases in the intestines, as well as aiding healthy intestinal bacteria that enhance proper digestion (Patel and Srinivasan 2001; Noreen *et al* 2023). Some scientists reported

that fennel could remove gas from the digestive system, releasing the respiratory system and providing a soothing impact on respiratory disorders; anethole and fenchone, the key components of its essential oil, have been proven to have a mucous-eliminating effect on the respiratory system (Noreen *et al* 2023). Of medicine, fennel seeds are boiled in syrups to alleviate cough and breathing difficulties (Razieh *et al* 2022). Fennel essential oil is considered beneficial for treating obesity (Hossein *et al* 2016). The weight loss effects of fennel are thought to be due to appetite suppression. Anetholes found in fennels could possibly be utilized for the prevention and treatment of cancer (Anand *et al.*, 2008). Anethole can disrupt TNF signaling, causing activation of necrosis factors including NF- $\kappa$ B and programmed cell death. Researchers explained that anethole might inhibit NF- $\kappa$ B-dependent gene expression triggered by TNF, which regulates the expression of certain genes related to cancer development and inflammation according to (Chainy *et al.*, 2000).

It has been observed that plants that mostly contain hydroxyl groups and isoprene units in their structure contain antioxidants properties (Manzoor *et al.* 2022; Süntar 2020). The fennel fruits yield products are important and contain antioxidant properties (Mata *et al.*, 2007). Previous studies showed that flavonoids present in fennel plants, recognized for their ability to combat free radicals with antioxidant properties (Anwar *et al* 2009). It has been well documented that significant amounts of overall phenolic compounds flavonoids present in plant have a capacity of radical scavenging that can inhibit peroxidation. It has been reported that reactive oxygen species (ROS) can be generated in the skin through chemical ionization and/or UV radiation, as well as enzymatically by polymorphonuclear leukocytes at infection sites (Goto *et al* 2002). Furthermore, it has been found that fennel seeds enhance catalase activities and increase the levels of plasma superoxide dismutase, along with an increase in high density lipoprotein-cholesterol level while the level of malondialdehyde as an indicator of lipid peroxidation was notably reduced in fennel treated individuals as compared to control (Eun and Hwang 2004).

The present study was designed to find out the antioxidant properties of fennel in albino rats especially to know the mechanism of action of fennel against reactive oxygen species that are commonly incorporated with environment which could elaborate about fennel and its beneficial effects in the

development of various medications that are essential for preserving human health.

## Materials and Methods

Fennel seeds used in current study are locally purchased. Fennel seeds known amount 200mg soaked in water overnight, and the extract was collected which was used as dose given to the rats following the protocol of Sajid *et al* (2017). Twelve locally bred Albino Wister rats (150-180g) purchased from Dow University Ojha Campus. All animals were kept individually and provided standard conditions with free access to a rodent diet. Animals were divided into two groups control and test. Control was given saline while test animals were given fennel seeds extract and administered orally for 23 days and were sacrificed at 25<sup>th</sup> day. Blood was collected in heparinized tubes to obtain plasma and immediately was stored for antioxidant analysis. All experiments were conducted according to a protocol approved by the Institutional Ethical Care Committee.

## Determination of Antioxidant Enzyme Activities

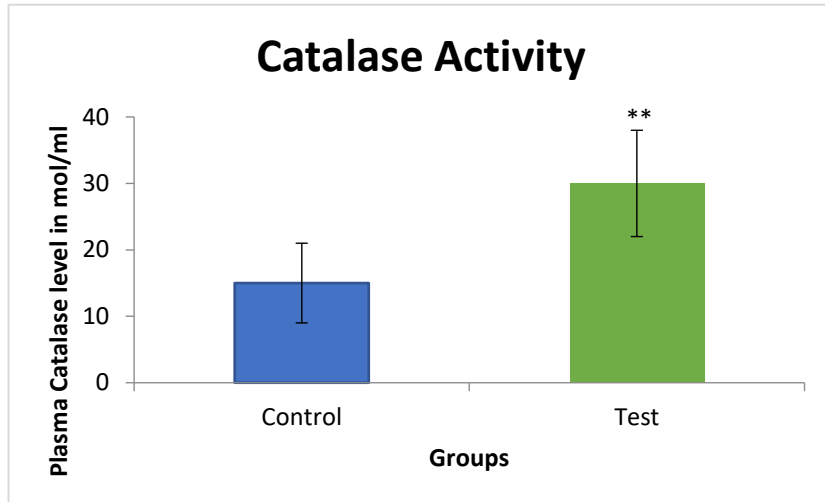
Estimation of activity of catalase, malondialdehyde, glutathione peroxidase and glutathione was performed following the protocol as described by Sajid *et al* (2017).

## Data Analysis

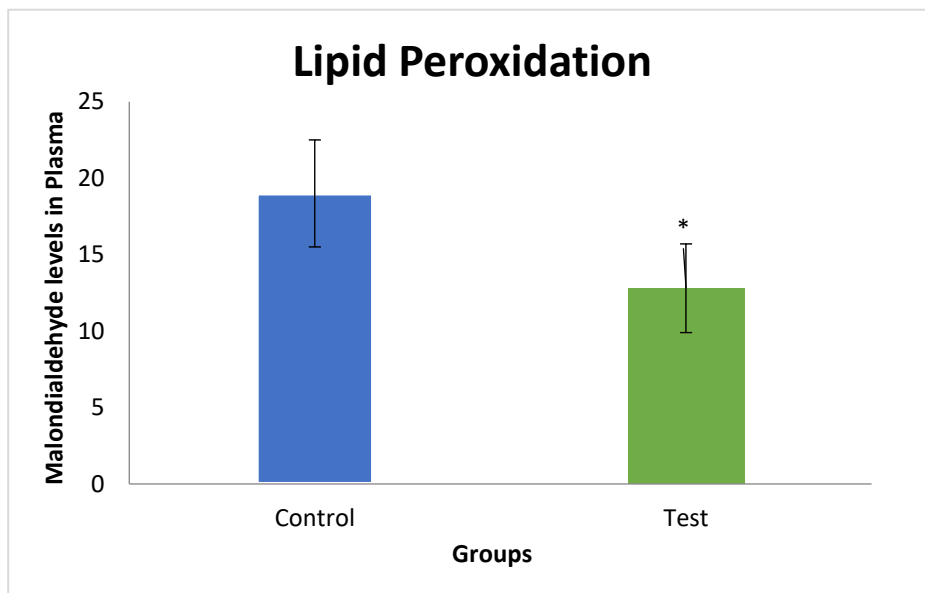
The data was analyzed using by Student's *t*-test. The results are represented as mean  $\pm$  S.D, and significant values are indicated when  $p < 0.05$ .

## Results

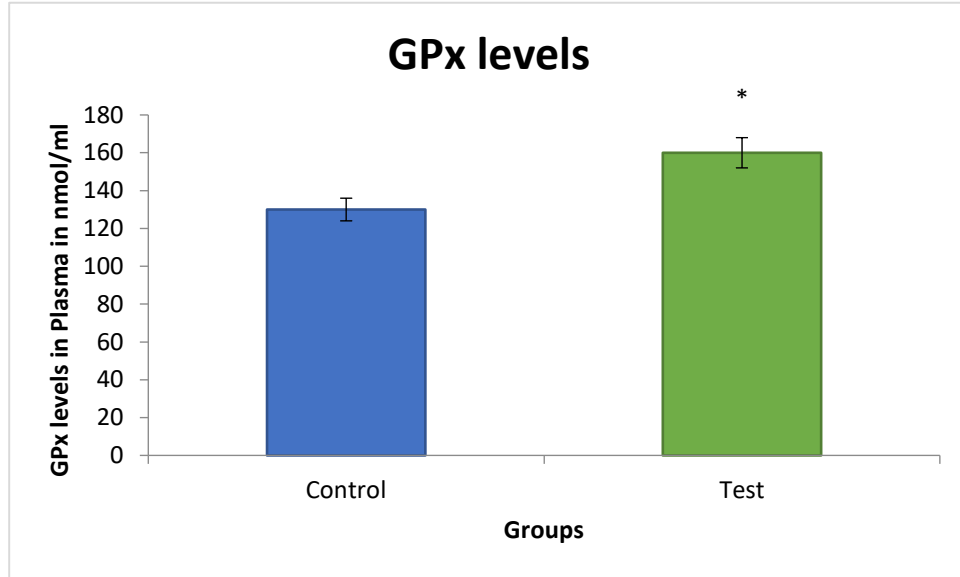
The effect of fennel extract on catalase antioxidant enzyme is shown in Fig. 1. Data analyzed by the *t*-Test reveals the significant effect on administration of fennel extract significantly increased ( $t = -5.61$ ,  $df = 10$ ) catalase enzyme as compared to control. Malondialdehyde (MDA) is a marker of lipid peroxidation showing oxidative stress and redox signaling studies. A significant decrease was found ( $t = 1.45$ ,  $df = 10$ ) under the administration of MDA when content LPO had a significant effect (Fig. 2). The current findings showed that fennel administration could be beneficial for membrane structure and helps in more protection against oxidative damage by free radicles. Similarly, Glutathione Peroxidase; an intracellular antioxidant enzyme was found significantly increased ( $t = -2.17$ ,  $df = 10$ ) as compared to control (Fig. 3). Glutathione reductase enzyme was found non-significantly increased ( $t = -0.42$ ,  $df = 10$ ) as compared to control (Fig. 4).



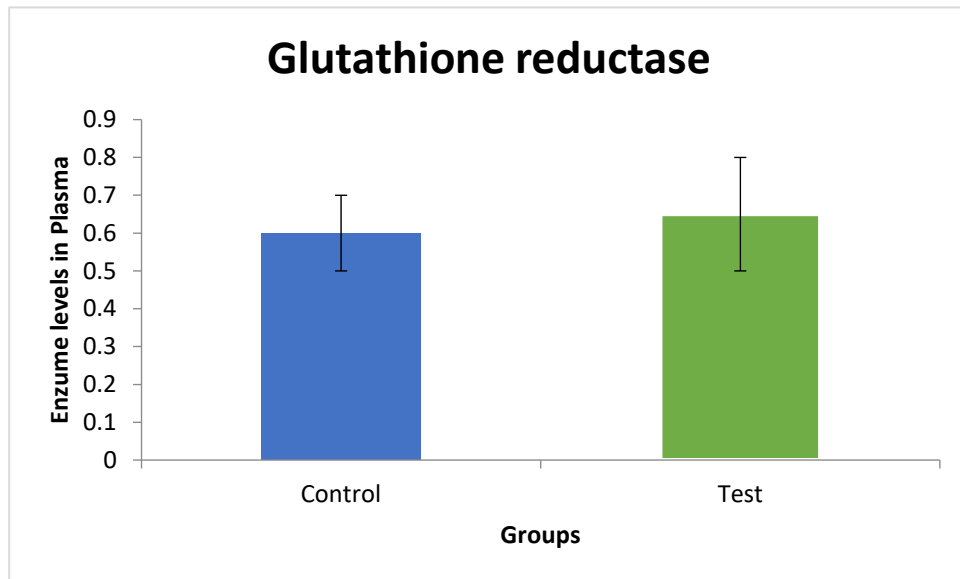
**Figure 1: Catalase enzyme activity in Blood Plasma**  
Mean  $\pm$  SD (n=6) analysis by student's t-test revealed a significant effect (\*\*P<0.01vs control)



**Figure 2: Malondialdehyde (MDA) levels in Blood Plasma**  
Mean  $\pm$  SD (n=6) analysis by student's t-test revealed a significant effect (\*P<0.05vs control).



**Figure 3:** Peroxidase Enzyme levels in Blood plasma  
 Mean  $\pm$  SD (n=6) analysis by student's t-test revealed a significant effect (\*P<0.05vs control)



**Figure 4:** Reductase levels in Blood Plasma  
 Mean  $\pm$  SD (n=6) analysis by student's t-test revealed a non-significant effect (P>0.05vs control)

**Discussion**

The current study revealed that fennel seeds have a notable effect on catalase, MDA content, and glutathione peroxidase, while showed no significant effect on glutathione reductase.

Studies reported that free radicals are reactive oxygen species (ROS) that can damage cells and are responsible for many diseases infertility, different carcinomas, diabetes, and cardiovascular issues, illness,

getting older, and neurodegenerative diseases (Mata *et al.*, 2007). The fennel fruits yield essential oil, water, and ethanol extracts that are important and contain antioxidant properties (Noreen *et al.*, 2023). Furthermore, it has also been reported that water and ethanol extracts of fennel show 99.1% and 77.5% peroxidation inhibiting in the linoleic acid system, respectively and  $\alpha$ -tocopherol, a natural antioxidant (Ahmed *et al* 2019). Both samples demonstrate strong abilities in scavenging free radicals, superoxide anion radicals, hydrogen

peroxide, and chelating metals, all of which are closely related (Oktay *et al* 2003). The level of concentration suggests that fennel seeds have the possibility to be a source of antioxidants that occur naturally. The present study showed significant effects of fennel on antioxidant enzyme levels that can be attributed with the beneficial and protective effect of seeds as reported in different previous studies to assess the antioxidant activity of fennel seeds by administering in rats 200 mg/kg/day. Previously it has been shown with a significant effect on SOD and catalase levels, while lipid peroxidation was significantly decreased (Hassan *et al* 2023). Effects on antioxidant enzymes levels and could be attributed to a decrease in harmful impact from the buildup of oxygen radicals that might produce positive impact on pathological changes, particularly in inflammatory conditions. Hassan *et al* (2023) noted an increase in HDL-cholesterol levels in fennel seeds administered group. This HDL effect could be occurring because it inhibits the oxidative alteration of LDL. Ragaa *et al* (2011) identified that fennel seed extract effectiveness in albino mice for its protective mechanism in cell and as a non-toxic radioprotector. After administration of fennel seeds extract, the improvement has been noticed in liver and tumor tissue of mice with ascites carcinoma due to notable rise in MDA levels and reduction in catalase activity and glutathione. Consistently the current findings showed a decrease in MDA participate in maintaining integrity of membranes of cell. In recent study glutathione peroxidase has crucial effect so that the oxidative stress can be reduced by scavenging of free radicals and conversion of hydrogen peroxide radical into water or alcohols fennel seeds contain these natural antioxidants in large quantity. Due to its high contents of polyphenols and flavonoids, this plant can help in inhibiting the production of free radicals (Parejo *et al.*, 2004b). In the body different antioxidants like molecules are involved that can neutralize reactive molecules. Moreover, Sura *et al* (2024) showed a notable increase in Glutathione peroxidase levels in chicks that consumed fennel seeds, along with a significant decrease in malondialdehyde; these alterations may be attributed to fennel's effective radical scavenging properties. A notable increase in the functions of antioxidant enzymes was seen in diets that included fennel (Nickavar and Abolhasani, 2009). Furthermore, Rezaq (2013) indicated in past research that providing diets enriched with varying amounts of

fennel seeds markedly enhanced the serum levels of Superoxide dismutase (SOD) and Glutathione peroxidase enzyme relative to the control group. Furthermore, it has been reported that dieting chicks with a high-fat diet enriched with fennel seeds notably lowered serum MDA levels in comparison to the positive control (Rezaq, 2013). Flavonoid and phenolic compounds contain antioxidants with a radical scavenging mechanism, which can potentially change the physiological antioxidant status by increasing GSH-Px and decreasing malondialdehyde, according to current findings (Zayachkivska *et al.*, 2005). The current results also explained beneficial effects of fennel seeds administration as enhancing activities of antioxidant levels in blood sample (Mohamad *et al* 2011). They further concluded in their research that fennel seed extract might diminish oxidative stress and safeguard mouse cells from harm induced by reactive oxygen species, and it may serve as a secure, efficient, and readily available source of natural antioxidants to enhance the oxidative stability of fatty foods while in storage. Extracts possess an antitumor effect by influencing lipid peroxidation and enhancing the antioxidant defense system in EAC-bearing mice, whether they were exposed to radiation or not. Mohammad *et al.* (2011) found that the activities of superoxide dismutase and catalase and MDA and GSH were enhanced. The current study in consistence to the findings of Choi *et al* (2004) revealed a decrease in MDA contents. Body has its own antioxidant defenses to keep free radicals in check and current study provides a concept that fennel seeds strengthen defense system of body.

## Conclusion

Present research showed that fennel seeds serve as excellent sources of vital phytonutrients and phytochemicals as fennel seeds have significant effect on catalase, MDA and glutathione peroxidase levels. Fennel seeds, thus, can be used as a functional, health boosting meal. Synthetic drugs possess several side effects that could be harmful for body, so knowledge of using natural plants as an alternative medicine for diseases has been raised. However, the use of fennel seeds as natural medicine for many years has been acknowledged. Further neurochemical research is needed to confirm the mechanism of fennel at molecular level.

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