Annals of Natural Sciences
Vol. 11(2), June 2025: 23-28
Journal's URL: http://www.crsdindia.com/ans.html
Email: crsdindia@gmail.com

e-ISSN: 2455-667X
Annals of Natural Sciences

ORIGINAL ARTICLE

Effect of Aqueous Extract of Tulsi on Liver Enzymes in Albino Rats Exposed to Cigarette Smoke

Suman and Rajvir Singh Ojha
Department of Zoology, Raja Balwant Singh College, Agra
(Affiliated to Dr. B.R. Ambedkar University, Agra)
Email ID: sumansingh46787@gmail.com

ABSTRACT

Cigarette smoke is a major source of oxidative stress and toxic compounds that can impair liver function, leading to altered hepatic enzyme activity. This study investigates the protective effect of aqueous extract of Ocimum sanctum (Tulsi) on liver enzymes in albino rats exposed to cigarette smoke. Adult albino rats were divided into four groups: control, cigarette smoke-exposed, Tulsi-treated, and cigarette smoke-exposed plus Tulsi-treated. Cigarette smoke exposure was carried out daily for a specified duration, while the Tulsi extract was administered orally at a standardized dose. Biochemical analysis focused on key liver function markers, including serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT). Rats exposed to cigarette smoke showed a significant elevation in these enzymes, indicating hepatic damage. In contrast, rats treated with aqueous Tulsi extract demonstrated a notable reduction in enzyme levels compared to the smoke-exposed group, suggesting a hepatoprotective effect. The antioxidant properties of Tulsi, attributed to its bioactive compounds such as flavonoids and phenolic acids, likely contribute to the stabilization of hepatocellular membranes and reduction of oxidative stress. Aqueous extract of Tulsi exhibits significant protective effects against cigarette smoke-induced liver damage in albino rats. This study highlights the potential of Tulsi as a natural therapeutic agent for mitigating oxidative stress and preserving liver function under toxic exposure conditions. Further studies are recommended to explore its mechanisms and clinical applicability.

***Key words**: Tulsi (Ocimum sanctum) aqueous extract, Cigarette smoke, Albino rat, AST, ALT*

Received: 12th April 2025, Revised: 15th May 2025, Accepted: 21st May 2025, Published: 30th June 2025

How to cite this article:
Suman & Ojha R.S. (2025): Effect of Aqueous Extract of Tulsi on Liver Enzymes in Albino Rats Exposed to Cigarette Smoke. Annals of Natural Sciences, Vol. 11[2]: June 2025: 23-28.

INTRODUCTION

Cigarette smoking remains one of the leading causes of preventable morbidity and mortality worldwide, contributing significantly to the development of various systemic disorders. While its detrimental effects on the respiratory and cardiovascular systems are well established, increasing attention has been directed toward its impact on other vital organs, particularly the liver. The liver plays a central role in detoxification, metabolism, and maintenance of biochemical homeostasis. Exposure to cigarette smoke introduces a wide array of toxic substances, including nicotine, carbon monoxide, polycyclic aromatic hydrocarbons, and reactive oxygen species (ROS), which can overwhelm the liver's antioxidant defense system. This imbalance often results in oxidative stress, cellular damage, and alterations in liver enzyme activity. Liver enzymes such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), are commonly used as biochemical markers to assess hepatic function and integrity. Elevated levels of these enzymes in serum typically indicate hepatocellular injury or dysfunction. Studies have demonstrated that chronic exposure to cigarette smoke leads to significant increases in

these enzyme levels, reflecting hepatic stress and damage. The mechanism underlying this damage is largely attributed to oxidative stress, lipid peroxidation, and inflammation induced by toxic constituents of smoke. Therefore, there is a growing need to identify effective protective agents that can mitigate these harmful effects and preserve liver function. In recent years, there has been a resurgence of interest in the use of medicinal plants and natural products for the prevention and treatment of various diseases. Among these, *Ocimum sanctum*, commonly known as Tulsi or Holy Basil, holds a prominent place in traditional medicine systems such as Ayurveda. Tulsi has been revered for centuries for its wide range of therapeutic properties, including antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective effects. The plant contains numerous bioactive compounds such as eugenol, ursolic acid, rosmarinic acid, and various flavonoids, which contribute to its pharmacological activities (Ahmad *et al.,* 2012).

The antioxidant potential of Tulsi is particularly significant in the context of oxidative stress-induced liver damage. By scavenging free radicals and enhancing endogenous antioxidant defenses, Tulsi may help in preventing lipid peroxidation and maintaining cellular integrity. Additionally, its anti-inflammatory properties can reduce hepatic inflammation and promote tissue repair. Several experimental studies have indicated that extracts of Tulsi can protect against chemically induced liver injury, but limited research has specifically focused on its role in mitigating damage caused by cigarette smoke exposure. Animal models, particularly albino rats, are widely used in biomedical research to study the pathophysiological effects of toxic agents and evaluate the efficacy of therapeutic interventions. Their physiological and metabolic similarities to humans make them suitable for investigating liver function and drug responses. In the context of this study, albino rats provide a controlled environment to assess the impact of cigarette smoke and the potential protective effects of Tulsi extract on liver enzymes (Bhattacharyya and Bishayee, 2013).

The use of aqueous extracts of medicinal plants is especially relevant as it mimics traditional methods of preparation and consumption. Water-based extraction ensures the isolation of hydrophilic compounds that are often responsible for therapeutic effects, while also being safe and non-toxic. Evaluating the efficacy of aqueous Tulsi extract can therefore provide insights into its practical applicability as a natural remedy. Despite the well-documented pharmacological properties of Tulsi, there remains a gap in understanding its specific effects on liver enzyme alterations induced by cigarette smoke. This study aims to address this gap by investigating the impact of aqueous Tulsi extract on serum levels of ALT and AST in albino rats exposed to cigarette smoke. By comparing enzyme levels across different experimental groups, the study seeks to determine whether Tulsi can attenuate hepatic damage and restore normal liver function.

Furthermore, this research contributes to the broader field of toxicology and herbal medicine by exploring a natural, cost-effective approach to combating oxidative stress-related disorders. With the increasing prevalence of smoking and environmental pollutants, identifying accessible and effective protective agents is of great public health importance. If proven effective, Tulsi could serve as a complementary therapeutic option for individuals at risk of liver damage due to smoke exposure. Cigarette smoke-induced hepatic injury is a significant health concern mediated largely through oxidative stress and inflammation. The exploration of natural antioxidants such as Tulsi offers promising avenues for prevention and treatment. This study is designed to evaluate the hepatoprotective potential of aqueous Tulsi extract in an experimental model, thereby providing scientific validation for its traditional use and paving the way for future clinical investigations.

MATERIALS AND METHODS

Experimental Animal: The wistar albino rat, *Rattus norvegicus* (Berkenhout) of both the sexes have been selected for the present study. Healthy and adult albino rats of both the

sexes of almost equal size and weight ranging from 100-158g were taken for the present study. They were kept in polypropylene cages measuring 45x27x15cms at temperature 21±5^{0}C, relative humidity 60±5% and photoperiod 12hrs/day. The top of the cages was made of galvanized steel mesh.

Experimental Cigarette: Cavanders Gold Leaf non-filtered cigarette, Godfrey Phillips India Ltd., Chakala, Andheri East, Mumbai was selected for the present study. A non-filtered cigarette requires 920mg tobacco and tar yields in the cigarette smoke is 22.1mg. The average nicotine yields of the cigarette smoke at that time are around 2.8mg.

Experimental Plant Extract: Leaf extract of tulsi (*Ocimum sanctum*) has been used as an antioxidant in the present study. The dose of tulsi extract will be 2ml/kgbwt.

Experimentation: The albino rats are divided into different groups exposed to cigarette smoke for 15, 30, 45, and 60 days with and without tulsi extract supplementation (Control and treated sets). The estimations were done serum taken from albino rats ventricle.

Procedure and Protocol: The rats of control set and experimental sets were sacrificed after 15, 30, 45 and 60 days for biochemical study. The double oxalate vials were used for various parameters. The blood samples were taken directly from the ventricles of the dissected rats with the help of 5.0 ml sterilized disposable syringe. The serum was separated for estimation of aspartate transaminase (AST) and alanine transaminase (ALT) by Reitman and Fankel (1957) method. The results are subjected to statistical analysis through Ky plot software.

RESULTS AND DISCUSSION

The results show increase in AST and ALT after cigarette smoke exposure which is declined when supplemented with tulsi (*Ocimum sanctum*) extract as shown in Table 1-2 and Figure 1-2.

Table 1: Aspartate Transaminase (u/l) after cigarette smoke exposure and supplementation with tulsi *(Ocimum sanctum)* extract in albino rats

Experimental days	Ambient air (Mean±S.Em)	Cigarette smoke (Mean±S.Em)	Cigarette smoke + tulsi extract (Mean±S.Em)	Significance level (t test for mean)
15 days	80.10±2.23	98.34±3.10	85.50±2.17	P<0.01
30 days	79.50±2.35	110.20±4.45	87.34±2.23	P<0.01
45 days	78.25±2.33	118.30±3.90	83.40±3.20	P<0.01
60 days	81.20±2.60	125.50±5.44	86.55±2.39	P<0.01

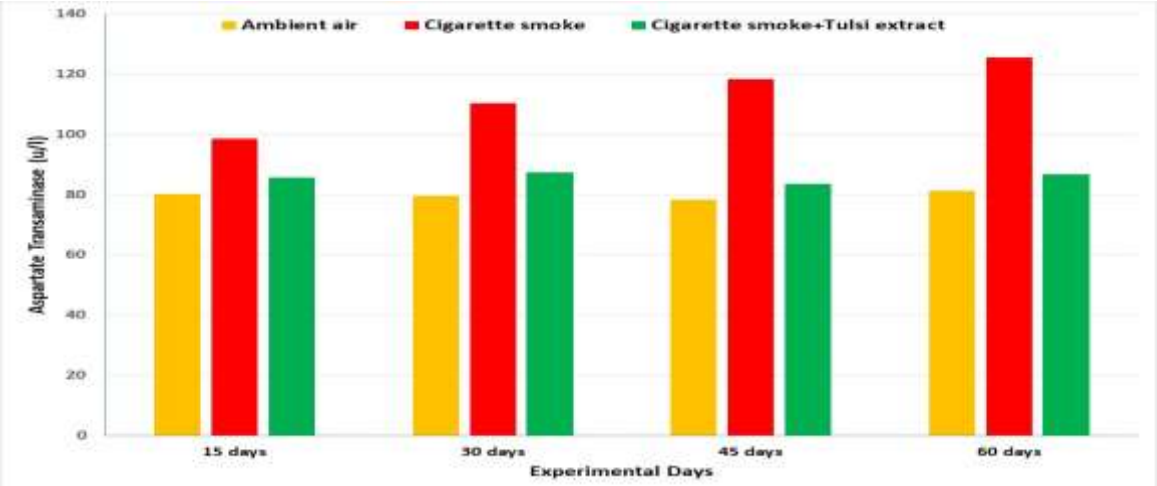

Fig. 1: Aspartate Transaminase (u/l) after cigarette smoke exposure and supplementation with tulsi *(Ocimum sanctum)* extract in albino rats

Table 2: Alanine Transaminase (u/l) after cigarette smoke exposure and supplementation with tulsi *(Ocimum sanctum)* extract in albino rats

Experimental days	Ambient air (Mean±S.Em)	Cigarette smoke (Mean±S.Em)	Cigarette smoke + tulsi extract (Mean±S.Em)	Significance level (t test for mean)
15 days	50.52±2.20	63.35±2.48	55.80±2.16	P<0.05
30 days	51.30±2.31	69.28±3.10	55.75±2.28	P<0.01
45 days	55.82±2.32	73.15±2.45	52.85±2.13	P<0.01
60 days	52.40±3.60	82.50±3.43	53.90±2.80	P<0.001

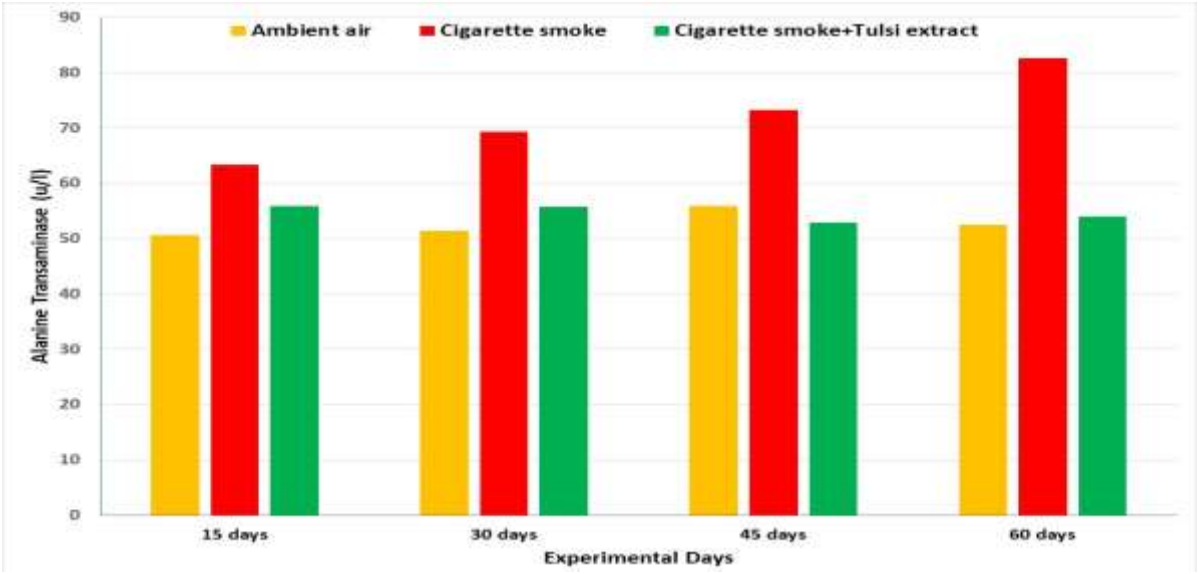

Fig. 2: Alanine Transaminase (u/l) after cigarette smoke exposure and supplementation with tulsi *(Ocimum sanctum)* extract in albino rats

The present study demonstrates that exposure of albino rats to cigarette smoke resulted in a significant elevation of serum liver enzymes, particularly aspartate aminotransferase (AST) and alanine aminotransferase (ALT), indicating hepatocellular damage. This observation is consistent with previous experimental findings that cigarette smoke induces oxidative stress and disrupts hepatic integrity through the generation of reactive oxygen species (ROS) and toxic metabolites. Cigarette smoke contains numerous free radicals and pro-oxidant compounds that can overwhelm endogenous antioxidant defenses, leading to lipid peroxidation, membrane damage, and leakage of intracellular enzymes into the bloodstream. The increase in AST and ALT levels observed in the smoke-exposed group in this study therefore reflects compromised hepatocyte membrane permeability and structural damage (Tian et al., 2024).

Similar elevations in hepatic marker enzymes following cigarette smoke exposure have been reported in earlier studies using rodent models. For instance, Ramesh et al. demonstrated that chronic cigarette smoke exposure significantly increased AST and ALT levels, along with markers of lipid peroxidation, confirming the role of oxidative stress in liver injury. These findings support the pathological basis of the present study, where untreated smoke-exposed rats exhibited pronounced hepatic dysfunction (El-Zayadi, 2006; Contreras-Zentella Hernández-Muñoz, 2016). Administration of aqueous extract of *Ocimum sanctum* (Tulsi) in the present investigation resulted in a marked reduction in serum AST and ALT levels in cigarette smoke-exposed rats. This suggests a protective or restorative effect of Tulsi on liver function. The reduction in enzyme levels indicates stabilization of hepatocellular membranes and decreased leakage of enzymes, implying attenuation of liver injury. Such hepatoprotective effects of Tulsi have been widely

documented in various experimental models of liver damage. The hepatoprotective activity of Tulsi is largely attributed to its rich phytochemical composition, including flavonoids, phenolic compounds, eugenol, ursolic acid, and rosmarinic acid (Pandey and Madhuri, 2013). These bioactive constituents possess strong antioxidant properties that neutralize free radicals and reduce oxidative stress. Studies have shown that Tulsi extracts significantly decrease elevated AST and ALT levels in toxin-induced liver injury models, thereby restoring normal hepatic function. In another study, Tulsi extract demonstrated a significant reduction in serum transaminases and lipid peroxidation markers while enhancing antioxidant enzyme activity, further supporting its role as a hepatoprotective agent (Shukla et al., 2012).

The mechanism underlying the protective effect observed in this study may involve multiple pathways. First, Tulsi's antioxidant activity helps in scavenging ROS generated by cigarette smoke, thereby preventing lipid peroxidation of cellular membranes. Second, it enhances endogenous antioxidant defense systems such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), which play a crucial role in detoxifying reactive intermediates. Third, Tulsi may exert anti-inflammatory effects by modulating inflammatory cytokines and reducing tissue inflammation, which is often associated with oxidative damage (Tatiya *et al.,* 2012). Further support for these mechanisms is provided by recent studies demonstrating that *Ocimum sanctum* extract significantly improves antioxidant status and reduces biochemical markers of liver injury in experimental models. For example, Kamel et al. reported that Tulsi extract effectively lowered elevated AST and ALT levels in galactosamine-induced hepatotoxicity while improving histological architecture of the liver. This aligns closely with the findings of the present study, suggesting that Tulsi's hepatoprotective effects are consistent across different types of hepatic insults, including chemical toxins and environmental pollutants such as cigarette smoke (Li *et al.,* 2015).

Another important observation in this study is that rats treated with Tulsi alone did not show any significant alteration in liver enzyme levels compared to the control group. This indicates that the aqueous extract is non-toxic at the administered dose and does not adversely affect normal liver function. Such findings are crucial in establishing the safety profile of Tulsi for potential therapeutic use (Lahon and Das, 2011). The use of aqueous extract in this study is also noteworthy, as it reflects traditional modes of preparation and consumption. Aqueous extracts primarily contain hydrophilic compounds, which are often responsible for antioxidant activity. Previous studies have confirmed that aqueous extracts of Tulsi possess significant biological activity, including lipid-lowering and antioxidative effects, without causing toxicity. Therefore, the observed hepatoprotective effect in this study may be attributed to these water-soluble bioactive compounds (Kamel *et al.,* 2023; Gumral *et al.,* 2021).

The findings of the present study clearly indicate that cigarette smoke exposure induces significant hepatic damage, as evidenced by elevated AST and ALT levels. Treatment with aqueous extract of *Ocimum sanctum* effectively mitigates this damage, likely through its antioxidant and anti-inflammatory properties. These results are in agreement with previous studies and highlight the potential of Tulsi as a natural hepatoprotective agent. Further research focusing on molecular mechanisms, histopathological evaluation, and clinical validation is warranted to fully establish its therapeutic potential.

REFERENCES

1. Ahmad, A., Rasheed, N., Chand, K., Maurya, R., Banu, N., & Palit, G. (2012). Restraint stress-induced oxidative changes in rats and their prevention by *Ocimum sanctum*. *Indian Journal of Medical Research, 135*, 548–554.
2. Bhattacharyya, P., & Bishayee, A. (2013). *Ocimum sanctum* Linn. (Tulsi): An ethnomedicinal plant for the prevention and treatment of cancer. *Anticancer Drugs, 24*(7), 659–666.
3. Contreras-Zentella, M. L., & Hernández-Muñoz, R. (2016). Is liver enzyme release really associated with cell necrosis induced by oxidant stress? *Oxidative Medicine and Cellular Longevity, 2016*, Article 3529149.

4. El-Zayadi, A. R. (2006). Heavy smoking and liver. *World Journal of Gastroenterology, 12*(38), 6098–6101.
5. Fisher, R. A., & Yates, F. (1963). *Statistical tables for biological, agricultural and medical research* (6th ed.). Hing Yip Printing Co.
6. Gumral, N., Aslankoc, R., Senol, N., & Cankara, F. N. (2021). Protective effect of alpha-lipoic acid against liver damage induced by cigarette smoke: An in vivo study. *Saudi Journal of Medicine & Medical Sciences, 9*(2), 145–151. https://doi.org/10.4103/sjmms.sjmms_387_20
7. Kamel, F. O., Karim, S., Bafail, D. A. O., Aldawsari, H. M., Kotta, S., & Ilyas, U. K. (2023). Hepatoprotective effects of bioactive compounds from *Ocimum sanctum* Linn against galactosamine-induced hepatotoxicity in rats. *Frontiers in Pharmacology, 14*, Article 1213052. https://doi.org/10.3389/fphar.2023.1213052
8. Lahon, K., & Das, S. (2011). Hepatoprotective activity of *Ocimum sanctum* extract against paracetamol-induced liver damage in rats. *Pharmacognosy Research, 3*(1), 13–17.
9. Li, S., Tan, H. Y., Wang, N., Zhang, Z. J., Lao, L., Wong, C. W., & Feng, Y. (2015). The role of oxidative stress and antioxidants in liver diseases. *International Journal of Molecular Sciences, 16*(11), 26087–26124.
10. Pandey, G., & Madhuri, S. (2013). Pharmacological activities of *Ocimum sanctum* (Tulsi): A review. *International Journal of Pharmaceutical Sciences Review and Research, 5*(1), 61–66.
11. Reitman, S., & Frankel, S. (1957). A colorimetric method for the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminases. *American Journal of Clinical Pathology, 28*(1), 56–63. https://doi.org/10.1093/ajcp/28.1.56
12. Shukla, V., et al. (2012). Hepatoprotective and antioxidant activities of *Ocimum sanctum* extracts in rats. *Asian Pacific Journal of Tropical Medicine, 5*(11), 879–884.
13. Tatiya, A. U., Surana, S. J., & Sutar, M. P. (2012). Hepatoprotective effect of polyherbal formulation against various hepatotoxic agents in rats. *International Journal of Green Pharmacy, 4*(1), 50–56.
14. Tian, Y., Wang, H., Han, S., et al. (2024). Liver toxicity in rats after subchronic exposure to heated tobacco product aerosol and cigarette smoke. *Toxicology Research, 13*(1), Article tfae002. https://doi.org/10.1093/toxres/tfae002