



Effect of *Tinospora cordifolia* (Giloy) Extract on Red Blood Cell Count and Hemoglobin Concentration in Albino Rats Exposed to Cigarette Smoke

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Abstract

Giloy, or *Tinospora cordifolia*, is a revered herb in Ayurvedic medicine, known for its wide-ranging health benefits. Among its many therapeutic properties, giloy has notable ameliorative effects on hematology, enhancing various aspects of blood health. Firstly, giloy exhibits strong immunomodulatory properties, significantly boosting the immune system. It stimulates the production and activity of white blood cells, essential for combating infections and maintaining immune homeostasis. This makes giloy particularly useful in enhancing the body's natural defense mechanisms. Additionally, giloy is rich in antioxidants, which play a crucial role in protecting blood cells from oxidative stress. These antioxidants help maintain the integrity of red blood cells, preventing hemolysis and ensuring efficient oxygen transport throughout the body. This antioxidant action also supports overall cellular health, reducing the risk of chronic diseases linked to oxidative damage. Giloy's anti-inflammatory properties further contribute to its hematological benefits. By reducing inflammation in the blood vessels, giloy helps improve blood flow and vascular health. This can mitigate the risk of conditions such as atherosclerosis and hypertension. Moreover, giloy has been found to stimulate hematopoiesis, the formation of new blood cells in the bone marrow. This property is particularly beneficial for individuals with anemia or those recovering from conditions that deplete blood cells. Enhanced hematopoiesis ensures a steady supply of healthy blood cells, crucial for overall vitality and disease resistance. In summary, giloy's multifaceted effects on hematology include immune enhancement, antioxidant protection, anti-inflammatory action, and stimulation of blood cell production, making it a valuable natural remedy for maintaining optimal blood health. The present study is conducted to assess the ameliorative effect of giloy extract (aqueous) various hematological parameters in albino rats after toxic exposure to cigarette smoke.

Keywords: Giloy (*Tinospora cordifolia*) extract, Cigarette smoke, Albino rat, RBC, Hemoglobin concentration

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Introduction

Cigarette smoking is one of the most pervasive and preventable causes of morbidity and mortality worldwide. According to the World Health Organization (WHO), tobacco use accounts for over 8 million deaths annually, of which more than 7 million are due to direct tobacco use and around 1.2 million are the result of nonsmokers being exposed to secondhand smoke. Cigarette smoke contains a complex mixture of over 7,000 chemicals, including toxic gases, oxidants, reactive free radicals, and carcinogens such as polycyclic aromatic hydrocarbons, nitrosamines, heavy metals, and nicotine (Ferdous, 2024). Prolonged inhalation of these toxicants affects almost every organ system of the body and is strongly associated with cardiovascular diseases, chronic obstructive pulmonary disease, cancers, and hematological disturbances (Mathur *et al.* 2024). The hematopoietic system is particularly vulnerable to the toxic impact of cigarette smoke because of its constant turnover and dependence on oxygen transport and cellular integrity.

Among the hematological parameters, red blood cell (RBC) count and hemoglobin (Hb) concentration are crucial indices reflecting the oxygen-carrying capacity of blood. Cigarette smoke disrupts these parameters through multiple mechanisms. Carbon monoxide, a major constituent of smoke, binds to hemoglobin with an affinity 200–250 times greater than oxygen, thereby reducing oxygen delivery to tissues and producing tissue hypoxia. Nicotine, tar, and free radicals accelerate oxidative stress, impair erythropoiesis, and damage erythrocyte membranes. Chronic smoking may lead to altered hematological homeostasis, manifesting as either anemia due to hemolysis and impaired erythropoietin activity or polycythemia due to compensatory erythrocytosis induced by chronic hypoxia. Therefore, monitoring RBC count and hemoglobin concentration in experimental models of cigarette smoke exposure provides important insights into the hematotoxic effects of smoking (Nargish *et al.* 2022).

In recent years, increasing attention has been directed towards the use of medicinal plants and herbal remedies for the prevention and amelioration of smoking-induced pathophysiological changes. Among these, *Tinospora cordifolia*, commonly known as Guduchi, Giloy, or Amrita, has gained considerable recognition for its wide spectrum of pharmacological activities. Belonging to the family Menispermaceae, *Tinospora cordifolia* is a large deciduous climbing shrub indigenous to tropical regions of India, Myanmar, and Sri Lanka. In Ayurveda, it is revered as a "Rasayana," a rejuvenating herb that promotes longevity, enhances immunity, and improves overall vitality (Chi *et al.* 2016). Its stem, roots, and leaves have been traditionally used to treat fevers, jaundice, diabetes, anemia, arthritis, and various inflammatory conditions. Modern pharmacological investigations have

validated many of these traditional claims by demonstrating antioxidant, immunomodulatory, anti-inflammatory, hepatoprotective, and hematinic properties of the plant extract (Balkrishna *et al.* 2023).

The bioactive constituents of *Tinospora cordifolia* include alkaloids (berberine, magnoflorine), glycosides, steroids, diterpenoid lactones, phenolics, and polysaccharides. These compounds collectively contribute to its medicinal potential. Of particular relevance to cigarette smoke-induced hematological alterations are its antioxidant and hematopoietic activities. The extract scavenges free radicals, enhances endogenous antioxidant enzymes such as superoxide dismutase and catalase, and reduces lipid peroxidation, thereby protecting cellular membranes including those of erythrocytes. Furthermore, several studies have suggested that *Tinospora cordifolia* stimulates erythropoiesis and improves hemoglobin synthesis, which may help to counteract the hypoxia and anemia associated with cigarette smoke exposure.

Animal models, particularly albino rats, have been widely used to investigate the toxicological impact of cigarette smoke and the protective role of medicinal plants. Rats share many physiological similarities with humans in terms of hematopoiesis, erythrocyte morphology, and response to toxins. Controlled experimental exposure to cigarette smoke over defined durations allows researchers to mimic chronic smoking conditions and assess progressive changes in hematological parameters. Evaluating the effect of *Tinospora cordifolia* extract in such models not only helps establish its protective role but also provides mechanistic insights into its mode of action against smoking-induced hematological damage (Mathur *et al.* 2024).

The present research focuses specifically on the effect of *Tinospora cordifolia* extract on red blood cell count and hemoglobin concentration in albino rats exposed to cigarette smoke for different durations—15, 30, 45, and 60 days. These time intervals are chosen to represent progressive exposure from short-term to chronic conditions. Cigarette smoke exposure is expected to disrupt hematological parameters gradually, with increasing oxidative stress and hypoxic insult over time. By administering *Tinospora cordifolia* extract concurrently, the study aims to determine whether its protective effects are evident at early stages or become more pronounced with prolonged exposure. Such information is critical for understanding the potential therapeutic window and efficacy of the extract in mitigating smoking-induced hematological changes.

Materials and Methods

Experimentation-While several studies have investigated the toxic effects of cigarette smoke on hematological parameters, and others have explored the hematinic potential of *Tinospora cordifolia*, there is limited scientific

data evaluating the interaction of these two aspects. Specifically, the ability of *Tinospora cordifolia* to restore RBC count and hemoglobin concentration in the context of progressive cigarette smoke exposure has not been comprehensively studied. This research addresses this gap by employing a controlled experimental design using albino rats. By dividing animals into different groups exposed to cigarette smoke for 15, 30, 45, and 60 days with and without *Tinospora cordifolia* supplementation this study provides a time-course analysis of both the damage induced by smoking and the protective efficacy of the herbal extract. Such an approach allows us to evaluate not only the magnitude of hematological disruption but also the temporal dynamics of recovery or protection offered by the extract. The findings are expected to contribute valuable evidence towards validating *Tinospora cordifolia* as a potential adjunct therapy for smoking-induced hematological disorders.

Experimental animal-The wistar albino rat, *Rattus norvegicus* (Berkenhout) of both the sexes have been selected for the present study. The colony of wistar albino rats was bred at the animal house of Zoology Department, Dr. B.R. Ambedkar University, Agra. 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±50C, 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 920 mg 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 (NCI, 1980).

Experimental plant extract-Stem extract of giloy (*Tinospora cordifolia*) has been used as an antioxidant in the present study. The dose of giloy stem extract will be 2ml/kgbw. The *Tinospora cordifolia* herb stem will be washed, remove the outer husks and cut the stem into smaller pieces of 2-3 inches length and dried under shade. Finally powder will be prepared by electric grinding of shade dried material. This *Tinospora cordifolia* powder will be mixed with deionized distilled water to prepare the solution for experiment and will be kept at 40C in sealed plastic packets until experiment to avoid the microbial contamination.

Procedure and protocol-The rats of control set and experimental sets were sacrificed after 15, 30, 45 and 60 days for haematological study. The double oxalate vials were used for various haematological 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 haemoglobin concentration was estimated by the standard Sahli's method (Wintrobe *et al.*, 1981). Total RBC count were estimated with the help of improved Standard Neubauer Haematocytometer (Dacie and Lewis, 1969). The results are subjected to statistical analysis through Ky plot software.

Results and Discussion

The results show decrease in total RBC count and hemoglobin concentration after cigarette smoke exposure. The toxic effect ameliorated by *Tinospora cordifolia* extract as shown in Table 1-2 and Figure 1-2.

Table-1 and Fig. 1: The values of Total RBC count (x10¹²/L) after cigarette smoke exposure and supplementation with *Tinospora cordifolia* in albino rats

Experimental days	Ambient air (Mean±S.Em)	Cigarette smoke (Mean±S.Em)	Cigarette smoke+ <i>Tinospora cordifolia</i> (Mean±S.Em)	Significance level (t test for mean)
15 days	7.32±0.35	6.32±0.36	7.31±0.17	P<0.01
30 days	7.30±0.30	6.15±0.35	7.30±0.20	P<0.01
45 days	7.10±0.33	6.10±0.32	7.35±0.25	P<0.01
60 days	7.25±0.60	5.90±0.34	7.40±0.29	P<0.01

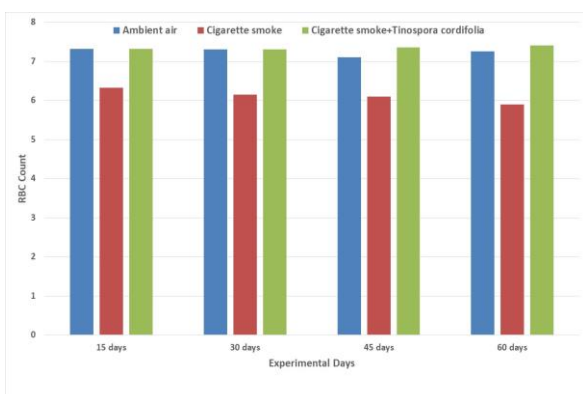
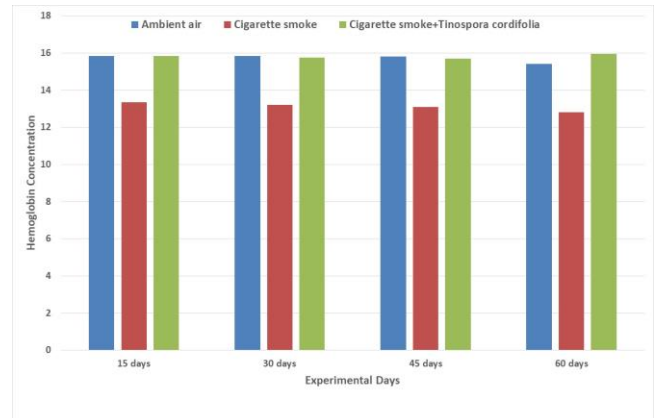


Table-2 and Fig-2: The values of Hemoglobin concentration (g/dl) after cigarette smoke exposure and supplementation with *Tinospora cordifolia* in albino rats

Experimental days	Ambient air (Mean±S.Em)	Cigarette smoke (Mean±S.Em)	Cigarette smoke+ <i>Tinospora cordifolia</i> (Mean±S.Em)	Significance level (t test for mean)
15 days	15.83±0.22	13.36±0.48	15.85±0.16	P<0.05
30 days	15.85±0.30	13.20±0.40	15.75±0.25	P<0.01
45 days	15.80±0.32	13.10±0.45	15.70±0.33	P<0.01
60 days	15.41±0.67	12.8±0.20	15.95±0.10	P<0.001



A significant reduction in total RBC count and haemoglobin concentration is correlated with the toxic effects of smoke on haemopoetic system. Cigarette smoke contains a toxic gas, carbon monoxide which binds to haemoglobin in red blood cell and interfere with body's ability to transport and utilized oxygen. The carbon monoxide in tobacco smoke exerts. Its negative effect by reducing oxygen carry capacity and leads to hypoxic anaemia in albino rats (Mathur *et al.* 2024; Khudhur *et al.* 2025).

The hematological system is among the first to be influenced by inhaled toxicants because blood serves as a medium for the transport of absorbed substances throughout the body. Cigarette smoke introduces thousands of xenobiotics into circulation. Carbon monoxide competes with oxygen for binding to hemoglobin, resulting in the formation of carboxyhemoglobin, which reduces oxygen availability (Dasrul and Amalia, 2020; (Ferdous, 2024). Nicotine stimulates catecholamine release, increases heart rate, and causes vasoconstriction, indirectly influencing oxygen delivery. Free radicals from cigarette smoke accelerate oxidative stress, leading to peroxidative damage of erythrocyte membranes, increased fragility, and premature hemolysis (Nargish *et al.* 2022). In addition, smoking interferes with iron metabolism and erythropoietin production, further compromising erythropoiesis. Epidemiological studies in humans have demonstrated significant variations in hematological indices among smokers compared to nonsmokers, including altered hemoglobin concentration, hematocrit, mean corpuscular volume, and total RBC count (Sharma and Pandey, 2010; Padma *et al.* 2016).

Traditional Ayurvedic literature describes *Tinospora cordifolia* as a potent blood purifier and health restorative herb. Its Sanskrit names—"Guduchi" (one that protects the body) and "Amrita" (nectar of immortality)—highlight its therapeutic reputation. Modern research supports its role in enhancing hematopoietic function (Priya *et al.* 2017). Studies have shown that administration of *Tinospora cordifolia* extract increases RBC count, hemoglobin concentration, and total leukocyte count in experimental animals (Chi *et al.* 2016; Mathur *et al.* 2024). Its polysaccharides and alkaloids are believed to stimulate bone marrow activity and promote erythropoietin-mediated erythropoiesis. In addition, the extract's antioxidant properties protect erythrocytes from oxidative lysis, thus prolonging their lifespan (Ghareeb, (2023).

Furthermore, *Tinospora cordifolia* has demonstrated efficacy against anemia of various etiologies, including iron-deficiency anemia, hemolytic anemia, and drug-induced hematotoxicity. By improving iron utilization, enhancing oxygen transport, and boosting antioxidant defense, the plant extract emerges as a promising natural remedy for hematological disturbances. Given these properties, it is logical to hypothesize that *Tinospora cordifolia* may counteract the hematotoxic effects of cigarette smoke exposure (Chi *et al.* 2016; (Balkrishna *et al.* 2023).

References

- The present investigation holds significance at multiple levels. Firstly, it provides experimental evidence on the progression of cigarette smoke-induced hematological damage in a controlled animal model, offering insights into the pathophysiology of smoking-related hematological disorders. Secondly, it scientifically validates the traditional claims regarding the hematinic properties of *Tinospora cordifolia* and expands its potential therapeutic applications. Thirdly, by demonstrating the protective effects of a natural, cost-effective, and widely available herbal extract, the study contributes towards the development of safer interventions for populations vulnerable to smoking-related health risks. The findings may also inspire further clinical research to evaluate the applicability of *Tinospora cordifolia* in human smokers or individuals suffering from smoking-induced anemia.
- Cigarette smoke exerts deleterious effects on hematological health by disrupting RBC count and hemoglobin concentration through mechanisms involving hypoxia, oxidative stress, and impaired erythropoiesis. *Tinospora cordifolia*, a versatile medicinal plant, possesses antioxidant and hematopoietic properties that may counteract these effects. Investigating its impact on hematological parameters in albino rats exposed to cigarette smoke across different durations offers a comprehensive understanding of its protective potential. The study is thus positioned at the intersection of toxicology, hematology, and herbal medicine, aiming to contribute novel insights into the mitigation of smoking-induced health hazards.
- Balkrishna, A., Joshi, K., Sahu, R., & Varadwaj, P. (2023). Pharmacological overview of *Tinospora cordifolia*: implications for modern therapeutics. *Frontiers in Pharmacology*, 14, 1095083. doi:10.3389/fphar.2023.1095083.
- Chi, S., She, G., Han, D., Wang, W., Liu, Z., Liu, B. (2016). Genus *Tinospora*: ethnopharmacology, phytochemistry, and pharmacology. *Evidence-Based Complementary and Alternative Medicine*, Article ID 9232593 (1–32). doi:10.1155/2016/9232593.
- Dacie, J.V. and Lewis, S.M. 1969. *Practical haematology* (5th ed.) J. and A. Charch Hill, Livingstone, Edinburgh.
- Dasrul D., Amalia S. (2020) Effect of seed extracts on erythrocyte, hemoglobin and hematocrit in rats exposed to cigarette smoke. *Jurnal Kedokteran Hewan (Indonesian Journal of Veterinary Sciences)*.:17(2):55-59.
- Ferdous, Z., (2024). Exposure to water-pipe smoke disrupts erythrocyte morphology and function. *Biology*, 13(6), 453. doi:10.3390/biology13060453.
- Fisher, R.A. and Yates, F. 1963. *Statistical tables for biological agricultural and medical research* (6th ed.) Hing Yip Printing Co. Hong Kong. 2146pp.
- Ghareeb, O. A. (2023). Hematotoxicity induced by copper oxide nanoparticles and the attenuating role of giloy (*Tinospora cordifolia*) in vivo. *Cureus*, 15(10), e46577. doi:10.7759/cureus.46577.
- Khudhur, Z. O., Smail, S. W., Awla, H. K., Ahmed, G. B., Omar, Y. O., Khdir, Y., & Janson, C. (2025). The effects of heavy smoking on oxidative stress, inflammatory biomarkers, vascular dysfunction, and hematological indices. *Scientific Reports*, 15, Article 18251. <https://doi.org/10.1038/s41598-025-03075-8>
- Mathur, K. T., Rawat, G., & Maheshwari, G. (2024). Effect of antioxidant activity of *Tinospora cordifolia* on the hemato-biochemical profile in Wistar rats exposed to passive smoking. *International Journal of Scientific Research in Modern Science and Technology*, 3(3), 32-53. <https://doi.org/10.59828/ijrmst.v3i3.194>
- Mathur, K. T., Rawat, G., & Maheshwari, G. (2024). The Effect of *Tinospora cordifolia* Leaf and Stem Aqueous Extracts on Hemato-biochemical Changes. *Toxicology International*, 31(3), 355-364. <https://doi.org/10.4103/toxi-toxi-4-24-39>
- Nargish S., Kabir M.H., Akhter K.A. (2022) Effect of Smoking on Red Blood Cell Count, Hemoglobin, Hematocrit and Red Cell Indices in Adult Male Smokers. *Eastern Medical College Journal*.:7(1):1-5.
- Padma, V. V., Baskaran, R., Divya, S., Priya, L. B., & Saranya, S. (2016). Modulatory effect of *Tinospora cordifolia* extract on cadmium-induced oxidative stress in Wistar rats. *Integrative Medicine Research*, 5(1), 48-55. <https://doi.org/10.1016/j.imr.2016.01.005>
- Priya, L. B., Baskaran, R., Elangovan, P., Dhivya, V., Huang, C.-Y., Padma, V. V. (2017). *Tinospora cordifolia* extract attenuates cadmium-induced biochemical and histological alterations in the heart of male Wistar rats. *Biomedicine & Pharmacotherapy*, 89, 280–287. doi:10.1016/j.biopha.2016.12.098.
- Sharma, V., & Pandey, D. (2010). Beneficial effects of *Tinospora cordifolia* on blood profiles in male mice exposed to lead. *Toxicology International*, 17(1), 8–11. doi:10.4103/0971-6580.68341.
- Wintrobe, M.M., Lee, G.R., Boggs, D.R., Bithell, T.C., Foerster, J., Athens, J.W. and Lukens, J.N. 1981. *Clinical haematology* (8th ed.). Lea and Febiger, Philadelphia 1882 pp.