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Review Article

The Protective Effect of Green Tea against Penicillin-Induced Liver and Kidney Tissue Damage in Male Rats

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Abstract: ***Background*:** Abundant contains polyphenolic components, green tea (GT) offers a wide range of proactive preventative and therapeutic benefits for the modulation of a number of disorders, including acute liver and kidney damage. This study postulated that by lowering inflammatory biomarker levels and exhibiting antioxidant qualities, GT mitigates penicillin-induced renal and the damage to the liver. ***Aims*:** The purpose of this study was to examine how penicillin affects kidney functions and to ascertain whether GT extract reduces or eliminates the negative effects of penicillin in male rats. ***Conclusion***: By increasing the activity of antioxidant enzymes, GT lessened the effects of penicillin and reduced oxidative stress and inflammation. These results point to a possible complementary role for GT extract in reducing liver tissue damage and nephrotoxicity caused by penicillin.

Keywords: Green tea (GT), Penicillin, Liver, Kidney Tissue, Male Rats, Antioxidant Properties.

INTRODUCTION

Green tea, or Camellia sinensis, is a semi-tropical shrub belonging to the Theaceae family (Shareef *et al*., 2022). In Europe and North America, green tea is used as a herbal cure and is a popular beverage in East Asia (Thasleema, 2013). Green tea has been shown to have anti-inflammatory, anti-oxidative, anti-mutagenic, and anti-carcinogenic qualities. It also helps avoid heart problems, protects against UV radiation from the sun, regulates body weight, and guards against infection and intestinal dysbiosis (Chu *et al*., 2022). A growing number of clinical diseases are being treated with herbal medications made from plant extracts. The protective benefits of natural antioxidants are receiving more attention than drug-induced toxicities, particularly when free radical production is involved (Chaachouay & Zidane, 2024).

The outcome of treatment with antibiotics is largely influenced by the best timing and dosage, as well as the mode of administration and appropriate use (Kiss *et al*., 2019). One of the most serious risks to global public health is bacterial resistance, which is the primary cause of nosocomial infections and is fostered by misuse and incorrect administration (including utilizing inappropriate doses) of antimicrobial treatments (WHO, 2018). As a result, the World Health Organization (WHO) consistently works to educate patients and medical professionals on the appropriate use of antibiotics. Several facets of antibiotic combinations have been thoroughly investigated (Bushra *et al*., 2011). It is generally recognized that co-administration from multiple antibiotics with milk-based goods should be prevented because milk's bivalent ions, such as calcium and magnesium, form complexes using these medications, reducing their absorption (Leibovitch *et al*., 2004). There isn't many research on this topic, despite the fact that various dietary and herbal interactions with medicines have also been reported. It is currently unknown if most medicinal plants affect the pharmacokinetics of antibiotics (Adamczyk *et al*., 2017). According to recent research, green tea provides some therapeutic and preventative benefits for liver illness. According to studies, green tea can aid in controlling lipid metabolism, which lowers the buildup of fats in the liver. Additionally, research has demonstrated that green tea has a high concentration of polyphenolic antioxidants, which may provide protection against cancerous changes (Leibovitch *et al*., 2004). However, the majority of the evidence supporting green tea's health benefits has come from animal studies. Nonetheless, the possibility of possible interactions is suggested by plausible theoretical considerations. Certain parts of

medicinal plants may reduce the absorption of antibiotics, hence interfering with their bioavailability. Fibers and polyphenols, which are most usually found in routinely used plants, are the two most significant families of chemicals that may potentially impact the pharmacokinetics of antibiotics (Duda-Chodak & Tarko, 2023).

The core polyphenol in green tea, epigallocatechin gallate (EGCG), can protect against drug-induced liver and kidney injury triggered by multiple harmful substances including antibiotics. It maintains tissue integrity through three core processes: antioxidant action, anti-inflammation, and anti-apoptosis. Among these mechanisms, its antioxidant effect increases the activities of catalase and superoxide dismutase (SOD) to reduce lipid peroxidation and reactive oxygen species (ROS) (Winiarska-Mieczan *et al*., 2024), while its anti-inflammatory effect downregulates pro-inflammatory molecules including nuclear factor κB (NF-κB), tumor necrosis factor α (TNF-α), and interleukin 6 (IL-6) (Küçükgünay *et al*., 2025). Anti-apoptotic Properties: EGCG lessens apoptosis, or cell death, in kidney and liver tissues (Mokra *et al*., 2022). As the main metabolic organ, the liver is vulnerable to a variety of stimuli that might damage liver cells and result in various liver disorders (Hassani, 2022). Green tea extract (GTE) has been demonstrated to lower increased ALT and AST levels, indicators of liver injury, and to have liver-protective actions that decreased hepatotoxicity. Fibrosis Mitigation: By reducing collagen deposition in liver cells, GTE stops the onset of hepatic fibrosis. Damage reversal: It has been demonstrated to improve liver function and promote healing following injury (Zhou *et al*., 2025). Nephrotoxicity reduction and kidney protection. Research has shown that GTE reduces renal impairment brought on by drugs, such as gentamicin and contrast media. Blood urea nitrogen (BUN) and serum creatinine, two important markers of kidney impairment, can be prevented by drinking green tea (Kumar *et al*., 2026). Tissue protection: It lessens tubular atrophy and necrosis while maintaining the integrity of the renal brush border membrane. It is crucial to remember that very high amounts of green tea extract may cause liver damage, thus modest consumption is advised even though studies, mostly in animal models, demonstrate high efficacy in reducing drug-induced organ toxicity (Rahman *et al*., 2025). To evaluate organic green tea's hepatoprotective qualities in a Chinese liver cell line. Green tea has been shown to possess anti-inflammatory, anti-oxidative, anti-mutagenic, and anti-carcinogenic qualities. It also helps avoid heart problems, protects against UV radiation from the sun, regulates body weight, and guards against intestinal dysbiosis and infection (Shareef *et al*., 2022). The hepatoprotective potential of green tea extract against CCl4-induced toxicity was assessed. This is accomplished by measuring the ALT and AST levels that are in vitro and using the MTT assay. When used with penicillin and other β-lactam antibiotics, green tea mostly exhibits a synergistic effect, which can improve their ability to combat bacteria. But it might also affect how these medications are absorbed by the body (Shareef *et al*., 2022). Epigallocatechin gallate (EGCG), the primary active ingredient in green tea, increases antibiotic activity in a number of ways: Restoring Sensitivity: By preventing the synthesis of enzymes like β-lactamase that bacteria utilize to break down the medication, EGCG can reverse antibiotic resistance in superbugs like MRSA and penicillin-resistant Bacillus anthracis (Donga & Chanda, 2022). Weakening Cell Walls: When bacterial cell membranes are damaged, antibiotics can more easily enter and kill the bacteria. The core function of green tea extract is to act as an anti-adherent, which can block bacteria from attaching to host cells. An external study (Hr *et al*., 2022). found that co-administration of green tea reduces the peak plasma concentration of amoxicillin, a penicillin derivative, weakening the drug's overall efficacy. Most studies confirm that green tea and related substances produce synergistic effects; only a subset of studies have observed antagonistic effects tied to specific pathogenic bacterial strains and the presence of biofilms, and in extremely rare cases, it may increase bacterial drug resistance. Study (Park *et al*., 2022) notes that caffeine in green tea can interact with antibiotics such as quinolones, raising the risk of adverse reactions including hand tremors and rapid heartbeat. Study (Rudrapal *et al*., 2022) verifies that the polyphenols in green tea can neutralize free radicals and reduce damage caused by reactive oxygen species (ROS). The authors judge that long-term intake of green tea catechins carries important value, on the premise that cells are continuously exposed to oxidative stress. Tea polyphenols have been shown to be able to contribute to vitamin E recycling in addition to directly quenching reactive oxygen species (Farhan, 2022). Because they contain other antioxidant components, green tea extracts are more stable than pure epigallocatechin gallate (EGCG), one of the main components of green tea (Gad & Zaghloul, 2013).

CONCLUSION

This study provides more proof that supplementing with green tea protects male rats' liver and kidney tissue against penicillin-induced damage. The liver and renal tissue responses of treated mice were significantly improved by oral administration of green tea extracts. To fully comprehend the underlying molecular mechanism for green tea's impacts on liver and kidney tissue, more research is necessary.

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