



Effect of Aqueous *Chasmanthera dependens* Leaf Extract on Mercury Chloride-Induced Gastric Damage in Adult Wistar Rats

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Abstract

BACKGROUND AND AIM: Mercury, used in industries and consumer products, poses serious health risks through contaminated food, water, occupational hazards, and inhalation. Chronic exposure causes neurotoxicity, nephrotoxicity, immunotoxicity, and gastrointestinal damage. Mercury chloride is particularly harmful to the stomach, causing inflammation and oxidative stress. Traditional medicinal plants, like *Chasmanthera dependens*, contain bioactive compounds with antioxidant and anti-inflammatory properties. Thus, the study was aimed at evaluating the effects of aqueous leaf extract of *Chasmanthera dependens* on mercury chloride-induced gastric damage in Wistar rats.

METHODOLOGY: Thirty (30) adult Wistar rats were randomly assigned into six groups (A-F). Group A served as control; Group B - 10 mg/kg of Mercury chloride only; Group C - 200 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract and 10 mg/kg of Mercury chloride; Group D - 400 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract and 10 mg/kg of Mercury chloride; Group E - 800 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract and 10 mg/kg of Mercury chloride; Group F - 800 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract.

RESULTS AND CONCLUSION: Results showed that mercury chloride increased lipid peroxidation and reduced antioxidant enzyme activity, causing significant gastric damage. Pre-treatment with *Chasmanthera dependens* improved the antioxidant defense system, reducing MDA levels and increasing SOD, CAT, and GPx activity. Histological findings showed reduced tissue erosion, with higher doses of *Chasmanthera dependens* offering better protection against mercury chloride-induced gastric damage.

Keywords:

Chasmanthera dependens, Gastric damage, Mercury chloride, Wistar rat.

INTRODUCTION

Mercury, a ubiquitous heavy metal, is extensively utilised in industrial applications, artisanal mining, and various consumer products. Despite its utility, mercury exposure poses serious health threats worldwide (Ha et al., 2017; Vianna et al., 2019). The contamination of water bodies with mercury has escalated into a global concern. Exposure routes include the ingestion of contaminated fish and shellfish, occupational hazards, and inhalation of mercury vapours, all of which can result in severe health consequences (Rice et al., 2014; Ha et al., 2017; Vianna et al., 2019). Chronic exposure to mercury is particularly

hazardous, leading to long-term effects such as neurotoxicity (Carocci et al., 2014; Cariccio et al., 2019), nephrotoxicity (Orr and Bridges, 2017), and immunotoxicity (Maqbool et al., 2017). Among the many detrimental effects of mercury toxicity, its impact on the gastrointestinal system, particularly the stomach, is crucial yet often underreported. Mercury chloride, a highly toxic form of mercury, has been linked to significant gastrointestinal distress, including nausea, vomiting, abdominal pain, and severe inflammation (Ezeuko et al., 2007; Zhao et al., 2022). In the stomach, mercury chloride disrupts the mucosal barrier, induces oxidative stress, and triggers inflammatory

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responses (Rodríguez-Viso et al., 2022; Rodríguez-Viso et al., 2023). These adverse effects undermine the stomach's essential functions in digestion and pathogen defense, potentially leading to broader systemic health issues. Given the severe implications of mercury chloride exposure, there is a growing interest in finding effective treatments that can mitigate its harmful effects. One area of research that has shown promise is the use of medicinal plants, which have been utilised for centuries in traditional medicine to treat various ailments. Throughout history, plants have played a pivotal role in traditional medicine due to their therapeutic properties, which are often attributed to bioactive compounds with antioxidant, anti-inflammatory, and detoxifying effects. Medicinal plants offer a natural, accessible, and potentially safer alternative to synthetic drugs, which can have significant side effects.

Chasmanthera dependens, indigenous to various regions of Africa, is recognised for its medicinal properties in traditional African medicine and used as a remedy for multiple maladies (Evbomwan et al., 2023). *Chasmanthera dependens* belongs to the Menispermaceae family and is a woody climber widely distributed across tropical Africa (Madueke et al., 2020; Enebeaku et al., 2021), including Nigeria. *Chasmanthera dependens* has slender, flexible stems that allow it to twine and climb several meters (Quadri and Yakubu, 2017). Its ovate to elliptical, medium-sized leaves are glossy with a darker upper surface and lighter underside, arranged alternately (Quadri and Yakubu, 2017; Aina et al., 2019). The plant produces small, yellowish-green flowers in clusters, which mature into drupes that turn green to black. It has woody, branching roots crucial for soil stabilisation and nutrient absorption (Quadri and Yakubu, 2017; Madueke et al., 2020; Enebeaku et al., 2021). *Chasmanthera dependens* is rich in bioactive compounds such as flavonoids, alkaloids, and glycosides, contributing to its therapeutic effects. Recent studies have begun to validate its use in healing gastric ulcers, particularly those induced by nonsteroidal anti-inflammatory drugs (NSAIDs) like indomethacin. While the specific effects of *Chasmanthera dependens* on mercury chloride-induced stomach damage has not been extensively studied, the plant's demonstrated efficacy in treating indomethacin-induced gastric ulcers suggests its potential protective and healing properties that could be beneficial in mitigating mercury chloride-induced gastric damage. Thus, this study was aimed at evaluating the effect of aqueous leaf extract of *Chasmanthera dependens* against mercury chloride-induced gastric damage in Wistar rats.

MATERIALS AND METHODS

Plant Extract: Fresh *Chasmanthera dependens* leaves were collected and thoroughly washed to remove dirt and impurities. After which, they were air dried and ground into fine powder using an electric blender. The ground leaves were then transferred into a beaker and distilled water was added. The mixture was stirred thoroughly, then heated in a

water bath at 60-70°C for 1-2 hours. The mixture was allowed to cool down and then filtered using a cheesecloth to separate the liquid extract from the plant residue. Rotary evaporator was used to reduce the volume by evaporating some water content under reduced pressure and low temperature.

Experimental Design: Thirty (30) adult Wistar rats weighing between 137 g and 234 g were obtained and randomly assigned into six (6) groups of five (5) rats each.

Group A Control (1 ml of distilled water);
 Group B 10 mg/kg of Mercury chloride only (HgCl₂)
 Group C 200 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract (CD1) + 10mg/kg of Mercury chloride (HgCl₂)
 Group D 400 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract (CD2) + 10mg/kg of Mercury chloride (HgCl₂)
 Group E 800 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract (CD3) + 10mg/kg of Mercury chloride (HgCl₂)
 Group F 800 mg/kg body weight of *Chasmanthera dependens* aqueous leaf extract (CD3).

The administration lasted 28 days and was done orally using an orogastric tube. At the end of the treatment period (28 days), the rats were weighed and sacrificed under chloroform anaesthesia. Samples were taken for oxidative stress and histological assessments. Oxidative stress assessment was carried out as previously described; Malondialdehyde (MDA) [Buege and Aust, 1978]; glutathione peroxidase (GPx) [Nyman 1959]; Catalase (CAT) [Cohen et al. 1970]; Superoxide dismutase (SOD) [Misra and Fridovich 1972]. The harvested stomach tissues were processed and routinely stained using hematoxylin and eosin, according to the method previously reported by Drury and Wallington (1980).

RESULTS

Effect of Treatment on Oxidative Stress: There was a significant decrease ($p < 0.05$) in superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) levels and a corresponding significant increase ($p < 0.05$) in malondialdehyde (MDA) concentration in mercury chloride-only treated rats when compared to control. However, there was a significant increase ($p < 0.05$) in SOD, CAT, and GSH levels and a corresponding significant decrease ($p < 0.05$) in MDA concentration in mercury chloride rats pretreated with *Chasmanthera dependens*.

Effect of Treatment on Stomach Histology: Plate 1 shows the stomach histology in the control group with normal histological structure with distinct mucosa pitted lining epithelium, glands, muscularis mucosa, and submucosa. Plate 2 shows the stomach histology of rats treated with mercury chloride (HgCl₂) only. Results showed marked signs of gastric damage, with funnel-shaped mucosal erosion, muscularis

mucosal degeneration, and mural infiltrates of inflammatory cells. The stomach histology of HgCl₂-exposed rats pre-treated with *Chasmanthera dependens* (200, 400 and 800mg/Kg) [Plate 3, 4, and 5] showed funnel-shaped ulcer, mural infiltrates of inflammatory cells, crater-shaped mucosal erosion, funnel-shaped mucosal ulcer. Plate 6 shows the stomach histology of rats given 800mg/kg of *Chasmanthera dependens* only, with mucosa, submucosa and muscularis propria, relatively normal.

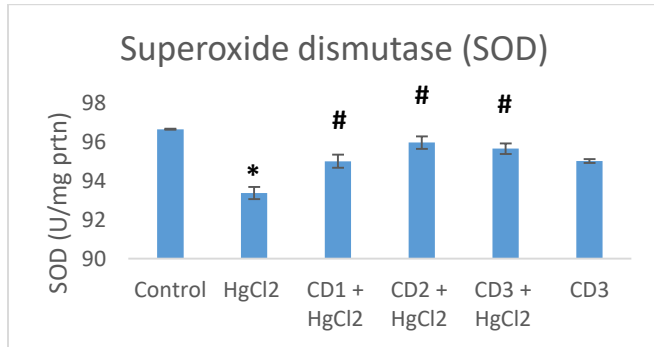


Figure 1: Chart showing Superoxide dismutase (SOD) activity across the experimental groups. Values are given as mean ± SEM. * $p < 0.05$ compared with the control group; # $p < 0.05$ compared with the mercury chloride only group.

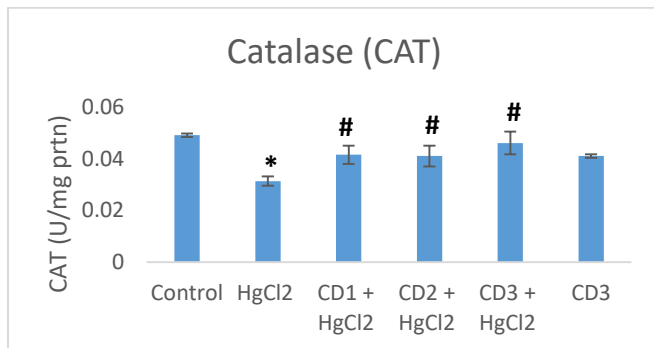


Figure 2: Chart showing Catalase (CAT) levels across the experimental groups. Values are given as mean ± SEM. * $p < 0.05$ compared with the control group; # $p < 0.05$ compared with the mercury chloride only group.

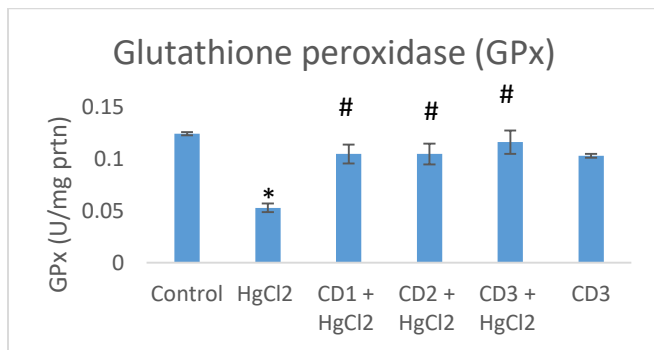


Figure 3: Chart showing Glutathione peroxidase levels across the experimental groups. Values are given as mean ± SEM. * $p < 0.05$ compared with the control group; # $p < 0.05$ compared with the mercury chloride only group.

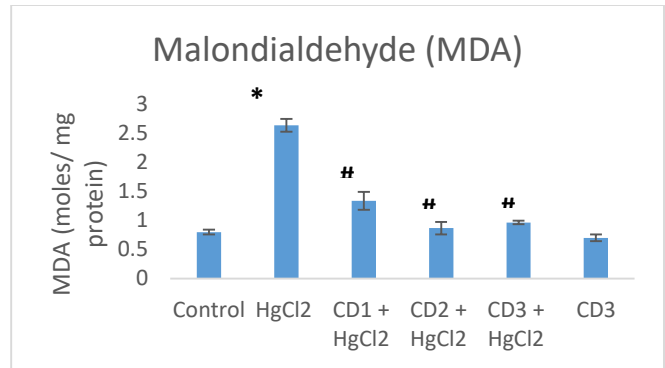


Figure 4: Chart showing Malondialdehyde (MDA) concentration across the experimental groups. Values are given as mean ± SEM. * $p < 0.05$ compared with the control group; # $p < 0.05$ compared with the mercury chloride only group.

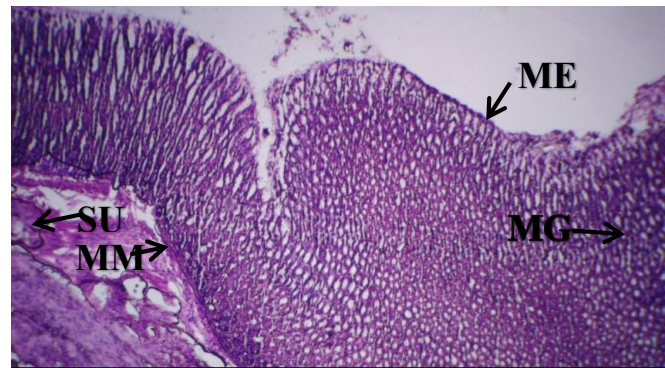


Plate 1: Rat stomach. Control. Showing: mucosa pitted lining epithelium (ME) Glands (MG), muscularis mucosa (MM), submucosa (SU).

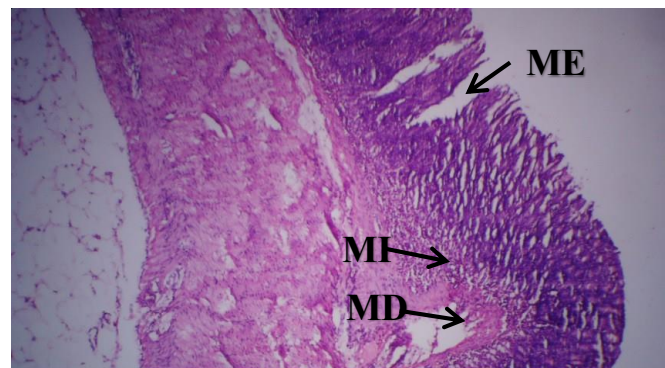


Plate 2. Rat stomach given 10mg/kg HgCl₂ only showing: funnel-shaped mucosal erosion (ME), muscularis mucosal degeneration (MD), mural infiltrates of inflammatory cells (ML).

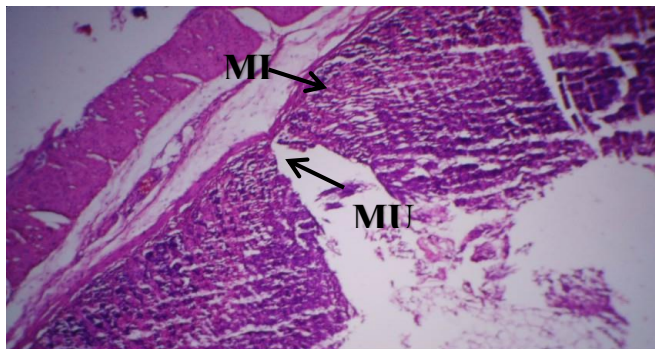


Plate 3. Rat stomach given 200mg/kg *Chasmanthera dependens* + 10mg/kg HgCl₂ showing funnel-shaped ulcer (MU), mural infiltrates of inflammatory cells (MI).

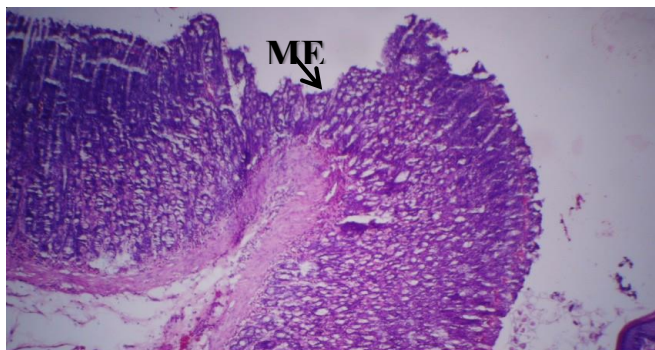


Plate 4. Rat stomach given 400mg/kg *Chasmanthera dependens* + 10mg/kg HgCl₂ showing: crater-shaped mucosal erosion (ME).

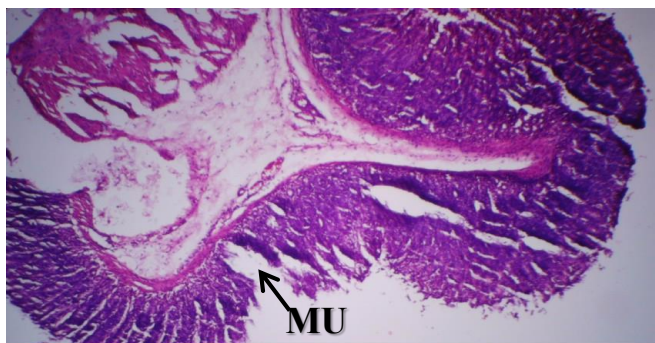


Plate 5. Rat stomach given 800mg/kg *Chasmanthera dependens* + 10mg/kg HgCl₂ showing: funnel-shaped mucosal ulcer (MU).

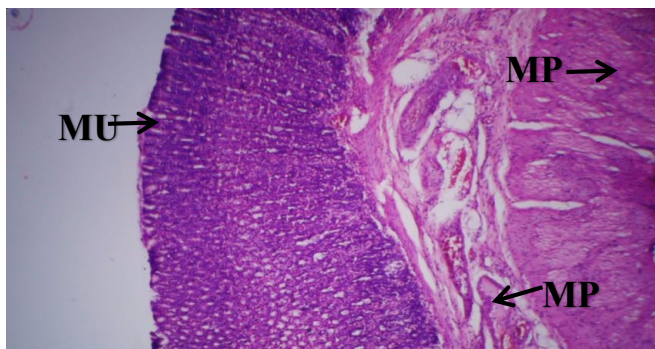


Plate 6. Rat stomach given 800mg/kg *Chasmanthera dependens* only showing: mucosa (MU), submucosa (SM), muscularis propria (MP), all normal.

DISCUSSION

Gastric damage resulting from mercury chloride exposure is a consequence of increased oxidative stress within the stomach, as supported by previous studies (Zhao et al., 2021; Chen et al., 2021). Mercury exerts its toxic effects primarily through the suppression of enzymatic antioxidants, which leads to a corresponding increase in lipid peroxidation (Jan et al., 2011; Jan et al., 2015; Branco et al., 2017). Lipid peroxidation is a critical factor underlining the toxicity of various heavy metals, including mercury (Parida and Patel, 2023). This agrees with the findings from this study showing that mercury increased the MDA level, an oxidative product of lipid peroxidation (Singh et al., 2024). As a way of counteracting the harmful effects of reactive oxygen species and free radicals, cells are fortified with potent antioxidant defence mechanisms. Findings from this study reveal that the mercury chloride-induced increase in lipid peroxidation corresponded with a significant decrease in the activities of the cellular enzymatic antioxidants SOD, CAT and GPx. This is in agreement with several reports showing that mercury deactivates several enzymes and proteins involved in the regulation and attenuation of stress (Agrawal et al., 2014; Sanchez, 2018). However, pretreatment of rats with aqueous *Chasmanthera dependens* leaf extract protected against the dysregulation of the antioxidant enzymes activity and induction of lipid peroxidation. This may be due to the extract's free radical scavenging and antioxidant properties, as previously reported (Madueke et al., 2020; Enebeaku et al., 2022).

Histological findings showed significant pathological changes following the administration of 10mg/kg HgCl₂, such as mucosal erosion and degeneration of the muscularis mucosa. These adverse effects corroborate with the extensive body of literature which has established mercury as a potent inducer of gastric lesions (Venkatalakshmi, 2010; Kleinow and James, 2017). The assault on the gastric mucosa inflicted by mercury chloride is likely attributable to the generation of oxidative stress—a disruptive imbalance between the production of reactive oxygen species and antioxidant defences (Branco et al., 2017). The oxidative stress model posits that mercury's deleterious influence involves the excessive generation of ROS, which damages cellular components, including lipids, proteins, and DNA. This cascade of disruption manifests histologically as erosion and degeneration, as observed in this study. The erosion likely stems from the direct cytotoxic effect of ROS on the gastric epithelium. In contrast, degeneration of the muscularis mucosa may be precipitated by the detrimental impact on the underlying connective tissue structure and cell integrity. However, on pre-treatment with *Chasmanthera dependens*, there were mild improvements in the stomach histology of the rats. Notably, the funnel-shaped ulcer and mural infiltrates, suggest that while *Chasmanthera dependens* at this concentration offers some mitigation against tissue erosion, it does not fully protect against HgCl₂-induced inflammation, as there was

continued inflammatory cellular infiltration. The presence of crater-shaped mucosal erosion as evidenced in the stomach histology of *Chasmanthera dependens* pre-treated rats indicates a partial protective effect of *Chasmanthera dependens*. Previous studies have reported the variable efficacy of herbal remedies on gastric ulceration (Bi et al., 2014; Kuna et al., 2019; Roy et al., 2023).

CONCLUSION

Findings from this study showed that *Chasmanthera dependens* at different dosages appear to provide varying degrees of protection against mercury chloride-induced gastric damage, with higher doses demonstrating better preservation of gastric tissue integrity.

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