Journal Homepage: www.ijarpr.com ISSN: 3049-0103 (Online)

International Journal of Advance Research Publication and Reviews

Vol 03, Issue 10, pp 705-708, October, 2026

Protective Role of *Syzygium aromaticum* in Dichlorvos-Induced Renal Oxidative Damage in Wistar Rats

Ezomoh, Olusoga Olubunmi; Dino, Ebieretei Seleke and Sule, Olayiwola Jimoh

Department Of Biochemistry, Faculty of Basic Medical Sciences, Niger Delta University, Wilberforce Island. Bayelsa State.

ABSTRACT :

Dichlorvos (DDVP) is a broad-spectrum organophosphate insecticide which has been linked to renal dysfunction following chronic oxidative stress. This study evaluated the renoprotective effect of *Syzygium aromaticum* extract against DDVP-induced nephrotoxicity in male Wistar rats. Thirty male Wistar rats were randomly allocated to five groups, each containing 6 rats: normal control, DDVP (8mg/kg), DDVP+*S. aromaticum* (200mg/kg), DDVP+*S. aromaticum* (400mg/kg) and DDVP + Vitamin E (200mg/kg). All treatments were administered orally once daily for 21 consecutive days. Kidney superoxide dismutase (SOD), reduced glutathione (GSH), catalase (CAT), malondialdehyde (MDA) were measured using standard biochemical methods as markers of oxidative stress, body weight, serum urea and creatinine. The body weight gain and antioxidant enzyme activities were significantly decreased and serum urea, creatinine and MDA significantly increased in DDVP compared to normal control ($p<0.05$). These biochemical changes were significantly improved by the treatment with *S. aromaticum* in dose dependent manner and the efficacy was more or less similar to vitamin E. The results showed that *Syzygium aromaticum* showed protective effect against DDVP-induced renal damage by improving kidney function and enhancing the endogenous antioxidant defence system.

Keywords: *Syzygium aromaticum*; dichlorvos; nephrotoxicity; kidney; oxidative stress; Wistar rats.

Introduction

The kidneys filter nearly 180 litres of fluid each day, removing metabolic waste while maintaining water, electrolyte and nutrient balance (Zawierucha et al., 2023). This continuous filtration is essential for maintaining cellular homeostasis, but it also means that the kidneys are continually exposed to circulating poisonous substances. Renal tissues are one of the earliest organs to be injured when a chemical is present in the environment, and this is especially the case when pesticides are repeatedly used (Lee & Park, 2026).

The widespread use of organophosphate insecticides has raised concerns beyond their well-known neurotoxic effects. Many agricultural communities use these compounds regularly to protect crops and to control pests in their homes, providing opportunities for chronic exposure through contaminated food, water and the environment (Zhou et al., 2025). Of these, dichlorvos (2,2-dichlorovinyl dimethyl phosphate; DDVP) is one of the most commonly used insecticides due to its rapid insecticidal action and low cost. Recent studies have shown that prolonged DDVP exposure damages several organs, particularly the kidneys, which can lead to oxidative and inflammatory damage (Saravanakumar et al., 2024).

Renal injury caused by toxicants usually develops through a series of interconnected cellular changes rather than a single pathological event which progressively impair the nephron function (Mishra et al., 2022). Experimental studies have shown that DDVP disrupts mitochondrial function, increases reactive oxygen species production and activates inflammatory signalling within renal tissue, leading to tubular epithelial cell degeneration and a decline in glomerular filtration (Saravanakumar et al., 2024). Acute kidney injury has also been reported as a severe effect of dichlorvos exposure, confirming the kidney as a crucial target organ of organophosphate toxicity from clinical observations (Veeranki et al., 2024).

Renal function is usually impaired when there are alterations in the circulating nitrogenous waste products (Knol et al., 2024). Urea and creatinine are the most accepted biochemical markers of renal function since their levels increase when glomerular filtration decreases (Avila et al., 2025; John & Pasha, 2024; Aklilu, 2023). Elevated urea and creatinine may occur before obvious structural kidney damage becomes evident and these are important indicators for investigating the protective effect of therapeutic drugs in experimental nephrotoxicity (Udupa & Prakash, 2018).

Interest in plant-derived antioxidants has grown because they may reduce renal damage caused by chemical toxicants. Although they do not replace conventional treatment, plant phytochemicals can strengthen natural defence mechanisms against oxidative injury and prevent oxidative damage to the tissue that would otherwise lead to permanent damage (Tüğen & Buruleanu, 2025). This has led to the scientific investigations of culinary spices which have been long used in traditional medicine for their therapeutic properties.

Clove (*Syzygium aromaticum*) is a traditional medicinal plant with a long history of dietary and therapeutic use (Gil et al., 2026). The dried flower buds

are rich in phenolic compounds such as eugenol, flavonoids and tannins, which have high antioxidant and anti-inflammatory properties (Adegbola et al., 2022). Experimental studies have shown that clove extract protects the kidney against chemically induced oxidative damage through its antioxidant activity, whereas more recent studies have shown the beneficial properties of clove extract in experimental renal disorders, owing to its antioxidant and anti-inflammatory effects (Aramash et al., 2025).

Although these promising observations were made, data on the protective effect of *Syzygium aromaticum* against DDVP-induced nephrotoxic effect is limited. This study therefore investigated whether clove extract could preserve renal function and antioxidant status in DDVP-treated Wistar rats.

Materials and Methods

Study area

This was an experimental study carried out in the Department of Biochemistry, Faculty of Basic Medical Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria. Animal handling, sample collection and biochemical analyses were carried out under standard laboratory conditions.

Collection and preparation of *Syzygium aromaticum*

The dried flower buds of *Syzygium aromaticum* were bought from Swali market in Yenagoa, Bayelsa state, Nigeria. The buds were ground to a fine powder and 500 g of the powdered material was macerated in 2 litres of ethanol for 48 hrs with periodic stirring. The mixture was filtered through 110 mm Whatman filter paper and the filtrate was concentrated in a rotary evaporator at 40°C to get the crude extract. Dried extract was reconstituted in distilled water before oral administration.

Experimental animals

Thirty healthy male Wistar rats of weight of 150-200g were purchased from the Animal House of the Department of Pharmacology, Faculty of Basic Clinical Sciences, University of Port Harcourt, Rivers State, Nigeria. All the animals were kept in plastic cages with 14 days acclimatisation period in the Animal House, Faculty of Basic Medical Sciences, Niger Delta University, Wills. The rats had free access to commercial growers' mash and clean drinking water under a 12-hour light/dark cycle throughout the study.

Experimental design

After acclimatisation, the rats were randomly assigned to five groups of six animals each. Distilled water was given to the normal control group, and DDVP (8 mg/kg body weight) to the positive control group. Two treatment groups were given DDVP (8mg/kg) followed by *Syzygium aromaticum* extract of 200mg/kg and 400mg/kg, respectively, to assess the renoprotective effect of clove. The fifth group was treated with DDVP and vitamin E (200 mg/kg body weight) as standard antioxidant treatment. All treatments were administered orally once daily for 21 consecutive days. After the experimental period, the animals were anaesthetised with chloroform, blood was collected by cardiac puncture for serum analysis, and the kidneys were excised and homogenised.

Sample collection and preparation.

Blood samples were drawn in plain sample containers and allowed to clot for 30 minutes and then centrifuged for 10 minutes at 2000 rpm. Serum was separated and renal function biomarkers determined. The kidneys were carefully excised, rinsed in normal saline and homogenised to obtain a 10% tissue homogenate, which was subsequently used for antioxidant analyses.

Biochemical analyses

Serum urea and creatinine were measured spectrophotometrically using Randox colourimetric diagnostic kits, using the urease–Berthelot and picrate methods, respectively. Superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and malondialdehyde (MDA) levels were measured in kidney homogenates to assess oxidative stress in the kidney. The activity of SOD was determined as per Misra and Fridovich (1972), catalase as per the method of Sinha (1972), reduced glutathione as per Beutler et al. (1963) and lipid peroxidation was assessed as malondialdehyde as per TBARS method described by Armstrong and Al-Awadi (1991).

Statistical analysis

All data are reported as mean ± standard deviation (SD). One-way analysis of variance (ANOVA) was used for statistical comparison among the groups with Tukey–Kramer multiple comparison test. Differences were deemed statistically significant when $p < 0.05$.

Results

Table 1. Effect of *Syzygium aromaticum* on body weight of DDVP-treated Wistar rats

Experimental group	Initial body weight (g)	Final body weight (g)
Normal control	159.73 ± 4.98^{a}	199.27 ± 4.47^{b}
DDVP (8 mg/kg)	157.14 ± 2.28^{a}	176.95 ± 190.97^{b}
DDVP + *S. aromaticum* (200 mg/kg)	157.96 ± 3.40^{a}	199.97 ± 3.13^{b}

DDVP + *S. aromaticum* (400 mg/kg)	158.90 ± 2.70[a]	199.53 ± 7.68[b]
DDVP + Vitamin E (200 mg/kg)	157.80 ± 4.84[a]	207.54 ± 8.14[b]

Values are expressed as mean ± SD (n = 6). Means with different superscript letters within the same column differ significantly at p < 0.05.

Table 2. Effect of *Syzygium aromaticum* on renal function biomarkers

Experimental group	Urea (mg/dL)	Creatinine (mg/dL)
Normal control	55.99 ± 2.10[a]	0.66 ± 0.03[a]
DDVP (8 mg/kg)	103.37 ± 7.41[b]	2.53 ± 0.40[b]
DDVP + *S. aromaticum* (200 mg/kg)	71.06 ± 3.94[c]	1.52 ± 0.05[c]
DDVP + *S. aromaticum* (400 mg/kg)	63.63 ± 2.44[d]	0.72 ± 0.05[a]
DDVP + Vitamin E (200 mg/kg)	62.24 ± 3.21[d]	0.66 ± 0.02[d]

Values are expressed as mean ± SD (n = 6). Means with different superscript letters within the same column differ significantly at p < 0.05.

Table 3. Effect of *Syzygium aromaticum* on renal oxidative stress markers

Experimental group	SOD (U/mg protein)	CAT (U/mg protein)	GSH (µmol/mg protein)	MDA (U/mg protein)
Normal control	10.89 ± 1.16[a]	7.93 ± 0.82[a]	8.73 ± 0.55[a]	1.86 ± 0.17[a]
DDVP (8 mg/kg)	2.45 ± 0.52[b]	1.67 ± 0.21[a]	1.98 ± 0.37[a]	7.61 ± 0.63[b]
DDVP + *S. aromaticum* (200 mg/kg)	5.01 ± 0.36[c]	4.23 ± 0.37[a]	4.01 ± 0.40[a]	4.80 ± 0.19[c]
DDVP + *S. aromaticum* (400 mg/kg)	6.74 ± 0.31[a]	6.07 ± 0.31[a]	6.05 ± 0.53[a]	2.59 ± 0.23[a]
DDVP + Vitamin E (200 mg/kg)	7.82 ± 0.50[a]	6.84 ± 0.32[a]	6.21 ± 0.43[a]	2.21 ± 0.10[a]

Values are expressed as mean ± SD (n = 6). Means with different superscript letters within the same column differ significantly at p < 0.05.

Discussion

The kidneys are continuously exposed to chemicals circulating in the blood because they filter and remove metabolic waste products. In the present study, DDVP exposure caused significant damage to the kidney, as shown by reduced body weight gain, serum urea and creatinine, reduction in antioxidant enzymes and increase in lipid peroxidation. These alterations were significantly reduced *Syzygium aromaticum,* with the 400 mg/kg dose producing the greatest protective effect.

The DDVP exposed rats body weight also reduced slightly as compared to the normal control group which suggests that chronic exposure with DDVP adversely affected the normal physiological growth. Weight loss is commonly reported in experimental models of organophosphate toxicity and is often linked to increased metabolic demand and reduced nutrient utilisation (Saravanakumar et al., 2024). The increase observed in the clove-treated groups suggests that the extract had some beneficial effect on the systemic action of DDVP.

The significant increase of serum urea and creatinine provided strong evidence of DDVP-induced nephrotoxicity. These biomarkers rise when the kidneys are not functioning properly to eliminate the nitrogenous wastes from the blood stream. The increase observed in the DDVP group suggests impaired glomerular filtration and reduced renal function. Veeranki et al. (2024) similarly reported that dichlorvos exposure causes both biochemical and structural kidney damage. After the treatment with *S. aromaticum*, the significant reduction in urea and creatinine indicates that the extract helped preserve renal function and prevented renal damage caused by DDVP that resulted in nephron damage.

Superoxide dismutase, catalase and reduced glutathione were significantly decreased in the positive control group, while the malondialdehyde level was significantly increased. This pattern is due to the decrease of the endogenous antioxidant defence system and an increased lipid peroxidation in renal tissue. Increased ROS is known to cause cellular membrane damage, oxidative stress to mitochondria, and inflammatory pathways leading to renal degeneration (Kishi et al., 2024; Saravanakumar et al., 2024).

Administration of *Syzygium aromaticum* significantly increased antioxidant enzyme activities in a dose-dependent manner and decreased the concentration of MDA. This increase in SOD, CAT and GSH is a sign of increased antioxidant activity while a decrease in MDA shows decreased membrane lipid oxidation. These findings agree with Adegbola et al. (2022), who attributed the strong antioxidant activity of clove to its rich phenolic content, particularly eugenol. Eugenol has been reported to possess antioxidant properties that help protect cell membranes from chemically induced oxidative damage (Damasceno et al., 2024).

In all experiments, the higher dose of *S. aromaticum* resulted in higher biochemical improvement when compared to the lower dose, indicating that there is a dose-dependent effect for *S. aromaticum* renoprotective efficacy. In this regard, Aramash et al. (2025) found a similar protective action in experimental nephropathy using formulations containing *Syzygium aromaticum* which decreased the oxidative stress and improved the renal function. Although those studies did not specifically examine DDVP toxicity, they support the role of antioxidant-mediated protection in preserving kidney function.

In addition, Vitamin E was used as a positive antioxidant in the experiment and the biochemical changes observed were similar to that of the higher dose of clove extract. This similarity reinforces the evidence that the protective effect of *S. aromaticum* is largely mediated through enhancement of endogenous antioxidant defence, rather than by solely minimizing renal injury, since in both cases, the antioxidant activity is not pronounced.

The present findings indicate that DDVP induces nephrotoxicity through oxidative stress, leading to impaired renal function; however, *Syzygium aromaticum* can reduce the nephrotoxic effects of DDVP by enhancing antioxidant status and maintain the functional integrity of the kidneys.

Conclusion

This study demonstrates that DDVP causes significant renal toxicity in Wistar rats by impairing kidney function and disrupting the renal antioxidant defence system. DDVP exposure significantly decrease body weight gain and increase in serum urea and creatinine, decrease in endogenous antioxidants and increase in lipid peroxidation level, which indicate severe oxidative damage of the kidney tissue. Treatment with *Syzygium aromaticum* significantly ameliorated these alterations in a dose-dependent manner and the extract at 400 mg/kg had the greatest renoprotective effect, which is comparable to that of vitamin E. These findings indicate that *Syzygium aromaticum* possesses strong antioxidant and renoprotective properties and it may serve as a promising natural therapeutic agent against organophosphate-induced kidney injury.

REFERENCES :

- Adegbola, M. V., Anyim, G., Ntwasa, M., Ayeleso, A. O., & Oyedepo, T. A. (2022). Potential effect of *Syzygium aromaticum* (cloves) extract on serum antioxidant status and lipid profiles in Wistar rats with artesunate toxicity. *Applied Sciences, 12*(16), 8216.
- Aklilu, A. M. (2023). Diagnosis of chronic kidney disease and assessing glomerular filtration rate. *Medical Clinics*, *107*(4), 641-658.
- Armstrong, D., & Al-Awadi, F. (1991). Lipid peroxidation and retinopathy in streptozotocin-induced diabetes. *Free Radical Biology and Medicine, 11*(4), 433–436.
- Avila, M., Mora Sánchez, M. G., Bernal Amador, A. S., & Paniagua, R. (2025). The metabolism of creatinine and its usefulness to evaluate kidney function and body composition in clinical practice. *Biomolecules*, *15*(1), 41.
- Beutler, E., Duron, O., & Kelly, B. M. (1963). Improved method for the determination of blood glutathione. *Journal of Laboratory and Clinical Medicine, 61*, 882–888.
- Damasceno, R. O. S., Pinheiro, J. L. S., Rodrigues, L. H. M., Gomes, R. C., Duarte, A. B. S., Emídio, J. J., ... & de Sousa, D. P. (2024). Anti-inflammatory and antioxidant activities of eugenol: An update. *Pharmaceuticals*, *17*(11), 1505.
- Gil, T. Y., Kim, S. J., & An, H. J. (2026). *Syzygium aromaticum* L.(Clove): a comprehensive Review of its ethnopharmacological uses and pharmacological activities. *Chinese Journal of Integrative Medicine*, *32*(2), 165-173.
- John, A., & Pasha, T. (2024). Laboratory tests of renal function. *Anaesthesia & Intensive Care Medicine*, *25*(5), 303-307.
- Kishi, S., Nagasu, H., Kidokoro, K., & Kashihara, N. (2024). Oxidative stress and the role of redox signalling in chronic kidney disease. *Nature Reviews Nephrology*, *20*(2), 101-119.
- Knol, M. G., Wulfmeyer, V. C., Müller, R. U., & Rinschen, M. M. (2024). Amino acid metabolism in kidney health and disease. *Nature Reviews Nephrology*, *20*(12), 771-788.
- Lee, S. E., & Park, Y. S. (2026). Environmental pollution and its impact on kidney diseases: a comprehensive review of current evidence. *Life*, *16*(2), 291.
- Mishra, M., Nichols, L., Dave, A. A., Pittman, E. H., Cheek, J. P., Caroland, A. J., ... & Bridges, C. C. (2022). Molecular mechanisms of cellular injury and role of toxic heavy metals in chronic kidney disease. *International Journal of Molecular Sciences*, *23*(19), 11105.
- Misra, H. P., & Fridovich, I. (1972). The role of superoxide anion in the autoxidation of epinephrine and a simple assay for superoxide dismutase. *Journal of Biological Chemistry, 247*(10), 3170–3175.
- Saravanakumar, K., Park, S., Vijayasarathy, S., Swaminathan, A., Sivasantosh, S., Kim, Y., Yoo, G., Madhumitha, H., MubarakAli, D., & Cho, N. (2024). Cellular metabolism and health impacts of dichlorvos: Occurrence, detection, prevention, and remedial strategies—A review. *Environmental Research, 242*, 117600.
- Sinha, A. K. (1972). Colorimetric assay of catalase. *Analytical Biochemistry, 47*(2), 389–394.
- Tüğen, A., & Buruleanu, C. L. (2025). The role of plant-derived bioactive compounds in mitigating oxidative stress. *Foods*, *15*(1), 108.
- Udupa, V., & Prakash, V. (2018). Gentamicin induced acute renal damage and its evaluation using urinary biomarkers in rats. *Toxicology reports*, *6*, 91–99.
- Veeranki, V., Prasad, N., Hussain, S., Patel, M. R., Kushwaha, R. S., Meyyappan, J., Agarwal, V., Jain, M., & Yadav, R. (2024). Severe and recurrent acute kidney injury following dichlorvos exposure: A case report. *Indian Journal of Nephrology, 34*(3), 263–265.
- Zawierucha, J., Marcinkowski, W., Prystacki, T., Malyszko, J. S., Pyrza, M., Zebrowski, P., & Malyszko, J. (2023). Green dialysis: let us talk about dialysis fluid. *Kidney and Blood Pressure Research*, *48*(1), 385-391.
- Zhou, W., Li, M., & Achal, V. (2025). A comprehensive review on environmental and human health impacts of chemical pesticide usage. *Emerging Contaminants*, *11*(1), 100410.