Sahel Journal of Life Sciences FUDMA (SAJOLS)
June 2025 Vol. 3(2): 97-103
ISSN: 3027-0456 (Print)
ISSN: 1595-5915 (Online)
DOI: *https://doi.org/10.33003/sajols-2025-0302-11*

Research Article

Effects of Aqueous Extract of *Mimosa pudica* in Sulfonamide-Induced Renal Dysfunction in Albino Wistar Rats

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ABSTRACT
Clinical management of renal dysfunction arising from toxicity and disease infestation has been very expensive, with more cases of mortality than success in developing countries like Nigeria. The abundant vegetation in the tropics holds huge possibilities for ethnobotanical management of diverse physiological aberrations, including kidney dysfunction. *Mimosa pudica* has been reported to improve cardiac, metabolic, and neural dysregulations. However, there is a dearth of its role in sulfonamide-induced renal damage in male Wistar rats. Forty-two (42) adult rats grouped into seven (7) groups, with six (6) rats per group, were acclimatized for one week and administered treatment for 14 days. The normal control group (group 1) was given water only, while the negative control group (group 2) was given 300 mg/kg.bw of Sulfonamide. Group 3 was given silymarin (210mg/Kg.bw) as a positive control. Varying concentrations of *M. pudica* 100, 200, and 300mg/kg.bw were administered to groups 4, 5, and 6. Urea, creatinine, potassium, sodium, chloride, and bicarbonate were assayed using standard procedures. There was a significant reduction ($p < 0.05$) of urea level by 274% in group 6 compared to the negative control. Groups 4 and 5 had significant ($p < 0.05$) reduction of creatinine level, respectively, when compared with the negative control. A similar trend was observed in potassium, sodium, and chloride levels. There was a significant ($p < 0.05$) reduction in bicarbonate levels by 54%, 55%, and 63%, respectively, across the aqueous treatments. This shows that mimosa may confer renoprotective function on sulfonamide-induced toxicity.

Keywords: Electrolyte; Kidney; *Mimosa pudica*; Renal dysfunction; Sulfonamide

Citation: Usiobeigbe, O.S., Ogbonnaya, F.C., Amah, G.H., Ogunbiyi, B.T. & Olaomoju, J.T. (2025). Effects of Aqueous Extract of *Mimosa pudica* in Sulfonamide-Induced Renal Dysfunction in Albino Wistar Rats. *Sahel Journal of Life Sciences FUDMA*, 3(2): 97-103. DOI: *https://doi.org/10.33003/sajols-2025-0302-11*

INTRODUCTION

Nephrotoxicity could result from the exposure of the kidney to exogenous or endogenous toxicants, which consequently affect the optimal function of the kidney due to the destruction of the kidney cells. Induction of nephrotoxicity by drugs remains a major problem as use of nephrotoxic drugs is unavoidable in clinical setting. Nephrotoxicity can be characterized by rapid serum creatinine increase and reduction of glomerular filtration rate (GFR) and may be associated with mild arterial hypertension (Lamin *et al*., 2025). Kidney dialysis and kidney transplantation are used to treat renal failure. Sulfonamides (SN) belong to an important class of synthetic antimicrobial drugs that are pharmacologically used as broad spectrum for the treatment of human and animal bacterial infections (Ottosen *et al*., 2024). Nucera and colleagues reported that sulfa-containing medications can cause crystal-induced acute renal failure from intra tubular

deposition or renal impairment from allergic interstitial nephritis (Nucera *et al*., 2017).

Herbs have been a source of medicinal compounds for centuries due to their phytochemicals (Ahmed *et al*., 2024). Cardiovascular dysfunctions, liver diseases, central nervous system disorders, digestive aberrations and metabolic disorders are key examples of major dysfunction that substances of plant origin have been used to ameliorate (Lu and Han, 2024). Researchers are currently focusing on the medicinal properties of potentially bioactive plant products with excellent therapeutic properties for clinical case management (Fatima *et al*., 2024). *Mimosa pudica* L. (commonly called Sensitive plant or humble plant in English, *ojigiso* in Japanese) is a creeping annual or perennial herb of the pea family (Fabaceae) that responds to tactile and other (such as light) stimuli by quickly closing and hanging down its leaves. *M*. *pudica* L. has two well-known movements – the very fast movement of the leaves when stimulated by tactile sensation, hit, et cetera; and the biological clock-controlled response called the movement of nyctinastic (Gulzar *et al*., 2016). The leaves are beneficial in managing hemorrhagic diseases, urinary illnesses, diarrhea, and gynecological disorders (Majeed *et al*., 2021). Identified as Lajjalu in Ayurveda, it has antiasthmatic, aphrodisiac, analgesic and antidepressant effects (Udyavar *et al*., 2023). *M*. *pudica* is known to have sedative, emetic and tonic effects. In Nigeria, it is traditionally used to treat a variety of diseases such as alopecia, diarrhea, dysentery, insomnia, tumors and various urogenital infections (Havaldar *et al*., 2022). Phytochemical studies revealed that *M*. *pudica* leaves contains alkaloids, non-protein amino acids (such as mimosine), flavonoids, glycosides, sterols, terpenoids, tannins, and fatty acids (Sundhararajan *et al*., 2025).

The associated side effects of orthodox therapeutics further increase the quest for the use of naturally occurring plant-derived agents in clinical case management. As indicated by its pharmacological profile, *M*. *pudica* appears to be a promising herbal candidate for further pharmacological study. Therefore, this work is an attempt to investigate the effects of the aqueous extract of *Mimosa pudica* in sulphanamide-induced renal damage in albino Wistar rats.

MATERIALS AND METHODS

Plant sample collection and leaf extract preparation

The samples (leaves of *M*. *pudica* L.) were collected from a local farmland in Ibadan, South-Western Nigeria and was identified and authenticated by local agronomic authority. The specimen voucher was raised and processed according to local regulations. Sample collection was carried out in the months of April, during which there was adequate rainfall to ensure they were fresh and healthy. Exactly 300 g of air-dried and pulverized sample was soaked in 900 mL of water with intermittent shaking for 72 hours. The mixture was sieved using a muslin cloth and filtered using Whatman grade 1 (125 mm) - filter paper and the filtrate concentrated at 40 ^{o}C to recover the extract.

Animal Study

Animal studies were carried out following the Helsinki declaration of ethics of animal handling for experimentation and clearance obtained from a local University Research Ethics regulatory body with certification number LCU-REC/22/041 assigned. The animal was purchased from, housed and managed in a local university facility. Forty-two rats were divided into 7 groups of 6 animals each and acclimatized for 14 days before being treated on group bases. The treated animals were observed for another 14 days and their sera samples collected for analyses. The animal groups and their respective treatments are detailed below:

Group 1: Rats given food and water only (Normal)

Group 2: Rats induced with renal damage using 3000 mg per Kg body weight sulfonamide (negative control).

Group 3: Rats induced with renal damage using 3000 mg per Kg body weight sulfonamide and administered with standard drug - silymarin 200 mg per kg body weight (positive control).

Group 4: Rats administered with 3000 mg sulfonamide and 100 mg of the plant extract per Kg body weight.

Group 5: Rats administered with 3000 mg sulfonamide and 200 mg of the plant extract per Kg body weight.

Group 6: Rats administered with 3000 mg sulfonamide and 300 mg of the plant extract per Kg body weight.

Group 7: Rats given 100mg of the plants extract per Kg body weight.

Sera analyses

Renal function tests were performed on the serum samples collected from the respective animal groups using levels of urea, creatinine, potassium, sodium, chloride and bicarbonate as evaluating indices. Ready-to-use kits of analytical chemicals were purchased from RANDOX (Randox Laboratories, County Auntrim, United Kingdom) and the manufacturer's instruction followed to run the assays.

Data Analysis

Replicate data obtained were analyzed using the Statistical Package for the Social Sciences (SPSS) version 21. The odds ratio for the study parameters were calculated. The correlation was assessed using Pearson's correlation coefficient and *p*-values were set at 0.05.

RESULTS AND DISCUSSION

The results show the response of male Wistar rats to treatment with *M. pudica* co-administrated with sulfonamide-induced renal damage. The renal function indices analyzed were sera urea, creatinine, potassium, sodium, chloride and bicarbonate.

Serum level of urea increased significantly ($p < 0.05$) in the untreated group (68.5±5.2 mg/dL) compared with the normal (25.7±6.3 mg/dL). However, treatment with the extract reduced serum urea level of the rats significant in a dose-dependent manner, with the group administered 300 mg/kg bw of the extract recording the highest ameliorating effect (Figure 1). Similar trend was observable in the effect of the treatments on serum creatinine level (Figure 2).

Sulfa-containing drugs are known as an inducer of acute renal failure and the present study showed that sulfonamide-induced groups showed elevated sera creatinine and urea, compared to the normal control group. The study demonstrated that sulfonamide is nephrotoxic, inducing significant alterations in the kidney parameters. This is demonstrated in the significant difference in the values of the parameters in the normal group, administered with feed and water only, when compared with the sulfonamide-induced group. However, co-administration of the nephrotoxin with silymarin in the animals reduced the kidney parameters significantly when compared with the sulfonamide-induced group. Although silymarin has been mostly under attention for its liver-protective effects, recent studies have indicated nephro-protective effects of this flavonoid complex as well. Several studies showed that silymarin and its complex components prevent nephrotoxicity of various drugs (Demerdash *et al*., 2024). Thus, it is confirmatory that silymarin could be an effect therapeutic agent in managing sulfonamide-induced nephrotoxicity.

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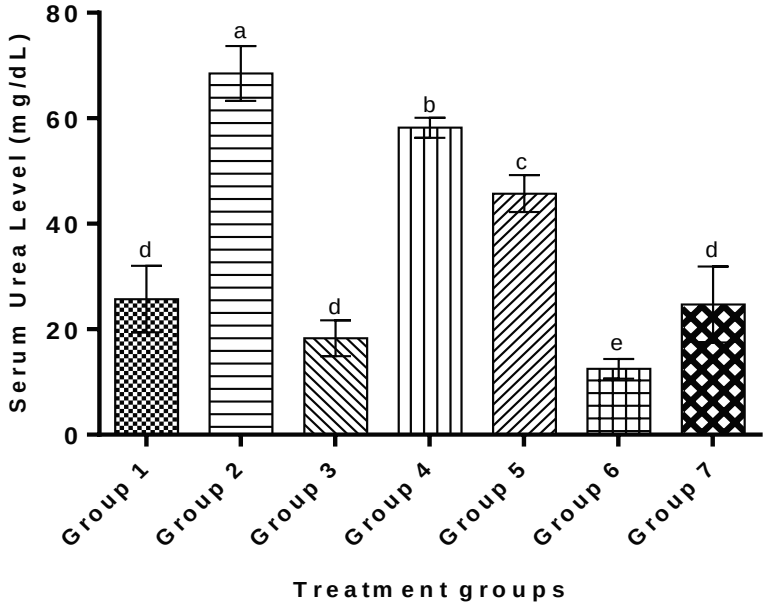

Fig. 1: Effects of aqueous extract of *M. pudica* leaf on serum urea level

Each bar represents Mean ± SD (n = 6). Similar letters indicate no significant difference between groups. Different letters denote significant difference at $p < 0.05$. Group 1: Normal rats; Group 2: Untreated rats; Group 3: 3000 mg/Kg sulphonamide + 200 mg/Kg Silymarin; Group 4: 3000 mg/Kg sulphonamide + 100 mg/Kg *M.pudica* leaf aqueous extract (MPLAE); Group 5: 3000 mg/Kg sulphonamide + 200 mg/Kg MPLAE; Group 6: 3000 mg/Kg sulphonamide + 300 mg/Kg MPLAE; Group 7: 100 mg/Kg MPLAE

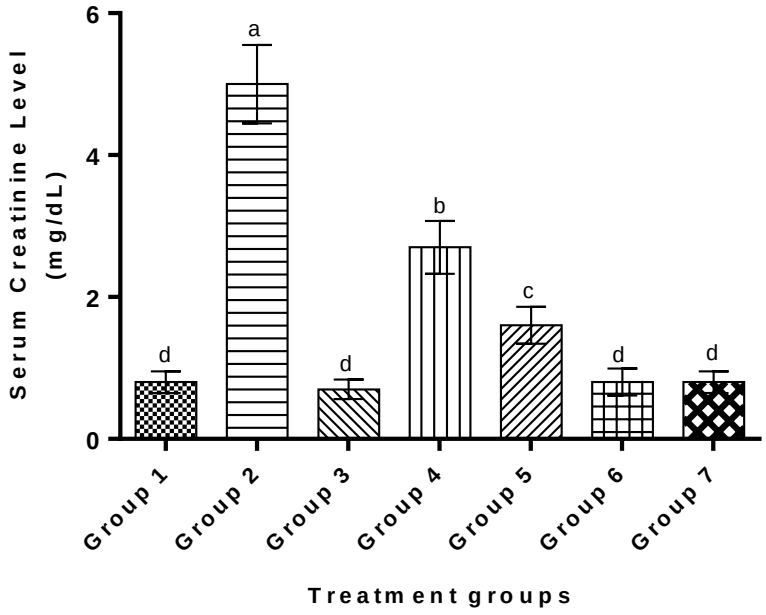

Fig. 2: Effects of aqueous extract of *M. pudica* leaf on serum creatinine level

Each bar represents Mean ± SD (n = 6). Similar letters indicate no significant difference between groups. Different letters denote significant difference at $p < 0.05$. Group 1: Normal rats; Group 2: Untreated rats; Group 3: 3000 mg/Kg sulphonamide + 200 mg/Kg Silymarin; Group 4: 3000 mg/Kg sulphonamide + 100 mg/Kg MPLAE; Group 5: 3000 mg/Kg sulphonamide + 200 mg/Kg MPLAE; Group 6: 3000 mg/Kg sulphonamide + 300 mg/Kg MPLAE; Group 7: 100 mg/Kg MPLAE

Urea and Creatinine are key markers of renal function in ascertaining the nephrotoxicity of drugs. Therefore, damage to proximal tubule cells will lead to changes in sera urea and creatinine concentrations due to a distorted nephron structure (van Galen *et al*., 2025). In this study, renal function impairment was demonstrated by increased sera urea and creatinine concentrations in the group administered with sulfonamide compared with the normal group. *M. pudica* leaf aqueous extract-treated animals induced with sulfonamide had reduced sera urea and creatinine concentrations when compared with the untreated control group. This suggested that the leaf aqueous extract of *M. pudica* contain nephroprotective compound(s) which might act by interfering with the mechanism of reabsorption and inhibition of urea and creatinine in nephrons. It might also be by inhibiting the obstruction caused by masses of sulfonamide crystals in the renal tubules or ureters, or protecting the parenchymal cells from damages. Previous research had shown that some plant extracts possess phenolic and flavonoid compounds exhibiting nephroprotective effects (Babtista *et al*., 2024). The effects of *M. pudica* may be due to its antioxidant and anti-inflammatory properties (Chukwu *et al*., 2017). Despite chronic exposure of sulfonamides, the ability of *M. pudica* to salvage elevated sera urea and creatinine levels supports high pharmacodynamics of the extract. Sulfonamide was reported to elicit toxicity by a spectrum of mechanisms, including hypersensitivity due to free radicals it generates in biological systems. Despite the nephrotoxic effects of the Sulfonamide and the changes it induced in the rats, the high pharmacodynamics of *M. pudica* (Mishra *et al*., 2014) appeared to be reason for the reductions in the indicative indices observed in the treatment groups. Similar trend was reported by Akinaw (2024) on the administration of *M. pudica* extract with gentamicin-induced nephrotoxicity in Swiss Albino mice.

There was no significant difference in the respective sera levels of potassium, sodium, chloride, and bicarbonate between normal group (one) and the group 7 (seven) administered with 100 mg/Kg bw of the extract only. A significant ($p < 0.05$) reduction was also observed in the extract-treated groups in a dose-dependent manner when compared to the untreated group (group 2) (Table 1).

Table 1: **Effect of Aqueous Extract of *M. pudica* Leaf on Levels of Serum Electrolyte**

Parameter	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Potassium (mM)	4.1±0.5^{c}	6.7±0.50^{a}	3.8±0.26^{c}	6.8±0.19^{a}	5.6±0.72^{b}	3.8±0.36^{c}	3.8±0.24^{c}
Sodium (mM)	138±2.6^{c}	152±1.9^{a}	139±1.9^{c}	152±1.5^{a}	146±1.1^{b}	137±1.9^{c}	138±1.9^{c}
Chloride (mM	99±2.4^{c}	108±1.4^{a}	100±2.5^{b,c}	109±1.2^{a}	104±1.9^{b}	99±2.0^{c}	101±1.8^{b,c}
Bicarbonate (mEq/L)	29±3.6^{a,b}	36±4.9^{a}	31±4.6	34±1.1^{a}	33±2.2^{a}	29±2.3^{a,b}	27±2.9^{b}

Values represent mean ± SD of replicate readings for n = 6. Values within same column having different superscripts are statistically different ($p < 0.05$)

Serum potassium level was significantly (p <0.05) reduced following the administration of 100 mg/Kg.bw and 200 mg/kg.bw of *M. pudica* aqueous leaf extract by 50% (p >0.05) and 60% respectively (in a dose-dependent manner), when compared with negative control. Similarly, elevated serum sodium level (55%) was significantly reduced on co-administration of 100 mg/Kg.bw and 200 mg/kg.bw of *M. pudica* extract by 50% (p >0.05) and 52% (p <0.05) respectively, when compared with the negative control group, but nor as low as was observed in the normal group. However, co-administration with 300 mg/kg.bw reduced serum potassium level to value not significantly different from both the normal group and positive control group. The sulfonamide administered induced elevation of serum chloride level in the rats significantly. But co-administration of 100mg and 200mg/Kg.bw of the extract significantly reduced the chloride level in the sera of the rats. Bicarbonate was also elevated (62%) by the administration of the sulfonamide alone. However, the elevated serum bicarbonate level was significantly reduced by the aqueous leaf extract of *M. pudica* by 54%, 55% and 63%, respectively.

From this study, the electrolyte elevation resulting from sulfonamide-induced nephrotoxicity was subsequently reversed by the aqueous leaf extract of *M. pudica*. The extract alone did not induce any significant modulation in the sera indices of kidney function evaluation. Hence, the extract did not elicit any form of nephrotoxicity in the subjects studied. The prophylactic activity of the extract can be attributed to phytochemicals that naturally occur in *M. pudica* which are flavonoid, alkaloid, tannin and quercetin. These phytochemicals have been previously identified to regulate water and electrolyte balance in bodily systems (Sayana *et al*., 2014). Ethanolic root extract of *M. pudica* showed reverse electrolyte imbalance, thus, possesses significant diuretic activity (Kalabhaarathi *et al*., 2015). When appropriately used, naturally occurring plant-based therapeutics have been associated either with very minimal or no less side effects and easy accessibility (Chandra *et al*., 2019). The ameliorating effect of the plant extract was comparable to that of the standard drug (silymarin) used.

CONCLUSION

Mimosa pudica co-administered with the toxicant protected the kidney against damage in a dose-dependent manner with the highest dosage studied being the most potent. *M. pudica* exhibits antioxidant and antitoxic ability; it has the potent capacity to reverse sulfonamide-induced renal damage in Wistar rat. Therefore, the plant is an indispensable medicinal herb in nephrotoxicology. In view of the aforementioned observation of effectiveness of the plant ability to reverse the damage caused by sulfonamide on co-administration, it is strongly recommended that *M. pudica* should be incorporated into the spectrum of herbal drugs used for the management of kidney dysfunction after further investigation.

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