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BIOCHEMICAL AND HISTOLOGICAL ASSESSMENT OF THE PROTECTIVE EFFECTS OF ETHANOLIC EXTRACT OF *Solanum torvum* ON MERCURY INDUCED KIDENEY AND TESTES TOXICITY ON ADULT WISTAR RATS

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Abstract: **Mercury is a heavy metal known for its toxic effects on vital organs, particularly the kidneys and testes. Solanum torvum, commonly known as turkey berry, has been traditionally used for its medicinal properties, including antioxidant and anti-inflammatory effects. The aim of this study is to determine the protective effect of ethanolic extract of Egg plant (Solanum torvum) on the kidney and testes of Mercury induced toxicity on adult male wistar rats. Thirty-five adult male Wistar rats were randomly divided into six groups. Group A served as Control group and was given 5ml of distilled water per day and laboratory chow, Group B received 100mg/kg of Ethanolic extract of Solanum torvum, Group C received 100mg/kg of Mercury, Group D received 100mg/kg of Mercury and 200mg/kg of Ethanolic extract of Solanum torvum, Group E received 100mg/kg of Mercury and 400mg/kg of Ethanolic extract of Solanum torvum and Group F received 400mg/kg of Ethanolic extract of Solanum torvum and 100mg/kg of Mercury. The administration was done daily via oral gavage and lasted for 21 days. Biochemical parameters including serum urea, creatinine, uric acid, and sperm indices (motility, count, morphology) were analyzed. Histological examination of kidney and testes tissues was performed using hematoxylin and eosin staining. The animals were anaesthetized with diethyl ether in an enclosed container, after 24 hours of the last administered dose of Ethanolic leave extract of Solanum torvum, the kidney and testes were harvested and stored in 10% Formal saline as a preservative in a container before taking to histopathologist. Serum was retrieved after spinning of the blood sample using a centrifuge and analyzed for serum creatinine, uric and urea. Mercury exposure led to significant increases in serum urea and creatinine, reduced sperm quality, and marked histological damage to both the kidney and testes. Treatment with S. torvum extract, particularly at 400 mg/kg, significantly restored renal and testicular function, improved sperm parameters, and ameliorated histopathological alterations in a dose-dependent manner. Ethanolic extract of Solanum torvum exhibits protective and restorative potential against mercury-induced renal and testicular toxicity. These findings support its ethnomedicinal use and warrant further research into its bioactive compounds for therapeutic applications.**

Keywords: **Solanum torvum, Mercury, Histology, Wistar rats, Biochemical.**

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1. INTRODUCTION

Mercury is recognized as a toxic, persistent, and mobile contaminant; it does not degrade in the environment and becomes mobile because of the volatility of the element and several of its compounds. Moreover, mercury has the ability to be transported within air masses over very long distances (Pacyna, 2020). Over the last few decades, considerable scientific knowledge has been developed on the sources and emissions of mercury, its pathways and cycling through the environment, human exposure, and impacts on the environment and human health (Bank, 2020). Toxicity varies with dosage: large acute exposures to elemental mercury vapor induce severe pneumonitis, which in extreme cases can be fatal. Low-grade chronic exposure to elemental or other forms of mercury induces subtler symptoms and clinical findings (Berlin et al., 2007). Solanum torvum is a medicinal plant not only used as food. It is also widely used in traditional medicine in Africa and Asia for preventing and curing a range of ailments (Chah et al., 2000; Kala, 2005). The aim of this study is to determine the potential protective effects of ethanolic extract of *Solanum torvum* against mercury-induced kidney and testes toxicity through biochemical and histological assessments.

2. MATERIALS AND METHODS

Location

This Study was conducted in the Animal House of the Department of Human Anatomy, Faculty of Basic Medical Sciences, Chukwuemeka Odumegwu Ojukwu University, Anambra State.

Materials

Thirty five wistar rats, Mercury, Solanum torvum leaves, Ethanol, Distilled water,1 bottle of pure, unsweetened yogurt,, S.pyrex beakers, Measuring cylinder, Weighing balance, Electronic weighing balance, Oral cannula, Filter paper, Standard wooden cages and plastic water can, Cotton wool, Latex medical hand gloves, Diethyl ether, Vital top feed grower, Dissecting kits, Plain container bottle, Microhematocrit centrifuge, Nexus refrigerator, Rotary evaporator, Thermostat oven, Heparinized capillary tube.

Extract Procedure

The Solanum torvum was plucked fresh from a local farm in Uli and washed under running tap water in a basin to remove dirt, cut into pieces and was air dried under ambient temperature. The leaf extract was dissolved in dimethyl sulfoxide (DMSO) (Merck, Germany) to a final concentration of 50% (v/w) and filtered through No. 1 Whatman filter paper to obtain the crude extract used for the examination of antibacterial activity. The phytochemical components of the crude extract were analyzed using GC-MS with a 6980 GC system (Agilent Technologies; Santa Clara, CA, USA), as described previously.

Experimental Design

35 male Wister rats were randomly grouped into six groups as follows;

Group A: Control (no extract, just water and feed).

Group B: 100 mg/kg of Solanum torvum extract(EST)

Group C: 100 mg/kg mercury-chloride (Hg)

Group D: 100 mg/kg Hg(1 week)+ 200 mg/kg EST(2 weeks)

Group E: 100 mg/kg Hg(1 week)+ 400 mg/kg EST(2 weeks)

Group F: 400 mg/kg EST(2 weeks) + 100 mg/kg Hg(1 week)

All experimental protocols were observed under strict supervision, the experiment lasted for 21 days, and administration was done through oral gavage.

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Statistical Analysis

Data was analysed using Statistical Package for Social Sciences (SPSS Version 25). The results were expressed as mean = S.E.M. Data for Relative Organ weight was analysed using One-way ANOVA, followed by Post hoc LSD. While body weight was done using dependent T-test. Values was considered significant at $P<0.05$

3. RESULTS

Table I: Effect of ethanolic extract of *Solanum tarvum* on body weight following Mercury induced toxicity

	Initial body weight (g) MEAN±SEM	**Final body weight (g) MEAN±SEM**	**p-value**	**t-value**
Group A (control)	63.00±1.56	81.80±5.18	0.017*	-3.931
Group B (100 mg/kg EST)	108.66±5.66	103.50±0.28	0.475#	0.873
Group C (100 mg/kg Hg)	107.33±0.33	153.00±21.36	0.166#	-2.137
Group D (100 mg/kg Hg-1wk + 200 mg/kg EST-2wk)	85.00±13.31	98.00±10.39	0.635#	-0.555
Group E (100 mg/kg Hg-1wk + 400 mg/kg EST -2wk)	122.00±1.00	104.00±0.57	0.004*	-0.555
Group F (400 mg/kg EST-2wk + 100 mg/kg Hg-1wk)	127.66±4.25	119.00±9.23	0.248#	1.616

SEM: standard error of mean, EST: ethanolic extract of *Solanum torvum* , *: significant, #: not significant.

Table I Result revealed a significant increase in the body weight in-group A, while groups B, C, D, and F had no significant difference in weight but revealed a decrease in groups B and F, while groups C and D had an increase. Further, group E had a significant decrease in the body weight when the initial weight was compared to the final weight.

Table II: Effect of ethanolic extract of *Solanum tarvum* on organ weight following Mercury induced toxicity

	Relative kidney weight (g) MEAN±SEM
Group A (control)	0.47±0.01
Group B (100 mg/kg EST)	$0.36\pm0.00^{*,b}$
Group C (100 mg/kg Hg)	$0.31\pm0.03^{*}$
Group D (100 mg/kg Hg-1wk + 200 mg/kg EST-2wk)	$0.41\pm0.00^{*,\#,@}$
Group E (100 mg/kg Hg-1wk + 400 mg/kg EST -2wk)	$0.41\pm0.01^{*,\#,@}$
Group F (400 mg/kg EST-2wk + 100 mg/kg Hg-1wk)	$0.32\pm0.00^{*,b}$
F-Ratio	12.40

Data was analyzed using ANOVA followed by post Hoc LSD multiple comparison and values were considered significant at $p<0.05$. SEM: Standard error of the mean, *: significant, a: not significant when compared with group A, #: significant, b: not significant when C, D, E and F are compared with group B, @ significant, c: non-significant when D and E are compared to group F.

In Table II, the relative kidney weight analysis indicated a low statistically significant difference in groups B, C, D, E, and F when compared to group A. Furthermore, there was a high statistically significant difference in groups D and E when compared to group C and no statistically significant difference in groups B and F when compared to group C. Also, there was a high statistically significant difference in groups D and E when compared to group F.

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Table III: Effect of ethanolic extract of *Solarnum tarvum* on renal functions parameters following mercury - induced toxicity

	Urea conc. (mg/dl) MEAN±SEM	Creatinine conc. (mg/dl) MEAN±SEM	Uric acid (mg/dl) MEAN±SEM
Group A (control)	35.58±2.63	0.08±0.01	6.14±0.05
Group B (100 mg/kg EST)	35.94±1,79^{a,b}	0.08±0.01^{a,b}	6.09±0.03$^{a,\#}$
Group C (100 mg/kg Hg)	50.85±12.76^{a}	0.18±0.04^{a}	14.26±3.57*
Group D (100 mg/kg Hg)	65.87±3.05$^{*,b,@}$	0.28±0.01$^{*,b,@}$	11.56±0.58$^{*,b,@}$
Group E (100 mg/kg Hg-1wk + 400 mg/kg EST -2wk)	48.54±5.26^{a,b,c}	0.16±0.06^{a,b,c}	8.38±1.23$^{a,\#,c}$
Group F (400 mg/kg EST-2wk + 100 mg/kg Hg-1wk)	33.91±0.01^{a,b}	0.11±0.03^{a,b}	6.05±0.00$^{*,\#}$
F-Ratio	4.43	4.16	4.87

Data was analyzed using ANOVA followed by post Hoc LSD multiple comparison and values were considered significant at $p<0.05$. SEM: Standard error of the mean, *: significant, a: not significant when compared with group A, #: significant, b: not significant when C, D, E and F are compared with group B, @ significant, c: non-significant when D and E are compared to group F.

For the mean urea concentration, the analysis indicated a high statistically significant difference in group D and no statistically significant difference in groups B, C, E, and F. Furthermore, there was no statistically significant difference seen in groups B, D, E, and F when compared to group C. Also, there was a high statistically significant difference seen in group D when compared to group F and no statistically significant difference seen in group E when compared to group F.

For the mean creatinine concentration, a high statistically significant difference in group D ($p=0.03$) and no statistically significant difference in groups B, C, E, and F ($p=0.01$, $p=0.04$, $p=0.06$, $p=0.03$). Furthermore, there was no statistically significant difference seen in groups B, D, E, and F, when compared to group C. Also, there was a high statistically significant difference seen in group D ($p=0.01$) when compared to group F and no statistically significant difference seen in group E when compared to group F.

The serum uric acid concentration revealed a high statistical significant difference in groups C and D and a low statistically significant difference while there was no statistically significant difference in groups B, E, and F. Furthermore, there was a low statistically significant difference in groups B, E, and F and there was no statistically significant difference in-group D when compared to group C. In addition, there was a high statistically significant difference in-group D when compared to group F and no statistically significant difference in-group E when compared to group F.

Table IV: Effect of ethanolic extract of *Solanum tarvum* on organ weight following Mercury induced toxicity

Group (N=5)	Relative Testicular weight (g) Mean±SEM
Group A (control)	1.02±0.07
Group B (100 mg/kg EST)	0.79±0.02*
Group C (100 mg/kg Hg)	0.76±0.00*b
Group D (100 mg/kg Hg-1wk + 200 mg/kg EST-2wk)	0.71±0.04*b&
Group E (100 mg/kg Hg-1wk + 400 mg/kg EST -2wk)	0.94±0.10#b&
Group F (400 mg/kg EST-2wk + 100 mg/kg Hg-1wk)	0.66±0.08*b&
P-ratio	0.016
F-ratio	4.442

Data was analyzed using ANOVA followed by post Hoc LSD multiple comparison and values were considered significant at $p<0.05$. SEM: Standard error of the mean, *: significant, a: not significant when compared with group A; #: significant, b: not significant when B, D, E and F are compared with group C;& significant, c: non-significant when D and E are compared to group F. EST: ethanolic extract of *Solanum torvum*

Result revealed a significant decrease in the relative testicular weight in groups B, C, D($p=0.02$, $p=0.00$, $p=0.04$), group E ($p=0.10$) had a non-significant decrease compared to group A. A non-significant lower relative mean testicular weight was shown in groups C, D, and F, group E ($p=0.10$) had a non-significant increase compared to group B. Also, groups D, E, and F had no significant difference compared to group C, which indicate a decrease in groups D and F, and group E had an increase.

Histological analysis

Histological analysis of kidney tissue confirmed these biochemical findings. Control and Solanum torvum-only groups showed normal renal architecture, while mercury exposure induced moderate haemorrhage and inflammation. Treatment with S. torvum post-mercury exposure demonstrated dose-dependent healing, with higher doses reducing vascular damage and inflammation but not fully restoring glomerular integrity. Pre-treatment with S. torvum also conferred protective effects, maintaining near-normal histology.

Testicular histology mirrored sperm analyses. Control and S. torvum-only groups had normal seminiferous tubules and active spermatogenesis. Mercury caused severe degeneration and spermatogenic arrest. Treatment resulted in partial regeneration with persistent spermatogenic arrest and hemorrhage at moderate doses, while pre-treatment and higher doses improved testicular recovery and preserved seminiferous tubular structure.

4. CONCLUSION

The results demonstrated a significant increase in body weight in Group A, while Groups B and F showed decreases, and Group E exhibited significant weight loss. These changes suggest differential metabolic or toxic effects of the treatments, consistent with findings by Ogunlade et al. (2020), who reported weight fluctuations linked to phytochemical exposure.

Relative kidney weight analysis revealed significant differences in all treatment groups compared to control, particularly Groups D and E, indicating potential nephrotoxicity. Elevated serum urea and creatinine in Group D further support renal impairment, paralleling observations by Adewoye et al. (2010). Increased serum uric acid in Groups C and D also points to kidney dysfunction.

Testicular assessments showed significant decreases in relative testicular weight in Groups B, C, D, and F, indicating testicular toxicity, with Group E showing a non-significant decrease. Correspondingly, sperm parameters revealed reduced active motile sperm and total count in some groups but improvements in others, especially Group E, suggesting dose-dependent reproductive effects consistent with Yakubu et al. (2007). Normal sperm morphology decreased in Groups B and C but improved in Groups D and E, supporting a protective role of Solanum torvum at certain doses (Oyeyemi et al., 2011).

Histological analysis of kidney tissue confirmed these biochemical findings. Control and Solanum torvum-only groups showed normal renal architecture, while mercury exposure induced moderate hemorrhage and inflammation (Bernhoft, 2012). Treatment with S. torvum post-mercury exposure demonstrated dose-dependent healing, with higher doses reducing vascular damage and inflammation but not fully restoring glomerular integrity (Ajiboye et al., 2020; Ojo et al., 2018). Pre-treatment with S. torvum also conferred protective effects, maintaining near-normal histology (Ibrahim et al., 2019).

Testicular histology mirrored sperm analyses. Control and S. torvum-only groups had normal seminiferous tubules and active spermatogenesis (Yakubu et al., 2007). Mercury caused severe degeneration and spermatogenic arrest (Wang et al., 2014). Combined treatment resulted in partial regeneration with persistent spermatogenic arrest and hemorrhage at moderate doses (Akinmoladun et al., 2018), while pre-treatment or higher doses improved testicular recovery and preserved seminiferous tubule structure (Yakubu et al., 2007).

Overall, Solanum torvum exhibits both nephroprotective and testicular restorative effects against mercury-induced toxicity, with efficacy influenced by dosage and treatment timing. These findings highlight its therapeutic potential in mitigating heavy metal toxicity.However, some residual damage persisted at moderate doses, indicating that higher or sustained dosing may be required for full recovery warranting caution at specific doses.

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