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Evaluation of the Effect of *Jatropha integerrima* (*Euphorbiaceae*) on the renal Function of Male Albino Wistar Rats Exposed to Chromium

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Authors' contributions

This work was carried out in collaboration among all authors. Author EON wrote the protocol, author ESB wrote the first draft of the manuscript and author MJAN managed the analyses and the literature searches of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the study was to evaluate the effect of *Jathropha interrigima* on renal function of male Albino Wistar rats exposed to chromium.
Study Design: The study is an experimental study.
Place and Duration of Study: Department of Animal and Environmental Biology, Rivers State University, Port Harcourt, Nigeria, between March 2020 and December 2020.
Methodology: A total of 30 male Albino Wistar rats that weighed between 140-210g were used for this study. This study was done in three phases: Acute, Sub-chronic and Chronic phases and *Jathropha interrigima* extract was given to the rats as a prophylaxis (PRE) within the three phases and as a therapeutic (POST) substance within the three phases. Blood samples were collected at the end of each phase for both PRE and POST by cardiac puncture and separated into microvials tubes for the evaluation of the renal parameters listed above using a Selectra Pro-S automated chemistry analyzer. The kidneys were also harvested for histological studies using haematoxilin stain. Data was analysed using SPSS version 22.0 and p values less than 0.05 were considered statistically significant.

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Results: For the Acute Phase, the rats exposed to Chromium (Treatment Group) given the Jathropha extract prophylactically(PRE) had mean Potassium level(7.33 ± 0.51mmol/l) which was significantly higher than the positive control (5.5 ± 0.42mmol/l); whereas for the Treatment group given the Jathropha extract therapeutically (POST) had mean Sodium level (134.7 ± 2.08mmol/l) which was significantly higher than the negative control (126.5 ± 2.21mmol/l) and the positive control(130.0 ± 0.01mmol/l), also a CRP level (1.6 ± 0.06u/ml) which was significantly higher than the PC (1.5±0.0u/ml1) and NC (1.3± 0.01u/ml) and a KIM level (16.7±0.10u/ml) which was significantly higher than the PC(14.3±0.01u/ml) and NC (1.3±0.01u/ml) respectively. In the Sub-chronic phase, Rats in the PRE had TG mean CRP (1.5±0.42u/ml) and KIM (16.1±1.72iu/l) which were significantly higher than the NC and PC (1.2±0.07); whereas those in POST had mean Potassium level (4.5 ± 0.20) which was significantly lower than PC and NC, a mean Bicarbonate level (20.0 ± 1.00) which was higher than PC and NC. And an Anion Gap (12.7 ± 0.58) which was significantly lower than the controls. Mean CRP, KIM, Urea and Creatinine levels in the treatment group where significantly lower than in the controls. A similar result occurred at the chronic phases for both PRE and POST.
Conclusion: The results of this study indicate that exposure to Chromium caused a Renal injury and *Jathropha interrigima* may have the potential to heal or reverse the injurious effect if given as a therapy for upto 30 to 60 days.

Keywords: Jathropha interrigima; chromium; C-reactive protein; kidney injury molecule; sodium; potassium; urea; creatinine; bicarbonate.

1. INTRODUCTION

The heavy industrialization and the resultant exposure to heavy metals into the ecosystem in the South- South region of Nigeria may be linked to the increase in renal diseases over the years. The activities of these industries produce metals into the air, land and water and are ultimately consumed by humans within this region.

Chromium is naturally occurring in the environment in trace amounts but its use in most industries such as cement, tanning, leather etc increases its prevalence into toxic amounts that are washed into the aquatic environment, [1]. Chromium, especially hexavalent chromium, is highly toxic to fish because it is easily absorbed across the gills, readily enters blood circulation, crosses cell membranes and bio- concentrates up the food chain. In contrast, the toxicity of trivalent chromium is very low, attributed to poor membrane permeability and little bio-magnification [2]. Acute and chronic exposure to chromium (VI) affects behaviour, physiology, reproduction and survival, [2,3] Characteristic clinical presentation of patients includes: sinusitis, nasal septum perforation, allergic and irritant dermatitis, skin ulcers, respiratory irritation, bronchitis, asthma and eventual lung cancer which is a long-term effect [4].

The global burden for renal diseases (GBD) in 2015 estimated that about 1.2 million deaths were as a result of renal failure which was about 32% increase from that in 2005. In 2010 about 2.3-7.0 million people died of end stage renal diseases and about 1.7 million death due to acute kidney injury globally, [5]. From these figures, an estimate of about 5-10million people dies annually from kidney diseases. This high prevalence rate of renal diseases could be attributable to poor health care, poor access to laboratory services to be able to diagnose kidney disease early and high exposure to heavy metals [6].

Kidney diseases are associated with a high economic burden on the society. It involves constant dialysis which most people do not have access to especially in developing countries. High income countries spend about 2-3% of their budget on end stage kidney diseases treatment and dialysis. The death toll in developing countries is quite high due to poor access to good health facilities. In 2010, about 2.6 million people were dialyzed and it is projected that this figure will double by 2030 [7].

The hub of pharmaceutical research is on the discovery of medicinal plants which may be an alternative to orthodox therapy, one of such plant is the Jathropha from Euphorbiaceae family. The Jathropha plants are readily available in the tropical rainforest of the South -South region of Nigeria. The high levels of minerals recorded in this study indicates that there is high uptake of this minerals from the soil and if taken in the right proportion could be beneficial in electrolyte

balance within intracellular environment hence its antidiarrheal properties [8]. Other studies carried out on the phytochemical components of Jathropha species revealed that most of them are rich in alkaloids, flavonoids, coumarins and tannins detected in different parts of the plants. These antioxidant components of the plants make them useful in the treatment of oxidative stress and as anti-hypertensives [9].

This study therefore evaluated the effect of *Jathropha interrigima* on renal function of male albino rats exposed to heavy metals using Chromium.

2. MATERIALS AND METHODS

2.1 Experimental Animals

A total of 30 male Albino Wistar rats that weighed between 140-210g were used for this study. The rats were purchased from the Department of Animal and Environmental Biology of Rivers State University, Port Harcourt. The rats were kept in well ventilated cages at room temperature; and were allowed to acclimatize for 2 weeks and were fed with standard feeds (Top feeds finisher mash, Sapele, Warri) and were given clean double distilled water. The animals were well treated according to the guidelines for the care and use of Laboratory animals [10].

2.2 Plant Material

Jathropha interrigima plant was obtained from a garden in Ibeto road, Port Harcourt town, Rivers State and was identified by Prof. Ben Ekeke of the Department of Forestry, Rivers State University, Port Harcourt, Nigeria.

2.3 Study Design

This study is an experimental study and was carried out in three phases: Acute phase (15 days), Sub- Chronic Phase (30 days) and Chronic Phase (60 Days). A total of 30 male Albino Wistar rats were used for the study. The rats were divided into two sets: the Prophylaxis set (PRE) where *Jathropha interrigima* leaf extracted and given by oral gavage according to body weight for 15 days before exposure to a calculated dose of the Chromium according to body weight. In the therapeutic Set (POST), the rats were exposed on first day to a calculated dose of Chromium then from the second day given the diluted Jathropha leaf extract for next fifteen days by oral gavage. In the Sub chronic phase, the PRE rats were given Jathropha extract for 30 days and on the 31st day they were given a calculated dose of the metal, whereas, the POST rats were exposed to the metal first then given Jathropha afterwards for 30 days before sample collection. Same methodology was used for the chronic phase as the study was stretched to 60 days before sample collection. There were also negative controls (NC) which were rats given only food and water, and positive controls (PC) which were rats exposed to the metal only.

2.4 Sample Collection

Blood samples were collected from the rats by cardiac puncture at the end of each phase into a fresh heparinized vacutainer bottles for analysis. Each blood sample was centrifuged at 3000 rpm for 5 minutes and serum aliquots were put into of micro- vial tubes for the measurement of hepatic parameters such as Electrolyte, Urea, Creatinine, C - reactive protein (CRP) & Kidney Injury Molecule (KIM) on Male Albino Wistar rats exposed to Chromium.

Harvested kidney tissues were fixed in 10% Formol saline for a minimum of 48hrs and representative tissue blocks of 3mm were taken for standard processing into paraffin embedded blocks. The blocks were sectioned in a rotary microtome at 3µm and tissue slides stained with the standard Haematoxylin and Eosin staining technique. Photomicrographs of the liver tissues were taken as shown in the result section.

2.5 Laboratory Analysis

2.5.1 Analysis of C - Reactive Protein (CRP) (Biocheck Inc, San Francisco)

CRP is an alpha globulin with a molecular mass of approximately 110,000 to 140,000 daltons. It is synthesized in the liver and is normally present in trace constituents in plasma. It is one of the acute phase proteins; its elevation is seen in inflammatory process of the liver and the bile duct. An elevation of CRP indicates an inflammation or a pathological change.

The hsCRP ELISA is based on the principle of a solid phase enzyme-linked immunosorbent assay. The assay system utilizes a unique monoclonal antibody directed against a distinct antigenic determinant on the CRP molecule. This mouse monoclonal anti-CRP antibody is used for solid phase immobilization. A goat anti-CRP antibody is in the antibody –enzyme (horseradish peroxidase) conjugate solution. The test sample is allowed to react simultaneously with the two

antibodies resulting in the CRP molecules being sandwiched between the solid phase and enzyme linked antibodies. After 45 minutes incubation, at room temperature, the wells are washed with water to remove unbound labeled antibodies. A 3,3′,5,5′-Tetramethylbenzidine (TMB) reagent is added and incubated for 20 minutes resulting in a blue color that turns yellow upon addition of a stop solution and is read at 450nm in a Microplate Reader.

2.5.2 Analysis of rat Kidney Injury Molecule (KIM) test (Melsin Med. Co. China)

KIM-1 is a type of trans-membrane protein containing a 6-cystein immunoglobulin like domain and a mucin domain that is not detectable in normal kidney tissue or urine. KIM-1 is a biomarker because trans-membrane protein is expressed by tubule epithelial cells in response to injury [11]. This assay employs the quantitative enzyme immunoassay technique (double antibody sandwich) to assay KIM in rats and humans.

The microtiter plates provided in this kit has been pre-coated with antibody. An addition of standards, samples and Horse-Radish Peroxidase (HRP) conjugate to the wells causes an antibody-antigen-antibody binding after an hour incubation, the unbound are washed and chromogen added to form a bluish colour which turns yellow on addition of Hydrochloric acid which is read spectrophotometrically at 450nm. The concentration of KIM in the samples is then determined by comparing the absorbance of samples against a standard curve.

2.5.3 Analysis of plasma urea using urease-berthelot colorimetric method

An automated Chemistry analyzer (Selectra Pro-S) was used to analyze the plasma urea.
Urea in plasma is hydrolysed to ammonia in the presence of urease. The ammonia is then measured photometrically by the Berthelot's reaction at 546nm wavelength.

Urea + H_2O ⟶ $2NH_3 + CO_2$ ⟶ $-NH_3$ + hypochlorite + phenol indophenol (blue compound)

2.5.4 Analysis of plasma creatinine test (Jaffe's kinetic method)

Creatinine is a waste product produced by muscles from the breakdown of Creatine. It is removed from the body by the kidneys which filter all of it from the blood into the urine. Its level in the blood is an indication and the body the functioning of the kidneys. The creatinine is measured using automated chemistry analyzer (Selectra Pro-S). The rate of formation of a coloured complex between creatinine and alkaline picrate is measured, the effect of interfering substances are reduced using the kinetic procedure.

2.5.5 Analysis of plasma electrolyte using ion selective electrode (Audicom Med. Technology, Jiangsu, China)

Plasma electrolytes of concern in this study are Sodium, Potassium, Chloride, Bicarbonates, Total calcium, Non-ionic Calcium, Ionic calcium, pH and a calculation of the Anion gap. Ion selective electrode (ISE) is an electrochemical sensor. It transfers the change of ionic activity in a solution into the change of electrode potential using the Nernst equation:
E= E0 + 2.2303RTlgaxfx nF

where E = potential of ion selective electrode in solution
E0 = standard electrode potential of ion selective electrode n= charge number of measured ion
R= Gas constant
T= Absolute temperature F= faraday constant
ax= measured ion activity
fx= measured ion activity coefficient

2.6 Statistical Analysis

Statistical analysis was done with Statistical Package for Social Sciences (SPSS) of Windows Stat Pack (version 22.0). Data generated were recorded as mean and standard deviations (Mean ± S. D), ANOVA (including Tukey's Multiple Comparative Test) and p values less than 0.05 were considered to be statistically significant.

3. RESULTS AND DISCUSSION

The Mean levels of the parameters under study are presented in Table 1 – 6. In the Acute phase, Potassium level in the Treatment Group when *Jathropha interrigima* extract was given as prophylaxis (7.33 ± 0.51mmol/l) was significantly higher than the positive control (5.5 ± 0.42mmol/l); whereas at POST, Mean Sodium level (134.7 ± 2.08) and Potassium levels (6.83 ± 0.42) in the TG were significantly higher than in the Positive Controls (130.0 ± 0.00) and (5.7 ±

Table 1. Determination of effect of *Jathropha interrigima* (PRE and POST) on electrolytes of male albino wistar rats exposed to chromium in acute phase

Phases	Groups	Parameters Mean ± SD									
		Pre					Post				
		Na^+ (mmol/l)	K^+ (mmol/l)	Cl^- (mmol/l)	-HCO_3 (mmol/l)	AG (mmol/l)	Na^+ (mmol/l)	K^+ (mmol/l)	Cl (mmol/l)	-HCO_3 (mmol/l)	AG (mmol/l)
15 Days	NC	126.5±2.12	7.9±0.84	91.5±2.12	13.5±2.1	22.5±2.12	126.5±2.12	7.9±0.85	91.5±2.12	13.5±2.12	22.5±2.12
	PC	132.5±0.70	5.5±0.42	95.5±2.1	11.5±0.7	26.0±2.82	130.0±0.00	5.7±0.00[1]	97.0±0.00	15.0±0.00	19.0±0.00
	TG	130.6±4.04	7.33±0.5	98.0±2.6	13.0±2.6	20.0±2.65	134.7±2.08[*]	6.83±0.42[*]	95.7±2.52	17.3±2.31	23.3±4.01
	p-value	*0.245*	*0.033*	*0.097*	*0.658*	*0.144*	*0.019*	*0.033*	*0.114*	*0.202*	*0.373*
	F-value	*2.035*	*9.039*	*4.410*	*0.466*	*3.261*	*12.582*	*12.582*	*3.925*	*2.446*	*1.275*
	Remark	*NS*	*S*	*NS*	*NS*	*NS*	*S*	*S*	*NS*	*NS*	*NS*

*S– Significant at p<0.05 (ANOVA); NS – Non-significant at p<0.05 (ANOVA); 1 – significant at p<0.05, PC compared with NC (Turkey's post hoc; # and * - significant, at p<0.05, TG compared with PC and NC respectively (Turkey's post hoc)*

Table 2. Determination of effect of *Jathropha interrigima* (PRE and POST) on electrolytes of male albino wistar rats exposed to chromium in sub-chronic phase

Phases	Groups	Parameters Mean ± SD									
		Pre					Post				
		Na^+ (mmol/l)	K^+ (mmol/l)	Cl^- (mmol/l)	-HCO_3 (mmol/l)	AG (mmol/l)	Na^+ (mmol/l)	K^+ (mmol/l)	Cl^- (mmol/l)	-HCO_3 (mmol/l)	AG (mmol/l)
30 Days	NC	126.5±2.12	5.1±0.07	91.5±2.12	21.5±0.71	9.5±0.71	126.5±2.12	4.4±0.14	91.5±2.12	13.5±2.12	14.0±0.0
	PC	132.5±0.71	5.5±0.42	95.5±2.12	22.5±0.71	10.5±0.71	130.0±0.0	5.7±0.0[1]	97.0±0.0	15.0±0.0[1]	21.0±0.0[1]
	TG	130.7±4.04	5.7±0.4	95.7±1.15	20.6±0.5	12.0±2.0	134.7±2.08[*]	4.5±0.2[#]	95.7±2.52	20.0±1.0[#]	12.7±0.5[*#]
	p-value	*0.246*	*0.274*	*0.107*	*0.085*	*0.285*	*0.019*	*0.002*	*0.114*	*0.010*	*<0.001*
	F-value	*2.035*	*1.819*	*4.122*	*4.857*	*1.746*	*12.582*	*44.171*	*3.925*	*18.132*	*267.143*
	Remark	*NS*	*NS*	*NS*	*NS*	*NS*	*S*	*S*	*NS*	*S*	*S*

*S– Significant at p<0.05 (ANOVA); NS – Non-significant at p<0.05 (ANOVA); 1 – significant at p<0.05, PC compared with NC (Turkey's post hoc; # and * - significant, at p<0.05, TG compared with PC and NC respectively (Turkey's post hoc*

Table 3. Determination of effect of *Jathropha interrigima* (PRE and POST) on electrolytes of male albino wistar rats exposed to chromium in chronic phase

Phases	Groups	Parameters Mean ± SD									
		Pre					Post				
		Na^+ (mmol/l)	K (mmol/l)	Cl (mmol/l)	HCO3 (mmol/l)	AG (mmol/l)	Na^+ (mmol/l)	K (mmol/l)	Cl (mmol/l)	HCO3 (mmol/l)	AG (mmol/l)
60 Days	NC	126.5±2.12	4.8±0.1	91.5±2.12	21.5±0.71	9.5±0.71	126.5±2.12	4.4±0.14	126.5±2.1	13.5±2.1	14.0±0.0
	PC	132.7±0.71	5.5±0.4	95.5±2.12	22.5±0.71	10.5±0.71	130.0±0.0	5.7±0.0[1]	97.0±0.0	15.0±0.0	21.0±0.0[1]
	TG	133.7±3.2	4.7±0.4	95.7±1.15	20.7±0.58	12.0±2.0	130.3±0.5[*]	4.5±0.2[#]	95.7±2.52	20±1.0[*#]	12.6±0.7[*#]
	p-value	*0.079*	*0.138*	*0.107*	*0.085*	*0.285*	*0.043*	*0.002*	*0.114*	*0.010*	*<0.001*
	F-value	*5.124*	*3.382*	*4.122*	*4.857*	*1.756*	*7.622*	*44.171*	*3.925*	*18.132*	*267.143*
	Remark	*NS*	*NS*	*NS*	*NS*	*NS*	*S*	*S*	*NS*	*S*	*S*

*S– Significant at p<0.05 (ANOVA); NS – Non-significant at p<0.05 (ANOVA); 1 – significant at p<0.05, PC compared with NC (Tukey's post hoc; # and * - significant, at p<0.05, TG compared with PC and NC respectively (Turkey's post hoc*

Table 4. Determination of effect of *Jathropha interrigima* (PRE and POST) on renal biomarkers of male albino wistar rats exposed to chromium in acute phase

Phases	Groups	Parameters Mean ± SD							
		Pre				Post			
		CRP (mmol/l)	KIM (mmol/l)	Urea (mmol/l)	Cr (mmol/l)	CRP (mmol/l)	KIM (mmol/l)	Urea (mmol/l)	Cr (mmol/l)
15 Days	NC	1.3±0.0	14.6±0.5	3.3±0.07	52.0±1.41	1.3±0.0	14.6±0.49	3.2±0.07	52.0±1.41
	PC	1.4±0.0	14.2±0.35	3.9±0.71	47.0±4.24	1.5±0.0[1]	14.3±0.0	2.7±0.0	54.0±0.0
	TG	1.37±0.06	13.5±0.25	3.6±0.38	58.3±9.45	1.6±0.06[*#]	16.7±0.1[*#]	3.1±0.85	58.3±9.45
	p-value	*0.151*	*0.070*	*0.309*	*0.409*	*0.005*	*0.001*	*0.652*	*0.599*
	F-value	*3.143*	*5.547*	*1.598*	*1.538*	*26.286*	*67.434*	*0.476*	*0.584*
	Remark	*NS*	*NS*	*NS*	*NS*	*S*	*S*	*NS*	*NS*

*S– Significant at p<0.05 (ANOVA); NS – Non-significant at p<0.05 (ANOVA); 1 – significant at p<0.05, PC compared with NC (Turkey's post hoc); # and * - significant, at p<0.05, TG compared with PC and NC respectively (Turkey's post hoc)*

Table 5. Determination of effect of *Jathropha interrigima* (PRE and POST) on renal biomarkers of male albino wistar rats exposed to chromium in sub-chronic phase

Phases	Groups	Parameters Mean ± SD							
		Pre				Post			
		CRP (mmol/l)	KIM (mmol/l)	Urea (mmol/l)	Cr (mmol/l)	CRP (mmol/l)	KIM (mmol/l)	Urea (mmol/l)	Cr (mmol/l)
30 Days	NC	1.2±0.07	11.4±0.14	2.6±0.07	52.0±1.41	1.3±0.0	14.6±0.49	2.7±0.14	52.0±1.41
	PC	1.2±0.0	12.2±0.14	2.9±0.14	47.0±4.24	2.3±0.0[1]	18.4±0.0[1]	4.4±0.0	85.0±0.0
	TG	1.5±0.12	16.1±1.72[*]	3.2±0.21[*]	54.7±3.5	1.3±0.06[#]	14.4 ±0.59[#]	2.6±0.15[#]	55.0±4.0[#]
	p-value	*0.016*	*0.025*	*0.039*	*0.150*	*<0.001*	*0.002*	*<0.001*	*0.001*
	F-value	*14.060*	*10.675*	*8.183*	*3.168*	*446.286*	*48.177*	*129.914*	*82.437*
	Remark	*S*	*S*	*S*	*NS*	*S*	*S*	*S*	*S*

*S– Significant at p<0.05 (ANOVA); NS – Non-significant at p<0.05 (ANOVA);1 – significant at p<0.05, PC compared with NC (Turkey's post hoc); # and * - significant, at p<0.05, TG compared with PC and NC respectively (Turkey's post hoc)*

Table 6. Determination of effect of *Jathropha interrigima* (PRE and POST) on renal biomarkers of male albino wistar rats exposed to chromium in chronic phase

Phases	Groups	Parameters Mean ± SD							
		Pre				Post			
		CRP (mmol/l)	KIM (mmol/l)	Urea (mmol/l)	Cr (mmol/l)	CRP (mmol/l)	KIM (mmol/l)	Urea (mmol/l)	Cr (mmol/l)
60 Days	NC	1.2±0.71	11.4±0.14	2.6±0.07	52.0±1.41	1.3±0.0	14.6±0.49	2.7±0.14	52.0±1.41
	PC	1.2±0.0	12.2±0.14	2.9±0.14	47.0±4.2	2.3±0.0[1]	18.4±0.0[1]	4.4±0.0[1]	85.0±0.0[1]
	TG	1.5±0.1[*#]	16.1±1.72[*]	3.2±0.21[*]	54.7±3.51[#]	1.3±0.06[*#]	14.4±0.59[#]	2.6±0.15[#]	55.0±4.0[#]
	p-value	*0.016*	*0.025*	*0.039*	*0.150*	*<0.001*	*0.002*	*<0.001*	*0.001*
	F-value	*14.060*	*10.675*	*8.183*	*3.168*	*446.286*	*48.177*	*129.914*	*82.437*
	Remark	*S*	*S*	*S*	*NS*	*S*	*S*	*S*	*S*

*S– Significant at p<0.05 (ANOVA); NS – Non-significant at p<0.05 (ANOVA);1 – significant at p<0.05, PC compared with NC (Turkey's post hoc); # and * - significant, at p<0.05, TG compared with PC and NC respectively (Turkey's post hoc)*

0.01) respectively; Mean CRP and KIM levels (1.6 ± 0.06 and 16.7 ± 0.10 iu/l) in the treatment group were significantly higher than in the PC (1.5 ± 0.01 and 14.3 ± 0.01iu/l). This may indicate that the exposure to Chromium may have caused a renal injury, Inflammation or dysfunction leading to a rise in the level of potassium, CRP and KIM which the Jathropha extract when given as prophylaxis and therapy could not protect within a short time frame. In the Sub-chronic phase, Rats in the PRE had mean CRP level (1.5 ± 0.12 iu/l), KIM (16.1 ±1.72iu/l) and Urea (3.2 ± 0.21mmol/l) which were significantly higher than the Positive control (1.2 ± 0.01iu/l), (12.2 ± 0.14iu/[) and (2.9 ± 0.14mmol/l). The significant increase in CRP, KIM and Urea levels in PRE may still buttress the fact of a renal injury or inflammation which the Jathropha extract could not mitigate against given as prophylaxis even when the duration is increased to 30 days, however, those in POST had mean Potassium level (4.5 ± 0.20mmol/l) and Mean Anion gap level (12.7 ±0.58mmol/l) which were significantly lower than PC and NC; mean CRP, KIM, Urea and Creatinine levels (1.3 ±0.06 iu/l, 1.44 ±0.59iu/l, 2.6 ±0.15mmol/l and 55.0 ± 4.00 umol/l) respectively which were significantly lower than the PC and NC.

The significant decrease in the Renal Parameters in Sub-chronic and chronic phases at POST may indicate a restorative process which is in tandem with the studies carried out by Panda and colleagues 2009 and [8,12] which states that some Jathropha species may have anti-inflammatory properties. A similar result occurred at the chronic phases for both PRE and POST.

4. CONCLUSION

The results of this study indicate that exposure to chromium caused a renal injury and Jathropha interrigima may have the potential to heal or reverse the injurious effect if given as a therapy over a long duration of time maybe between 30 - 60 days.

CONSENT

Not applicable.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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