Original Research Article

Multicellular effects of aqueous stem bark extract of *Cadabafarinosa* Forskon selective internal organs of Wistar rats

ABSTRACT

Introduction: *Cadabafarinosa* Forskbelongs to the family Capparirаceaeand is used in the treatments of breast cancer, snakebite, and retained placentain African folklore medicine. However,information about thetoxicity profile of the plant and risk awareness are largely unknown.

Aim: To determine the histopathological, biochemical, and haematological effects of aqueous stem bark extract of *Cadabafarinosa* Forskon selective internal organs of Wistar rats.

Methods: Twenty (20) Wistar rats were ~~randomly~~ divided into five (5) groups of four rats each. The extract was administered by oral gavage in doses of 100, 200, 300, and 400 mg/kg body weight for 28 days. Blood samples were collected for haematological and biochemical analyses, while the liver, kidney, spleen, lung, brain, and stomach were harvested and processed histopathologically using standard methods.

Results: Oral administration of the aqueous stem bark extract from *Cadabafarinosa* Forskcaused a significant increase in haematocrit (P=0.044) and haemoglobin (P=0.046). However, thewhite blood cellswere significantly (P=0.011) reduced at doses of 300 and 400 mg/kgcompared to control.The serum albumin of treated animals was also significantly (P=0.017) reduced in adose-dependent manner compared to control. In addition, histopathological sectionsof treated animals showed pulmonary haemorrhage, stomach oedema, vacuolation in the spleen, and necrosed hepatocytes.

Conclusion

Oral administration of the aqueous stem bark extract from *Cadabafarinosa* Forskfor 28 days is toxic to the liver, spleen, stomach, and lung. Reducing the therapeutic dose and period of exposure, may minimize the deleterious effects of plant toxins.

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Keywords: *Cadabafarinosa Forks*, leukocytopenia, fatty changes, hypoalbuminemia, liver cell damage,apoptotic changes

1.0 INTRODUCTION

Humans all over the world have developed ways to maintain health as well as prevent and treat diseases[1]. Ethnomedicinal studies documented that about 80% of the population in developing countries depend on medicinal plants for their healthcare needs[2]. The limited accessibility and affordability of modern healthcare in most developing countries have necessitated the extensive use of plant resources as medicines[3,4]. However,the toxicity studies for most medicinal plants often associated with allopathic medicines are unevaluated[5,6].

*Cadabafarinosa*Forsk (*C. farinosa*) belongs to the family Cappariraceae(capparaceae), a slender, evergreen woody shrub growing up to 5 meters tall and rarely trees with 45 genera and about 600 species found throughout the world, mostly in tropical and subtropical regions[7]. All parts of theplant seemed to be useful in traditional medicine. The leaf extracts are used for the treatments of diabetes[8], snakebite[9], haemorrhage[10], parasitic worms[8], mastitis, and breast cancer[11]. The flowers are used as a stimulant, purgative, anthelmintic, and antiphlogistic agents[7].The stem bark is documented to be antimicrobial[12], anti-ulcerative[13], and hepatoprotective[7]. The roots are used for retained placenta[11], breast cancer[14], and female infertility[12].

Ethnobotanical studies have identified secondary metabolites of *C. farinosa* such as flavonoids, alkaloids[8], amino acids, saponins, steroids[12], tannins, phenols, and diterpenes[15].New spermidine alkaloids,cadabicine, L-stachydrine, 3- hydroxystachydrine[10], capparisine, cadibicilone, and ά, β-dihydroferulic acid[16]have been isolated from *C. farinosa*. Other phytochemicals include isoorientin, quercetin, hydroxybenzoic acid, vanillic acid, syringic acid, and 2-hydroxy-4-methoxy benzoic acid have been identified in *C. farinosa*[17]. These secondary metabolites may explain the anti-oxidative, anti-diabetic, anti-inflammatory, anti-tumor, and antimicrobial effects of *C. farinosa*[8,14,18].

In Northern Nigeria, *C. farinosa* sprouts are used to spice foods[19]. The leaves are scorched with cereals to make pudding (cake) called Farsa, Tigiraganda, or Balambo[20]. Decoction of *C. farinosa*is used in makinglocal drinks (gruel) and the dark chocolate colored cake (Farsa) which

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is common in Nigerian the markets for consumption[19]. without considering the body's physiological state. In Maiduguri[21] and Jigawa States[22] of Nigeria, the roots, leaves, and stems of *C. farinosa* are documented to be treatments for breast and skin cancers. "One of the interviewed respondents claimed that there is no type of cancer the plant cannot cure, and he was ready to bet the authors in case they doubted his submission"[8]. However, information about the plant toxicity profile and risk awareness are largely unknown.

This study aimed to determine the histopathological, biochemical, and haematological effects of from aqueous stem bark extract of *Cadabafarinosa* Forskon selective internal organs of Wistar rats.

2.0 MATERIALS AND METHODS

2.1 Plant Material

The fresh plant was collected from UsmanuDanfodiyo University Sokoto, Nigeria. A voucher specimen (Ref. No. PCG/UDUS/CAPP/0002) was deposited for future reference.

2.2 Preparation of extracts

The aqueous extract was prepared using the standard procedure as outlined by Gamde et al.[23] to yield 10.67% with few modifications. Plant material which remaineds from the aqueous extract were resuspended in methanol and allowed to stay for 24 hours. Both the aqueous and methanol extracts were stored in air-tight containers in a refrigerator below 10°C. The suspensions of aqueous and methanol extracts for the phytochemical screening tests were prepared by using distilled water as the solvent and for t The aqueous extracts were used for the oral administration of the aqueous extract to the of the experimental animals.

2.3 Determination of Aqueous Extract Yield

The percentage yield of the aqueous extract (dry weight) was calculated from the equation:

Percentage yield (g/g) = W_1 / W_2 X 100.

Where W_1 signifies the dry extract weight (22.4 g) following solvent evaporation of the aqueous extract and W_2 signifies the powder weight of plant material (210 g) before maceration.

2.4 Phytochemical Tests

Both the aqueous and methanol stem bark extracts of *Cadabafarinosa* were characterized by color reactions indicating the presence or absence of alkaloids, glycosides, tannins, saponins, terpenoids, flavonoids, saponins, cardiac glycosides, anthraquinones following standard methods[12,15].

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2.5 Animals Used

Twenty Wistar rats of both sexes weighing160±10g were procured from The Animal House, Faculty of Pharmaceutical Sciences, UsmanuDanfodiyo University Sokoto Nigeria. The rats were fed with standard chow and water ad libitum. The rats were maintained in standard environmental conditions of temperature (25±2°C), relative humidity, and 12 hours of dark/light cycle before and during the experiment. All experimental procedures were approved by the Animal Ethics Committee, UsmanuDanfodiyo University Sokoto Nigeria.

2.6 Experiment Design

The experiment followed the 'Guide for Care and Use of Laboratory Animals of Laboratory Animal Centre at the Animal House, UsmanuDanfodiyo University Sokoto Nigeria. The rats were ~~randomly~~ divided into five groups (n = 4). The first group received distilled water (control) and the treated groups received a ~~new~~ formulation of *C. farinosa*extract administered orally at doses equivalent to 100, 200, 300, and 400 mg/kg body weight extracts. Under partial anesthesia using chloroform. About 8 mL blood was drawn by cardiac puncture and the target organs were excised ~~from rats~~ 24 hours post-dosing for analysis.

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2.7 Sample Collection

Within 24 hours of the last dose being administered, all animals were weighed and anesthetized with chloroform. Blood samples were collected by cardiac puncture. The blood samples for haematological analysis were collected in EDTA bottles and ~~we used~~ plain sample bottles for biochemical analysis were used, following standard procedures. Stomach, brain, kidney, spleen, liver, and lung tissue samples were excised from the animals, weighed, washed, and fixed with 10% formal saline for histopathological studies.

2.7.1 HaematologicalAssessment

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Blood samples were collected into tubes containing ethylene diamine tetraacetic acid (EDTA) for the determination of red blood cell (RBC), white blood cells ~~total leukocyte count~~ (WBC), platelet count (PLT), haematocrit (HCT), and haemoglobin concentration (Hgb) using a~~n~~Sysmex automated haematology and haemostasis analyser(Sysmex XK-21N, USA).

2.7.2 Biochemical Assessment

Blood samples collected for the liver and kidney function tests were allowed to clot, spun, and analyzed for serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total protein (TP), albumin (ALB), bilirubin (BIL), and electrolytes;

potassium (K^+), sodium (Na^+), and chloride (Cl^-) using aRaytoChemrayautomatic biochemistry analyzer(RaytoChemray 120, Germany).

2.7.3 Histopathological Assessment

Tissue sections measuring 3 mm thick were processed by the paraffin wax method and the paraffin sections were cut at 3 µm using Rotary Microtome (Surgcare Microtome, Model 335A USA) and stained with haematoxylin and eosin (H and &E stain) for the demonstration of general tissue structures.

2.7.4 Statistical Data Analysis

All statistical values were expressed as Mean ± SD and analyzed using the one-way ANOVA (SPSS, 23.0 version, Chicago, IL, USA) followed by the Bonferroni post hoc test. A statistically significant difference between experimental groups was accepted at $P \leq 0.05$.

3.0 RESULTS

3.1 Phytochemical Analysis

The phytochemical testsfor both aqueous and methanolic stem bark extracts of *C. farinosa*showed the presence of carbohydrates, phenols, flavonoids, tannins, saponins, proteins, diterpenes, cardiac glycosides, and triterpenes (Table 1).

Table 1: Phytochemical aAnalysis of*C. farinosa*aqueous and methanolic stem bark extracts

Selected Phytochemical	Test Methodology	Observation	Aqueous Inference	Methanol Inference
Flavonoids	Shinoda's test	An intermediate orange color formed	present	present
	Ferric chloride test	A Blue-black colorwas formed	present	present
Phenols	$FeCl_3$ reagent	A Blue-black colorwas formed	present	present
Carbohydrates	Molisch test	Golden interphase was formed	present	present
	Fehling's solution	An orange colorwas formed	present	present
Alkaloids	Mayer reagents	A brown precipitate was formed	present	present
	Wagner's reagents	A brown precipitate was formed	present	present
	Dragendorff's reagent	Red precipitate was formed	present	absent
Protein/amino acid	Million's test	A yellow color was formed	present	present
Saponins	Ffrothing test	Frothing formed remaineds	present	present
Diterpenes	Copper acetate test	An Emerald green color was formed	present	present
Tannins	$FeCl_3$ reagent	A Blue-black color was formed	present	present
	Lead sub-acetate test	The conspicuous precipitate formed	absent	present
Cardiac	Keller-Killiani's	Brown interphase was formed	present	absent

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glycosides	test			
Triterpenoids	Salkwaski's test	A ~~The~~ golden yellow color ~~was~~ formed	present	present

3.2 Physical Observation and Mortality

No obvious signs of toxicity and mortality were observed in the treated animals as compared to the normal control.

3.3 Effect of E~~e~~xtract on the Haematological Parameter

The effect of the extract on hematological Parameters are~~is~~ presented in Table 2. Oral administration of aqueous stem bark extract of *C. farinosa* for 28 days caused a significant ($P<0.05$) increase in hemoglobin ($P=0.046$) and hematocrit ($P=0.044$), while white blood cell counts ~~(leukocyte)~~ significantly ($P<0.05$, $P=0.011$) were reduced to ~~at~~ 300 and 400 mg/kg. No significant differences were observed in the platelet and red blood cell count of treated animals.

Table. 2: Effect of *C. farinosa* extract on the hematological parameter

Parameter	Unit	Control	100 mg/kg	200 mg/kg	300 mg/kg	400 mg/kg	P-value
Platelet	10⁹/L	1081.7±297.3	721.0±103.00	1270.3±327.52	2128.7±841.69	1551.7±106.49	0.232
Haematocrit	%	31.233±0.284	25.500±4.957	25.800±5.100	30.900±0.000	51.500±10.300*	0.044
Haemoglobin	g/dL	10.400±0.100	8.600±1.700	8.600±1.700	10.300±0.000	17.167±3.433*	0.046
Red blood cells	10⁹/L	3.003±0.467	2.473±0.353	2.473±0.353	3.180±0.000	2.827±0.353	0.529
White blood cells	10⁹/L	38.297±6.020	26.100±0.907	26.800±1.000	19.933±2.239*	21.300±1.234*	0.011

Statistical data are expressed as Mean ± SD and analyzed by ANOVA followed by Bonferroni Post Hoc Test. A statistically significant difference was accepted at *P≤ 0.05.

3.4 Effect of E~~e~~xtract on ~~the~~ B~~b~~iochemical P~~p~~arameter~~s~~

The effect of the extract on the biochemical parameters is presented in Table 3. Oral administration of aqueous stem bark extract of *C. farinosa* on the biochemical parameters for 28 days, significantly ($P<0.05$, $P=0.017$) reduced serum albumin compared to the control. Other biochemical changes were not statistically different from the control.

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Table 3: Effect of *C. farinosa* aqueous stem bark extract on the biochemical parameter

Parameters	Units	Control	100 mg/kg	200 mg/kg	300 mg/kg	400 mg/kg	P-value
Albumin	g/L	3.100±0.28	2.400±0.12*	2.300±0.00*	2.500±0.10*	2.167±0.15*	0.017
Total protein	g/L	5.967±0.6	6.067±0.18	5.567±0.04	5.833±0.66	5.633±0.47	0.941
Total bilirubin	µmol/L	1.067±0.06	0.913±0.09	0.877±0.19	0.837±0.08	0.817±0.04	0.544
Dir. Bilirubin	µmol/L	0.067±0.00	0.090±0.02	0.097±0.01	0.067±0.01	0.083±0.01	0.203
ALP	UI/L	670.6±109.4	1029.0±92.31	1117.3±196.5	1060.7±153.7	597.6±99.9	0.064
ALT	UI/L	97.6±8.41	158.3±17.0	119.6±23.0	129.3±19.3	197.6±5.2	0.113
AST	UI/L	12.6±21.07	261.3±17.9	269.0±42.1	180.6±38.5	223.6±22.0	0.285
Chloride (Cl-)	mmol/L	84.667±1.453	85.000±1.732	80.667±5.238	72.33±5.239	84.67±3.283	0.162
Sodium (Na+)	mmol/L	135.67±1.453	133.00±0.577	142.67±16.384	142.33±15.026	178.67±4.910	0.058
Potassium (K+)	mmol/L	7.2667±0.376	7.6000±0.322	5.5333±1.656	7.2667±0.607	7.000±0.116	0.462

Statistical data are expressed as Mean ± SD and analyzed by ANOVA followed by Bonferroni Post Hoc Test. A statistically significant difference was accepted at $^{*}P \leq 0.05$.

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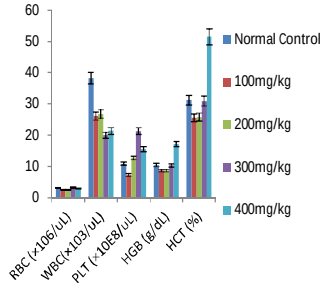

Figure. 1. Effects of extract on some haematological parameter. Analysed by ANOVA and Bonferroni post hoc. Significant at *$P \leq 0.05$.

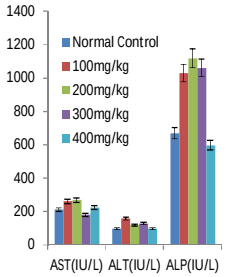

Figure. 2. Effects of extract on serum aminotransferases. Analysed by ANOVA and Bonferroni post hoc. Significant at *$P \leq 0.05$.

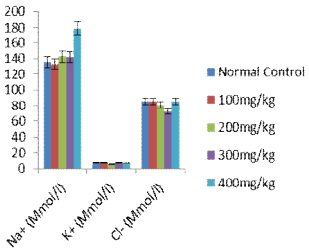

Figure. 3. Effects of extract on electrolytes. Analysed by ANOVA and Bonferroni post hoc. Significant at *$P \leq 0.05$.

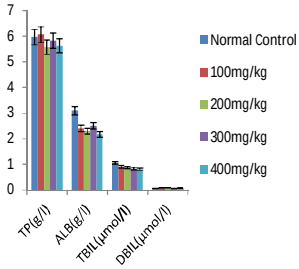

Figure. 4. Effects of extract on liver functions. Analysed by ANOVA and Bonferroni post hoc. Significant at *$P \leq 0.05$.

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3.5 HistopathologyEeffect

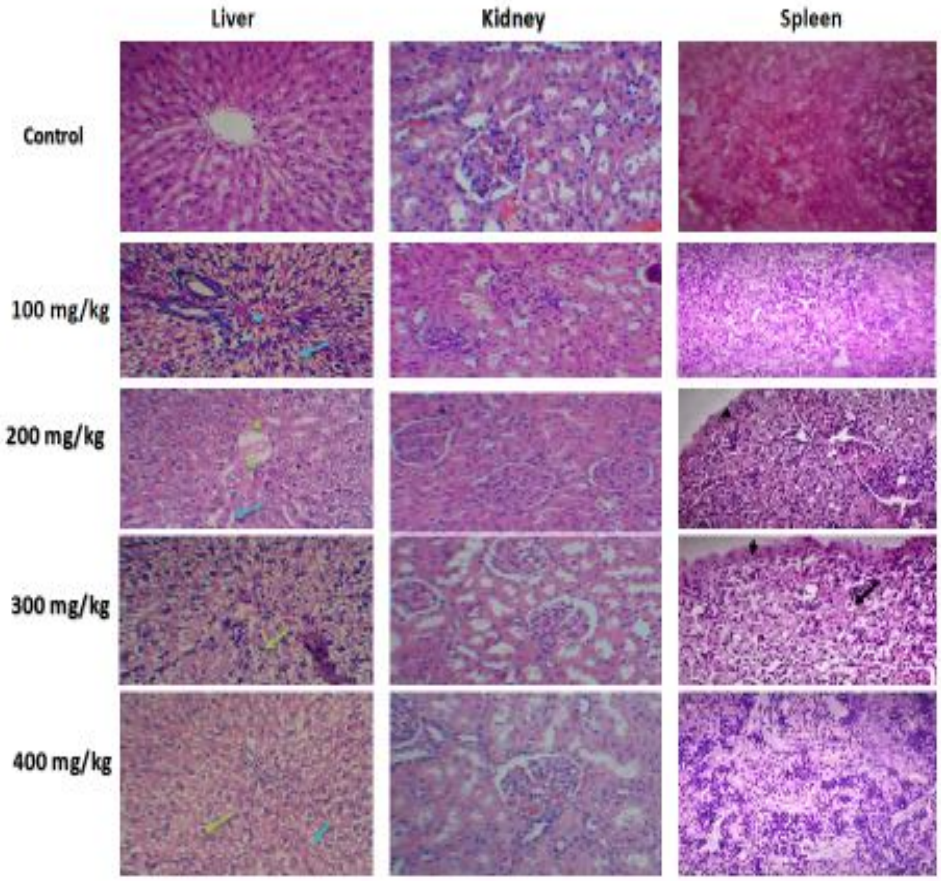

Figure. 5. The representative liver sections of animals administeredextract of *C. farinosa* showed morphological characteristics of vacuolated degeneration of hepatocytes (green arrow), piecemeal necrosis (green arrowhead), inflammatory cells (blue arrowhead), and fatty changes (blue arrow). The spleen showed apoptotic changes (black arrow) and thickened capsule (black arrowhead). No histopathological changes were observed in the kidney parenchyma. (H and &E stain. X 400).

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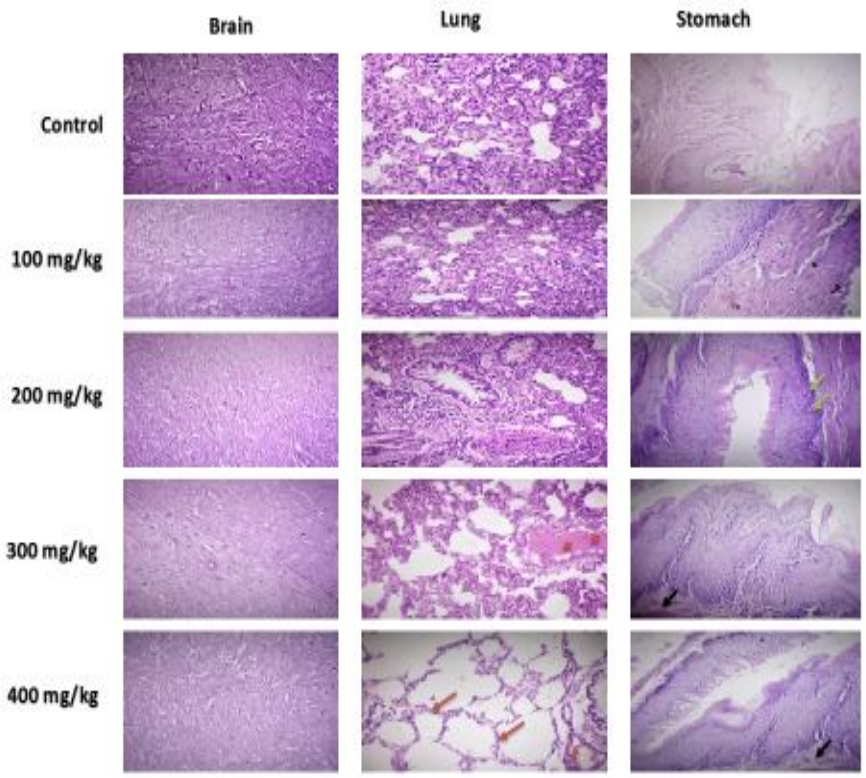

Figure. 6. The representative sections of the lung of Wistar rats ~~animals~~ administered with extract of *C. farinosa*showed expanded alveoli septae (red arrow) and pulmonary hemorrhage (red arrowhead). The stomach showed areas of interstitial edema (black arrow) and hyperplastic cells (green arrow). No histopathological changes were observed in the brain parenchyma (H and ~~&~~E stain. X 400).

4.0 DISCUSSION

The principal aim of evaluating the safety of any ~~medicinal~~ plant extract is to identify the nature and significance of the adverse effect and to establish the exposure level at which the effect is observed[24]. Based on ~~our~~ resultof this study, ~~chronic~~ oral administration of the aqueous stem bark extract from *C. farinosa*Forsk caused statistically significant haematological changes

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(P<0.05). The hemoglobin and hematocrit values in the treated Wistar rats ~~animals~~ were significantly elevated (Figure.1). The elevated hemoglobin and hematocrit values might be beneficial to sickle cell patients with reduced haemoglobin[25]. The identified ~~(Table.1)~~ phytochemical (Table 1)~~antioxidant properties~~ of the extract such as flavonoidspreserved the heme iron of blood in its ferrous state. This trend ~~is in agreement~~agrees with the previous reports[25,26] where the extract increases the oxygen-carrying capacity of red blood cells. However, ~~our data~~ results of this study showed that the extract significantly reduced the white blood cell count (P<0.05, Table. 2) compared to the control. W~~The w~~hite blood cells are ~~is~~ one of the most important immune components against ~~invading~~ pathogens[27]. Some studies have associated the reduced white blood cellcount with the effects of toxicants in the extract and to stress[28].F~~Our f~~inding of this study agree~~s~~with previous reports[25,29]. This implied that prolonged oral administration of aqueous stem bark extract of *C. ~~adaba~~farinosa*induced leukocytopenia.

In the biochemical result, oral administration of aqueous stem bark extract of *C. farinosa* caused a statistically significant decrease inserum albumin (P<0.05, Table. 3). However, serum aminotransferases (Figure. 2), electrolytes (Figure. 3), and other metabolic functions (Figure. 4) were not statistically different compared to the control. Serum aminotransferases may show low sensitivity in chronic liver damage where there is significant degeneration of the hepatocytes[30,31]. Moreover, the reduced serum albumin deduced that the extract of *C. farinosa*induced hypoalbuminemia inWistar rats ~~animals~~ (Table. 3).Hypoalbuminemia is a sensitive indicator for liver dysfunction[32,33]. F~~f~~urthermore, the histopathological sections of the liver showed morphological characteristics of cell death which models hepatocyte apoptosis (Figure. 5). The significance of apoptosis is appreciated to be the main mode of cell death in liver diseases[34].

~~The functional integrity of the kidney is to maintain the body's homeostatic functions through the excretion of metabolic waste products and in the regulation of intracellular fluid volume, electrolyte compositions, and acid-base balance[35].~~ The electrolyte result showed that the extract of *C. farinosa*ha~~d~~s no statistically significant effect on the kidney (Table. 3). This biochemical result was further supported by the normal histological sections of the kidney (Figure. 5).

Further histopathological studies showed morphological characteristics of apoptosis in the spleen (Figure. 5). A similar trend to this model of apoptosis was caused by the continues consumption of Chili pepper[36]. Apoptosis is a mode of cell death characterized by specific morphological and biochemical features[34]. Since spleen is the body's filter against foreign substances from the

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circulatory system, some neutrophils wander from the peripheral blood into the splenic parenchyma to be contributing to the humoral immunological responses[37]. This may perhaps explain the neutrophils in the spleen (Figure. 5). This trend agrees with the number of effeted erythrocytes of ~~in~~ the hematological parameters (Table. 2).

In addition, extract induced interstitial ~~hemorrhage~~haemorrhagein the lungs of treated Wistar rats~~animals~~compared to control (Figure.6). A similar finding was documented from the aerial parts of *Carallumadalzielii*[38]. Furthermore, drug-induced gastrointestinal injury is a common medical problem[39]. Wistar rats ~~animals~~ treated with *C.~~adaba~~farinosa*extract were studied and model the characteristic features of stomach edemawith mild inflammatory cell presentation (Figure. 6)were found. The representative sections of stomach edema were further justified by the reduced serum albumin (hypoalbuminemia) in all treated animals (Table. 3). However, the extract did not cause any pathological changes in the brain cells (Figure. 6). This trend is ~~also~~ in agreement with the report of Kaid et al.[6], where oral administration of Goniothalamin~~us~~extract had no remarkable pathology effect on the brain.

In conclusion, oral administration of the aqueous stem bark extract from *Cadabafarinosa*Forskfor 28 days is toxic to the liver, spleen, stomach, and lung of Wistar rats. Reducing the therapeutic dose and period of exposure may minimize the deleterious effects.

Consent for publication

Consent for publication was obtained from all authors.

Ethical approval

Approved by the Animal Ethics Committee, UsmanuDanfodiyo University Sokoto Nigeria.

Data Availability

Data are available from the corresponding author upon request.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation

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but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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