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Research Article

Ethanolic Leaf Extract of Parsley (*Petroselinum crispum* (Mill.) Nym. ex A.W. Hill, Apiaceae) Effects of Oral Administration on Haematology, Hepatic and Renal Function Biomarkers in Wistar Albino Rats

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Abstract
The ethanol leaf extract of parsley, *Petroselinum crispum,* a widely used vegetable and traditional medicinal plant, was assessed for possible sub-acute toxicity in Wistar rats. Twenty female Wistar rats were divided into four groups of five rats each. The ethanol leaf extract was orally administered daily, for 14 days in varying doses of 500, 1000, 2000 mg/kg body weight (bw), to the experimental groups B, C, and D while the control group A, was given 1ml distilled water. After two weeks, the toxic effects were assessed by quantifying haematological parameters, the hepatic and renal function biomarkers. Liver and kidney tissues samples of the animals in all groups were histopathologically examined. The extract caused a significant increase $p < 0.05$ of the serum activity of alkaline phosphatase enzyme and a significant increase at $p < 0.05$ of the serum creatinine levels at the highest dose of 2000 mg/kg bw. Other biomarkers and haematological parameters were not affected at lower doses. However, there was a significant decrease in the packed cell volume (PCV) at the highest dose of 2000 mg/kg. The liver and kidney organs obtained for pathological study, were structurally unchanged under histopathological evaluation at a lower dose but inflammatory and necrotic features were observed at doses of 1000 and 2000 mg/kg. Conclusively this study indicates that the plant is relatively non-toxic to the haematological, renal and hepatic system at low dose of 500 mg/kg however not safe at the higher concentrations of 1000 and 2000 mg/kg or above for a duration of 14 days, thus caution should be employed especially in its use in ethno-medicine.
Keywords: Haematology, *Petroselinum crispum*, Histopathology, Biomarkers, Renal.

Introduction

Medicinal plants are mainly considered as those used in traditional medicine and aromatic plants are those used for their aroma and flavor. From antiquity, aromatic plants and herbs play a crucial role in the primary healthcare of humans as therapeutic agents for the treatment of many illnesses (Christaki *et al.,* 2020). Parsley (*Petroselinum crispum*), an aromatic plant commonly called garden parsley is a green vegetable garnish in soups, salads, meat and sauces. Parsley is known for its unique aroma thus the use as flavourings in food condiments and the seed used in the manufacturing of soaps, cosmetics and perfumes (Mahmood *et al.,* 2014). The leaf, seed and root are employed in traditional and folklore medicine in many European, Mediterranean and Asian countries of the World (Soliman *et al.,* 2015; Meenakshi, 2019). Parsley leaves and seeds have been used as antibacterial, antiseptic, antispasmodic, carminative, gastrotonic and sedative agents (Farzaei *et al.,* 2013).

The seeds have also been used in the treatment of gastrointestinal disorders, inflammation, halitosis, kidney stones and amenorrhea, dysmenorrhea, menstrual disorders, as emmenagogue and galactagogue (Bisset and Wichtl, 1994; Castleman, 2009; Rehecho *et al.,* 2011; Yousofi *et al.,* 2012). In Italy, its aerial parts are used as an abortifacient (Montesano *et al.,* 2012). Parsley has numerous pharmacological activities such as antifungal, antibacterial, immune-suppressant, antiplatelet and estrogenic effects (Agyare *et al.,* 2017; Akpaso *et al.,* 2023). Studies have demonstrated significant antioxidant properties of the methanol and

ethanol extracts derived from different parts of parsley plant, including the leaves, seeds and stems (Stitou *et al.,* 2017; Gnintoungbe *et al*., 2023).

Parsley is known to be a valuable and important medicinal plant but may pose a great risk on the female reproductive system (Daradkeh and Essa, 2016). With reference to herb-drug interactions, parsley has been known to interfere with warfarin (Coumadin) treatment due to its high content of vitamin K (Bransgrove, 2001). It is pertinent to also note that the ingestion of the leaves of parsley is toxic to many domestic animals including horses, cats, pigs and dogs due to the action of furocoumarins, causing symptoms such as photosensitization, ulceration, photodermatitis and ocular toxicity (Griffiths and Douglas, 2000). The plant has also been shown to have resorptive properties by accumulation of heavy metals when grown on soil irrigated with untreated waste water thus making the plant a potential source of heavy metal toxicity (Keser and Buyuk, 2012). Acute toxicity of parsley was evaluated in rat and no toxicological effect was observed at a dose of 1g/kg bw (Al-Howiriny *et al*., 2003).

The study of the haematological status is one important way for diagnosis of the root cause of diseases. The blood is the most important tissue in which changes in metabolic processes are reflected, therefore abnormal alteration in the blood parameters are the reliable indicator of toxic effects of drugs, chemicals and diseases (Lodia and Kansala, 2012). It thus implies that the evaluation of various haematological parameters can be used to determine the extent of deleterious effect of extracts on the blood of animals (Yakubu *et al.,* 2007). The liver and the kidney are major organs in the body with multifunctional capabilities. They are involved in metabolism of nutrients, detoxification and elimination of toxins most especially the liver (Abilash *et al.,* 2014; Okaiyeto *et al.,* 2018). The biomarkers which include liver enzymes and other parameters are reflective of the status of both organs thus their assessment in toxicity study. Parsley has been used for the treatment of so many diseases, and this has resulted to the assumption that the plant is nontoxic; however experimentally, research has not been extensively carried out to support this assumption. The danger of self-medication without prescribed standard dose may result in measureless side effects which may be acute, sub-acute or chronic toxicity.

In view of the above, this study was undertaken to evaluate and ascertain the safety of parsley plant which is widely employed in ethno medicine as well as its consumption; with focus on assessment of the haematological parameters, the hepatic and renal function tests (AST, ALT ALP, total protein, albumin, globulin, urea, creatinine, uric acid, total and direct bilirubin, sodium, potassium and chloride) as well as the histopathology of liver and kidney tissues.

Methodology

Plant Collection and Extraction

Fresh leaves of *P. crispum* were obtained from a local market in Abuja Municipal Area Council of the Federal Capital Territory (FCT) Nigeria. The identification was done by a botanist in the department of Medicinal Plant Research (MPR) of the National Institute for Pharmaceutical Research and Traditional Medicine (NIPRD) Idu, Abuja; a specimen voucher number of NIPRD/H/7350 was deposited in the same unit. The leaves were dried at the temperature of 25^0C in a shade and pulverized into fine powder using a blender and stored in an airtight container until required. Plant extraction was by maceration of one kilogram of the leaves, using 1500ml of 95% ethanol for 72hours with intermittent shaking and then filtered using Whatman filter paper grade no 1. The filtrate was concentrated to dryness using a rotary evaporator under reduced pressured at 60^0C. The ethanol extract was kept in the fume cupboard to allow the residual ethanol in the extract to evaporate and then air-dried to give the crude extract. It was stored under refrigerated condition until used. The ethanol extract was dissolved in distilled water and administered for the toxicity studies.

Experimental Animal

Female Wistar rats weighing between 117-228g were obtained from the Faculty of Veterinary Medicine, University of Abuja, experimental animal unit. They were kept in properly labeled shoebox cages in the laboratory and fed with standard commercial pelletized rat feed (Vital feed Nig. Ltd); water was provided *ad libitum.* They were allowed to acclimatize for two weeks before the commencement of the experiment.

Acute Toxicity Study of the *P. crispum*

The acute toxicity of the ethanol leaf extract was conducted by modified method of Lorke (1983). This was conducted in two phases. The first phase consisted of nine rats with three rats in each group, administered single doses 10, 100, 1000 mg/kg bw of the ethanol leaf extract *P. crispum* to establish the range of dose producing any toxic effect. In the second phase the extract was further administered sequentially at doses of

1600, 2900 and 5000 mg/kg bw to three rats (one per dose), and this was observed for acute signs of toxicity including behavioral symptoms and death and for 24hours.

LD_{50} value was then determined using:

LD50 = √ (D 0 × D 100).

Where, D_0 = Highest dose that gave no mortality and D_{100} = Lowest dose. The LD_{50} was calculated to be greater than 2000 mg/kg bw.

Subacute Toxicity Test

The rats were randomly divided into four groups of five rats per group. The crude leaf extract was then dissolved in distilled water and administered orally at doses of 500, 1000, and 2000 mg/kg bw for 14 days to groups B, C and D respectively while group A(control) was given 1ml of distilled water. Rats were observed for 14 days for clinical signs. The experiment was carried out according to the guidelines set by Organization of Economic Cooperation Development (OECD, 2002) and the approval from the University of Abuja Animal Ethics Committee on animal use with number (UAE CAU/2024/001).

Determination of Haematological Parameters

At the end of the experimental period blood samples were obtained from the rats via the orbital sinus using microhaematocrit tubes according to the method adopted by Hoff (2000). Whole blood sample was collected into EDTA for the determination of haematological parameters; haemoglobin (Hb), red blood cell count (RBC), total white blood cell count (WBC), other blood cells and specifically, red blood cell index using standard veterinary automated Haemoanalyzer (Orphee Mythic 18, Japan).

Determination of Hepatic and Renal Function Biomarkers

Blood sample collected into plain tubes was centrifuged for 10minutes at 4000 rpm. The clear supernatant (serum) was used for the spectrophotometric determination (Spectrum Lab 750, Huddinge, Sweden) of the biochemical parameters; alanine aminotransferase (ALT), aspartate aminotransferase (AST) at 510nm (Reitman and Frankel, 1957). And alkaline phosphatase (ALP) at 405nm (Englehardt, 1970), plasma albumin by bromocresol green method at 630nm (Doumas *et al.,* 1971), total protein (Gornall *et al.,* 1949), blood urea and creatinine determined by Jaffe reaction and urease enzymatic method (Tietz, 1987), uric acid, total and direct bilirubin (Pearlman and Lee, 1974). All were standard commercial test kits (Randox Laboratory Ltd, UK, Human Laboratories Germany).

Histological Examination of Kidney and Liver Tissues

The liver and kidney tissue samples were allowed to fix in 10% neutral buffered formalin for 48hours and later dehydrated in ascending grades of ethyl alcohol concentration, cleared in xylene, embedded in parraffin wax, sectioned 4um thick and stained with haematoxylin and eosin (Culling, 1983). The stained slides were examined under the microscope at 40, 100, 400 magnifications.

Statistical Analysis

Data obtain from this study were expressed as mean $\pm$ SEM (standard error of the mean). The significant difference in means between treatment and control groups was determined by one-way analysis of variance (ANOVA) followed Duncan's multiple range test. P values ($p < 0.05$) were considered significant.

Results

Effects of Oral Administration of Parsley (*P. crispum*) Leaf Extract on Haematological Parameters of Female Wistar Albino Rats

The effects of oral administration of parsley (*P. crispum*) leaf on haematological parameters are presented in Tables 1 and 2. There was no significant differences in all the haematological parameters evaluated, however in the packed cell volume (PCV) which showed a significant decrease in the highest dosed group D administered 2000mg/kg bw, when compared with the control group A.

Effects of Oral Administration of Parsley (*P. crispum*) Leaf Extract on Renal Function Biomarkers of Female Wistar Rats

The result of the effects of ethanol leaf extract of parsley on kidney function is presented in Table 3. The result showed that the extract caused no variation in all the parameters at all doses however in the

creatinine parameter there was a significant increase at $p < 0.05$ in the highest dosed group D administered 2000 mg/kg bw when compared to the control group A.

Effects of Oral Administration of Parsley (*P. crispum*) Leaf Extract on Hepatic Function Biomarkers of Female Wistar Rats

The result of the effects of ethanol leaf extract of parsley on liver function tests is presented in Table 4. The result showed no significant differences in all the parameters except in the enzyme alkaline phosphatase activity in which there was a significant increase in the highest dosed group D administered 2000 mg/kg bw at $p < 0.05$ when compared to the control group A.

Table 1. Effects of a 14-day oral administration 500, 1000, 2000 mg/kg of parsley (*P. crispum*) leaf extract on haematological (erythrogram) parameters of female Wistar rats.

Haematological parameters/ Groups (doses)	RBC (x 10^6ul)	HB (g/dl)	PCV (%)	MCV (fl)	MCH (pg)	MCHC (g/dl)	PLT (10^9)
Group A (Control)	9.25 ± 0.29	15.75 ± 0.70	53.75± 2.25[a]	58.13 ± 0.88	16.95 ± 0.32	29.13 ± 0.23	681.0 ± 64.17
Group B (500mg/kg)	9.50 ± 0.51	15.65 ± 0.30	54.25 ± 1.11	57.65 ± 4.02	16.58 ± 0.78	28.90 ± 0.66	743.8 ± 78.23
Group C (1000mg/kg)	9.00 ± 0.48	15.55 ± 0.46	51.50 ± 1.76	57.73 ± 1.30	17.35 ± 0.50	30.08 ± 0.39	645.5 ± 70.16
Group D (2000mg/kg)	8.60 ± 0.16	14.69 ± 0.30	47.33 ± 0.47[b]	54.70 ± 0.60	16.98 ± 0.07	31.05 ± 0.23	509.8 ± 8.25
RBC: Red blood cells; Hb: Hemoglobin; PCV: Packed cell volume; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; PLT: Platelet count.							
n = 4; Results expressed as mean ± SEM; Superscript 'a' and 'b' ' indicates significance at ($p < 0.05$).							

Table 2. Effects of a 14-day oral administration 500, 1000, 2000 mg/kg of parsley (*P. crispum*) leaf extract on haematological parameters (leucogram) of female Wistar rats.

Haematological parameters/ Groups (doses)	WBC (x 10^3ul)	LYMP (%)	NEUT (%)	MONO (%)	EOSI (%)	BAS (%)
Group A (Control)	12.83 ± 1.88	77.00 ± 4.20	3.50 ± 1.85	17.25 ± 2.43	0.04 ± 0.04	0.50 ± 0.29
Group B (500mg/kg)	11.38 ± 1.22	87.68 ± 2.01	3.00 ± 0.41	19.00 ± 1.87	0.0 ± 0.0	0.25 ± 0.25
Group C (1000mg/kg)	15.58 ± 2.12	81.25 ± 4.75	4.25 ± 1.65	14.00 ± 3.77	0.0 ± 0.0	0.0 ± 0.0
Group D (2000mg/kg)	9.52± 1.17	72.75 ± 4.84	1.50 ± 0.29	25.00 ± 8.50	0.0 ± 0.0	0.75 ± 0.25
WBC: White blood cells; LYMP: Lymphocytes; NEUT: Neutrophils; MONO: Monocytes; EOSI: Eosinophils; BAS: Basophils.						
n = 4; Results expressed as mean ± SEM; Significance at ($p < 0.05$).						

Table 3. Effects of a 14-day oral administration 500, 1000, 2000 mg/kg of parsley (*P. crispum*) leaf extract on renal function biomarkers in Wistar rats.

Biochemical parameters/ Groups (doses)	Urea (mg/dl)	Creatinine (mg/dl)	Uric acid (mg/dl)	Sodium (mmol/L)	Potassium (mmol/L)	Chloride (mmol/L)
Group A (Control)	37.73 ± 6.06	1.64 ± 0.14[a]	4.95 ± 1.03	150.6 ± 6.06	6.678 ± 0.48	68.58 ± 2.47
Group B (500mg/kg)	47.41 ± 2.34	1.85 ± 0.07	4.61 ± 0.59	150.5 ± 7.93	7.310 ± 0.98	75.44 ± 3.29
Group C (1000mg/kg)	49.40 ± 2.62	2.04 ± 0.05	3.21 ± 0.26	146.9 ± 1.14	6.605 ± 0.75	66.99 ± 0.64
Group D (2000mg/kg)	46.89 ± 1.26	2.18 ± 0.16[b]	3.26 ± 0.40	155.9 ± 5.70	7.545 ± 0.81	78.26 ± 6.40
n = 4; Results expressed as mean ± SEM; Superscript 'a' and 'b' indicates significance at ($p < 0.05$).						

Table 4. Effects of a 14-day oral administration 500, 1000, 2000 mg/kg of parsley (*P. crispum*) leaf extract on hepatic function biomarkers of female Wistar rats.

Biochemical parameters/ Groups (doses)	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	ALP (u/L)	ALT (u/L)	AST (u/L)	Total bilirubin umol/L	Direct bilirubin umol/L
Group A Control	6.72 ± 0.38	3.87 ± 0.12	2.85 ± 0.27	443.0± 68.90[a]	20.91± 2.36	9.91 ± 2.36	8.47 ± 1.46	10.58± 2.71
Group B 500mg/kg	6.73 ± 0.86	3.24 ± 0.18	3.50 ±0.37	368.9 ± 24.12	22.47 ± 5.91	11.02 ± 2.68	12.12 ± 0.33	13.87 ± 0.56
Group C 1000mg/kg	6.34 ± 0.24	3.46 ± 0.40	2.88 ± 0.45	429.2 ± 24.18	13.79 ± 1.62	11.84 ± 4.19	10.46 ± 0.38	10.56 ± 0.36
Group D 2000mg/kg)	7.16 ± 0.52	3.31 ± 0.27	3.86 ± 0.36	635.0 ± 41.35[b]	24.03 ± 7.24	12.56 ± 1.43	12.24 ± 0.45	12.79 ± 0.37
ALP: Alkaline phosphatase; ALT: Alanine transaminase; AST: Aspartate aminotransferase.								
n=4; Results expressed as mean± SEM; Superscript 'a' and 'b' indicates significance at ($p < 0.05$).								

Histopathological Findings

The histopathology of the kidney and liver tissues showed no obvious pathological lesions at the lower dose of 500 mg/kg bw, however at the higher doses, there were inflammatory and necrotic changes observed in the kidney and liver tissues.

Histological sections of the kidney tissue of Wistar rats exposed to a 14-day oral administration of 500, 1000, 2000 mg/kg of ethanol leaf extract of parsley (*P. crispum*) (Figure 1: A-D).

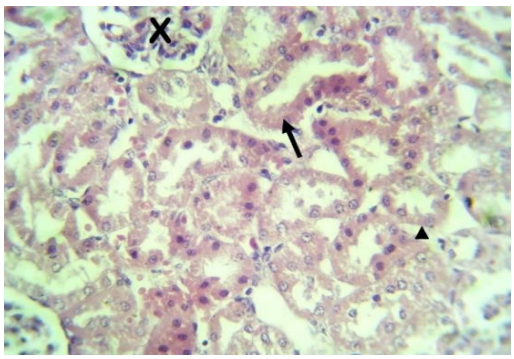

Figure 1A. Histological section of the kidney of a control albino rat not administered with the extract. Note the glomerulus (X), proximal convoluted tubule (arrow). H & E X 400.

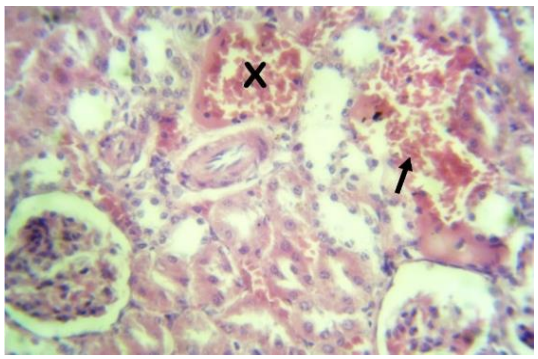

Figure 1B. Histological section of the kidney of albino rats exposed to 500 mg/kg of the ethanol leaf extract of *Petroselinum crispum*. Note the renal congestion (X) and interstitial haemorrhage. H & E X 400.

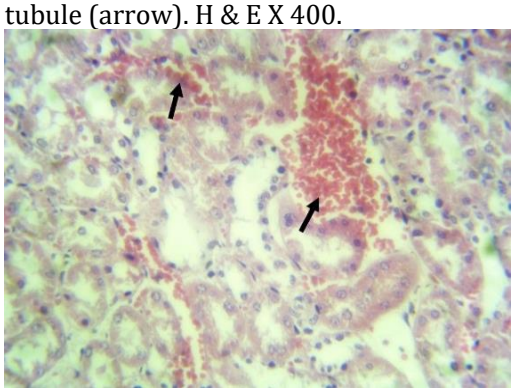

Figure 1C. Histological section of the kidney of albino rat exposed to 1000 mg/kg of the ethanol leaf extract of *Petroselinum crispum*. Note the interstitial haemorrhage (arrow). H & E X 400.

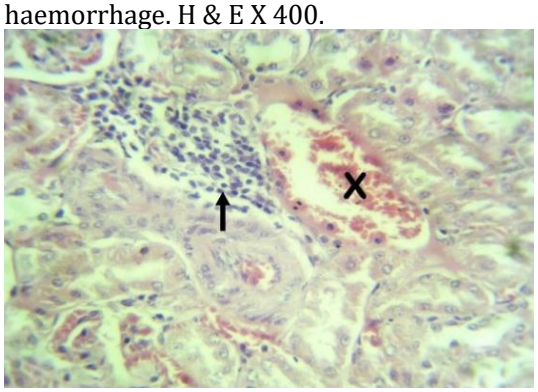

Figure 1D. Histological section of the kidney of albino rat exposed to 2000 mg/kg of the ethanol leaf extract of *P. crispum*. Note the renal congestion (X) and the interstitial tubular necrosis with inflammatory cellular infiltrates (arrow). H & E X 400.

Histological sections of the liver tissue of Wistar rats exposed to a 14-day oral administration of 500, 1000, 2000 mg/kg of ethanol leaf extract of parsley (*P. crispum*) (Figure 2: A-D).

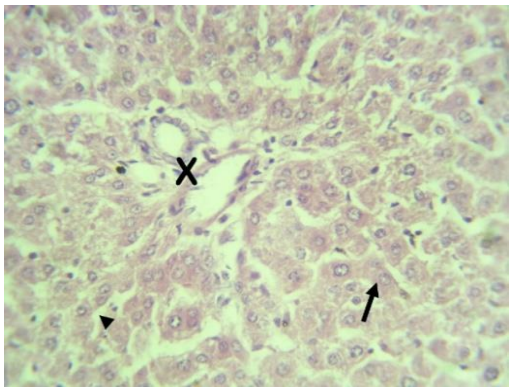

Figure 2A. Photomicrograph of the liver of a Wistar rat. Control group A. Note the portal triad (X), hepatic cord (arrow), and the hepatic sinusoids (arrowhead) normal. H & E X 400.

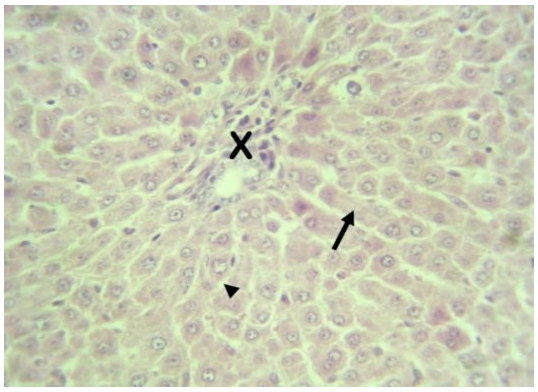

Figure 2B. Photomicrograph of the liver of a Wistar rat exposed to 500mg/kg bw of the ethanol leaf extract of *P. crispum*. Note the portal triad (X), hepatic cord (arrow), and the hepatic sinusoids (arrowhead) normal. H & E X 400.

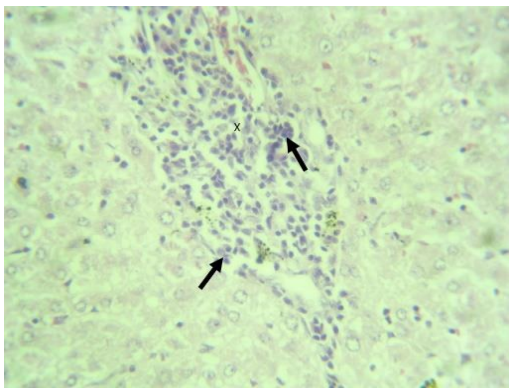

Figure 2C. Photomicrograph of the liver of a Wistar rat exposed to 1000 mg/kg of the ethanol leaf extract of *P. crispum*. Note the hepatic necrosis with inflammatory cellular infiltrates (arrows). H & E X 400.

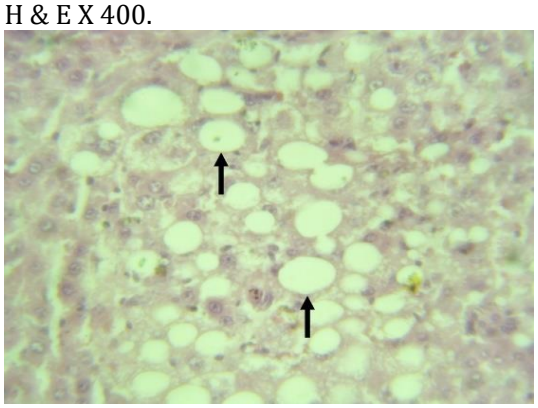

Figure 2D: Photomicrograph of the liver of a Wistar rat exposed to 2000 mg/kg of the ethanol leaf extract of *P. crispum*. Note intracytoplasmic vacuolations (arrows). H & E X 400.

Discussion

The strategy for establishment of a test item depends on the demonstration of its adverse effects (toxicity) or absence of adverse effects under the conditions of exposure of high dose to the test animals (Vandivort and Eaton, 2014). Parsley, is widely used for the treatment of several ailments and its use in traditional medicine however does not have a standard dosing regimen; sequel to this, it is widely believed that this 'wonder plant' is not toxic when administered orally. This claim does not however have sufficient evidence, thus the need for this study. The present study was aimed at investigating the effect of oral administration of ethanol leaf-extract of parsley on the haematology, hepatic and renal function biomarkers in female Wistar rats, so as to ascertain its safe use in ethno-medicine. There was no death recorded after the fourteen days treatment at the dose range of 500-2000mg/kg.

The result of the effect of ethanol leaf extract of parsley, *P. crispum* administered orally on the haematological parameters showed no significant differences at $p < 0.05$ in the haematological parameters (the white blood cell-and red blood cell) evaluated, except for the PCV (Table 1 and 2), this result is similar to that observed by Awe and Banjoko (2013) in a toxicity study of ethanol extract of *P. crispum* on Wistar rats for eight weeks in that it did not show any effect on the haematological parameters at the doses administered (10-1000 mg/kg); an indication that the extract does not affect the haemopoetic system when administered orally at the dose used in this study. There was a significant decrease $p < 0.05$ in the packed cell volume (PCV) of the highest dosed group D administered 2000mg/kg bw, when compared with the control group A (Table 1). Thus in the present study, the leaf extract can be observed to cause anaemia at the highest dose of 2000 mg/kg.

The estimation of liver and kidney function biomarkers could be indicators of liver or kidney diseases. The activities of some of the enzymes such as AST, ALT and ALP in the tissues and body fluids play major role in disease investigation, diagnosis and toxicity (Evalde *et al.,* 2018). The result from the present study showed that, the leaf extract did not show any obvious variation in all the renal function parameters evaluated at the lower dose when compared with the control; except in the creatinine levels, there was a significant increase at $p < 0.05$ in the highest dosed group D administered 2000 mg/kg bw when compared to the control group A (Table 3). Creatinine is a renal function biomarker which is clinically relevant under conditions of impaired renal function (Wyss and Kaddurah-Daouk, 2000). In the present study there was no effect on all other hepatic function biomarkers, but there was a significant increase $p < 0.05$ in the enzyme alkaline phosphatase activity in the highest dosed group D administered 2000 mg/kg bw at $p < 0.05$ when compared to the control group A (Table 4). On the contrary, Awe and Banjoko (2013), reported that the ALT was significantly increased at the highest dose of 1000 mg/kg administered, while the AST and ALP were not affected, indicating a liver injury. In the present study there may have been an injury in the liver, since the liver tissue showed some histological changes in the group with highest dose of 2000 mg/kg bw, upon exposure for 14days. Abnormal levels of AST, ALT and ALP in serum are usually indicative of disease and necrosis of the liver of animals. Analysis of these parameters is important since there are several reports of liver toxicity related to the use of medicinal plants (Pittler and Ernst, 2003).

The histopathology result showed normal architecture at the low dose of 500mg/kg; however, changes were observed at the higher doses in the kidney that may be concentration dependent; with renal congestion, interstitial haemorrhage and tubular necrosis with inflammatory cellular infiltrates. At a higher dose of the extract, it was observed that there were degenerations in the liver suggesting early signs of liver cell injury. This type of liver injury is however known to be reversible upon withdrawal of the toxicant allowing the liver cells to regenerate. This early stage of liver injury may not necessarily reflect in elevation of liver enzymes (Ezeokeke *et al.,* 2017). This may also be the reason for the observed histopathological findings in relation to the levels of hepatic and renal function biomarkers in the present study. The result thus indicates that a daily oral dose of 1000-2000 mg/kg or greater for 14 days can cause damage to the liver and kidney, hence caution should be employed in its use for treatment to avoid overdosing bearing in mind the challenge of overdosing in herbal medicine. In addition, the ingestion of parsley should be discouraged in pregnancy, lactating mothers and individuals on opioids, lithium salts, diuretics and warfarin therapy due to potential drug-herb interaction (Ge *et al.,* 2014). Also, to be noted is that parsley bioaccumulate heavy metals (Keser and Buyuk, 2012), its cultivation should not be done on soil irrigated with treated waste water.

Conclusion

The results of this study indicate that the ethanol leaf extract is relatively nontoxic to the haematological parameters, the renal and hepatic function biomarkers at the low dose of 500 mg/kg, however it is hepatotoxic and nephrotoxic at higher doses of 1000 mg/kg 2000 mg/kg bw; therefore, caution should be taken in the administration of the plant product at high doses 2000 mg/kg bw and above, especially in its use in ethno medicine.

Declarations

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Author Contributions: ENG and ESA: Concept and design of the study, reviewed the literature; ASA and ENG: Implementation of study protocol, data collection and statistical analysis; ASE: Interpretation and review of manuscript; ENG: Manuscript preparation; ESA and ENG: Revision of the manuscript.

Conflict of Interest: The authors declare no conflict of interest.

Consent to Publish: The authors agree to publish the paper in International Journal of Recent Innovations in Academic Research.

Data Availability Statement: The datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

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Institutional Review Board Statement: The experiment was carried out according to the guidelines set by Organization of Economic Cooperation Development (OECD, 2002) and the approval from the University of Abuja Animal Ethics Committee on animal use with number (UAE CAU/2024/001).

Informed Consent Statement: Not applicable.

Research Content: The research content of manuscript is original and has not been published elsewhere.

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