

Effect of Lion's Foot (*Alchemilla vulgaris*) on Liver and Renal Functions in Rats Induced by CCl₄

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Abstract

The present work aims to study the influence of antioxidants activity of lion's foot (*Alchemilla vulgaris*) leaves at different concentrations to give more protection against chronic liver disease. Results indicated that dried lion's foot leaves had rich in total polyphenolic and flavonoids content (395.65 and 183.10 mg/100g, respectively). These results were reflected to the antioxidant activity (DPPH); it's noticed that the antioxidant activity of dried lion's foot leaves was high (131.74%). The major polyphenolic components were benzoic acid (1084.63 ppm) followed by ellagic acid, catechol, and catechin (614.16, 580.54, and 566.53 ppm, respectively) then salicylic acid and protocatechuic acid (479.71 and 444.43 ppm, respectively). On the same trend, flavonoids fractions indicated the highest content in luteo-6-arabinase 8-glucose, apig. 6-rhamnase 8-glucose, acatein, narengin and luteolin (40.01; 15.04; 8.07; 6.64 and 6.42 ppm, respectively). Fifty-six male albino rats were used in biological experiments. Rats fed on basal diet for two weeks before the performance of the experiment. At the beginning, rats divided into eight main group were fed on diets for 45 days as follows: Negative control group (first group) was fed on basal diet. Forty nine rats were fed on basal diet and induced by CCl₄ in paraffin oil (50% v/v, 2 ml/Kg) twice weeks subcutaneous injection to induce chronic damage in the liver, then divided into 7 groups numbered from group 2 to group 8. Positive control group rats fed on basal diet till final experiment (second group). Group 3 and 4 rats treated with 50 and 100 ppm ethanolic leaves extracts, respectively. Also, group 5 and 6 treated with 50 and 100 ppm aqueous leaves extracts, respectively. All extracts were fed on orally every day. While, rats in group 7 treated with 1% and 2% dried lion's foot leaves. At the end of the experimental period, serums were collected to determine liver and

renal functions. The liver was removed surgically for histopathological observation. The results revealed that CCl₄ intoxication impaired liver function. Serum AST, ALT, ALP and total bilirubin levels were elevated by CCl₄ administration, while significant decreasing was noticed in serum albumin in CCl₄ group. Histopathologically, CCl₄ caused congestion of central vein, fatty change of hepatocytes, and focal inflammatory cells in filtration. Treatment with lion's foot with different forms and concentration attenuated these adverse effects and markedly ameliorated histopathological and biochemical alterations caused by CCl₄ especially with 2% powder and 100 ppm ethanol extract administration. Therefore, the results of this study concluded that lion's foot can be proposed to protect hepatotoxicity induced by CCl₄ in rats. The results also revealed that the hepatoprotection effect of lion's foot may be attributed to its antioxidant contents and free radical scavenger effect.

Keywords

Lion's Foot (*Alchemilla vulgaris*), Polyphenols, Flavonoids, Chronic Liver Disease, Liver and Renal Function, Histopathological Evaluation

1. Introduction

Alchemilla vulgaris (Lion's foot or Lady's mantle) is an uncommon herbaceous member of the rose family (Rosaceae). Lady's mantle is native to Europe and Asia and grows well in New Zealand. The medicinal part of the *Alchemilla vulgaris* is aerial part with flowers and stems. The recommended official dose of Lion's foot, the main medicinal plant weigh level is 5 - 10 g/day of the dried plant noticed by [1]. Toxicity, as defined by the LD₅₀ in rats, was observed only at the high concentrations of 5 g/Kg. Concentrations as high as 360 mg/mL did not show any sign of cellular toxicity in the LDH test. Higher concentrations did not substantially add to such properties. These observations show a very high therapeutic index [2]. Also, [3] reported that LD₅₀ for *A. vulgaris* leaves is 17.3 g/Kg.

The liver is a highly sensitive organ which plays a major role in maintenance and performance of the homeostasis in the body. It is the chief organ where important processes like metabolism and detoxification take place. The entry of these toxicants into the body is principally *via* the gastrointestinal tract and after absorption; they are transported through the hepatic vein to the liver revealed by [4] and [5].

Hepatic disorders are one of the most global health problems, considering drugs, chemicals and/or alcohol as main triggers of the disease [6]. Non-alcoholic fatty liver disease (NAFLD) is the main cause of hepatic diseases in the developed countries. As benign steatosis to steato hepatitis and dramatically cirrhosis, NAFLD indicates various hepatic disorders may due to mal-deposition of fats deposition in hepatic cells, which varies in terms of severity from simple

non-inflammatory hepatic steatosis, to steato hepatitis (NASH) that finally progress to liver cirrhosis. NAFLD is mainly found as “a metabolic syndrome” participant with central obesity, hyperlipidemia, impaired glucose tolerance and hypertension revealed by [7] and [8].

Alchemilla mollis (Buser) Rothm aerial part and root methanolic-water extracts were evaluated for their hepatoprotective activity on carbon tetrachloride induced hepatotoxicity and hypoglycemic activity on alloxan-induced diabetic mice. Hepatoprotective activity results have revealed that serum ALT levels were significantly lowered by both the aerial part and root extracts at doses of 100 mg/Kg and 200 mg/Kg. Histopathological examination showed that *A. mollis* aerial parts and roots induced significant recovery from cellular damage; when compared to the carbon tetrachloride group, the most significant activity was observed with *A. mollis* aerial part extracts at a dose of 200 mg/Kg [9]. There is evidence of a hepatoprotective activity of *A. mollis* on the polyphenolic contents of the plant, especially in the case of flavonoids, which have potent antioxidant properties.

The aim of the present work was to high light the reverse effect of dried Lion’s foot; its aqueous and ethanol extracts at various ratios against the toxicity of CCl₄, also to evaluate the various ratios on body weight, feed intake, liver and renal functions and histopathological changes that may occur on rats suffering from chronic liver disease.

2. Materials and Methods

2.1. Materials

Lion’s foot dried leaves was obtained from Horticultural Research Institute, Agriculture Research Center Giza, Egypt. Carbon tetrachloride (CCl₄), casein, vitamins, minerals, cellulose and choline chloride will be purchased from El-Gomhoreya Company, Cairo Egypt. Animals: Fifty six male albino rats will be obtained from Helwan breeding farm, Cairo-Egypt. Weighing an average will be between (200 ± 10 g). Casein, cellulose, all vitamins and minerals were obtained from El-Gomhoria Pharmaceutical Company, Cairo, Egypt. Corn oil and starch were obtained from the local market. Kits to determine serum aspartate amine transaminase (AST), alanine amine transaminases (ALT), and alkaline phosphates (ALP), total bilirubin, albumin, glutathione reductase and malonaldehyde were purchased from Biodiagnostic Company in Egypt.

2.2. Methods

2.2.1. Chemical Analysis of Raw Materials

Total polyphenolic compounds were determined by the Folin-Ciocalteau method [10]. The absorbance was measure at 760 nm. Results were express as gallic acid equivalents (GAE) per 100 g sample. Also, the content of flavonoids was determined by Chen and Li [11]. The absorbance of the solution at a wavelength of 510 nm was determined. Total flavonoid content in each spice extract was then calculated using a standard curve prepared as rutin per 100 g sample.

Soluble tannins were evaluated using the Folin Denis method as described by Taira [12]. Absorbance was measured with a spectrophotometer at 725 nm. While, saponins in Lion's foot leaves was determined by gravimetrically methods as described by Anhawange *et al.* [13].

Polyphenols and flavonoids compounds determined by HPLC according to method Goupy *et al.* [14] and Mattila *et al.* [15], respectively as follow: 5 g of sample were mixed with methanol and centrifuged at 1000 rpm for 10 min and the supernatant was filtrated through 0.2 μm Millipore membrane filter, then 1 - 3 ml was collected in avail for injection in HPLC Hewlett-packard (series 1050) equipped with auto sampling injector, solvent degasser, ultraviolet (UV) detector set as 289 nm and 330 nm and quarter HP pump (series 1050). The column temperature was maintained at 35°C. Gradient separation was carried out with methanol and acetonitrile as a mobile phase at flow rate 1ml/min.

DPPH scavenging activity tests were carried out according to the method of Brand-Williams *et al.* [16]. 0.01 g of sample was dissolved in 10 ml DMSO and seven different concentrations (1 mg/ml to 0.015 mg/ml) were prepared with $\frac{1}{2}$ dilutions. 2.9 ml DPPH solution (10^{-4} M in ethanol) was added into 0.1 ml of sample solutions. The mixture was shaken vigorously and incubated 30 minute in 30°C water bath. Absorbance of the resulting solution was measured at 517 nm UV/visible spectrophotometer (Shimadzu). Percentage of inhibition (DPPH scavenging activity) determined as follows:

% DPPH radical-scavenging

$$= \left[\frac{\text{Absorbance of DPPH} - \text{Absorbance of sample}}{\text{Absorbance of DPPH}} \right] \times 100$$

2.2.2. Preparation of Extracts

Lion's foot (*Alchemilla vulgaris*) leaves were washed in aqueous several times to remove any adhering flesh, dried in oven under vacuum, then ground well. Ground Lion's foot was dipping in ethanol 80% (1:100 w/v) or in distilled water (1:100 w/v) in dark bottle for 48h in refrigerator at 4°C temperature. To obtain extracts, then mixtures were filtered by filter paper (Whatman1). Aqueous and ethanolic extracts were evaporated in rotary evaporator at 50°C.

2.2.3. Diet Composition and Animal Groups

1) Diet composition: Basal diet was prepared according to Reeves *et al.* [17]. The vitamin and mineral mixture had the prepared according to Campbell [18].

2) Experimental design: Animal house in Food Technology Research Institute, Agriculture Research Center albino rats were adapted for one week prior to commencement of the experiment, housed in well aerated cages under hygienic condition and aqueous was introduced *ad-libitum*. After this week, rats were divided into 8 main groups (seven rats of each) and fed on diets for four weeks as follows: Group 1: Negative control group fed on basal diet. Forty nine rats fed on basal diet and treated with CCl_4 , in paraffin oil (50% v/v 2 ml/Kg) twice weeks subcutaneous injection to induce chronic damage in the liver [19], 7 groups numbered from 2 to group 8. Group 2: Positive control group had fed on basal

diet till final experiment. Group 3: treated as group 2 with 50 ppm Lion's foot leaves ethanol extract daily orally. Group 4: treated as group 2 with 100 ppm Lion's foot leaves ethanol extract daily orally. Group 5: treated as group 2 with 50 ppm Lion's foot leaves aqueous extract daily orally. Group 6: treated as group 2 with 100 ppm Lion's foot leaves aqueous extract daily orally. Group 7: treated as group 2 with 1% Lion's foot leaves powder. Group 8: treated as group 2 with 2% Lion's foot leaves powder. During the experiment period, the quantities of diet, which were consumed and/or waste, were recorded every day. In addition, rat's weight was recorded weekly, to determine feed intake, Body weight gain%, and feed efficiency ratio according to Chapman *et al.* [20].

3) Blood Sampling: At the end of the experiment period, the rats were fasted overnight then the rats were anaesthetized, sacrificed and blood samples were collected from the aorta. The blood samples were centrifuged for 15 minutes at 3000 rpm to separate the serum. The serum was carefully separated into dry clean Wassermann tubes by using a Pasteur pipette and kept frozen till analysis at -20°C .

2.2.4. Biochemical Analyses of Serum

1) Liver functions: Aspartate amine transaminase (AST), Alanine amine transaminases (ALT), and Alkaline phosphates (ALP) were measured according to the method described by Tietz *et al.* [21]. Albumin was measured according to the method described by Burtis *et al.* [22]. Bilirubin was determined according to the method described by Tietz and Saunders [23].

2) Kidney Functions: Uric acid was determined in the serum according to the method described by Fossati *et al.* [24]. Urea nitrogen and Creatinine were determined according to Young and Friedman [25].

2.2.5. Histopathological Studies

Liver and kidney tissues stained by Hematoxylin and Eosin according to Bancroft *et al.* [26] Histopathological examination was performed at the Histology laboratory, Faculty of Veterinary Medicine, Cairo University.

2.3. Statistical Analysis

Results were expressed as the mean standard deviation \pm SD. Data were statistically analyzed for variance "ANOVA" test at $P \leq (0.05)$ using SPSS statistical software, "version 20" will be used for these calculations [27].

3. Results and Discussion

3.1. Antioxidant Contents

Total polyphenols, total flavonoids, soluble tannins, saponins and antioxidant activity of dried lion's foot are recorded in **Table 1**. The data indicated that dried lion's foot leaves had rich in total polyphenolic and flavonoids content (395.65 and 183.10 mg/100g, respectively). Also, it's observed the highest content of soluble tannins and saponins (150.64 and 296.32 mg/100g) in dried leaves. These

Table 1. Antioxidant contents in dried lion's foot leaves (mg/100g).

Compounds	mg/100g
Total polyphenols	395.65 ± 21.43*
Total Flavonoids	183.10 ± 8.70
Soluble Tannins	150.64 ± 10.22
Saponins	296.32 ± 14.51
Antioxidant Activity% (DPPH)	131.74 ± 2.05

*Values are means of triplicates ± Standard deviation.

results were reflected to the antioxidant activity, its noticed that the antioxidant activity of dried lion's foot leaves was high (131.74%). European Pharmacopoeia described the aerial parts of lion's foot and its chemical content as containing a minimum of 6% tannin, chlorogenic acid and caffeic acid [28].

Table 2 and **Table 3** indicated high contents of polyphenolic and flavonoids compounds in dried lion's foot leaves (ppm on dry weight basis). The major polyphenolic components were benzoic acid (1084.63 ppm) followed by ellagic acid, catechol, and catechin (614.16, 580.54, and 566.53 ppm, respectively) then salicylic acid and protocatechuic acid (479.71 and 444.43 ppm, respectively). Also, flavonoids fractions indicated the highest content in luteo-6-arabinase 8-glucose, apig. 6-rhamnase 8-glucose, acatein, narengin and luteolin (40.01; 15.04; 8.07; 6.64; 6.42 mg/100g, respectively). These data was adapted by [29] they reported that, benzoic acid, ellagic acid, catechol, catechin, ellagic acid, salicylic acid and vanillic acid recorded the highest contents which known with their antioxidant and anti-inflammatory properties.

3.2. Biological Parameters

Data in **Table 4** showed that, control positive group was significant decrease in body weight gain%, feed intake and feed efficiency ratio compared with control negative group, while all treatment groups with lion's foot at different concentration whether aqueous extract, ethanol extract or powder showed significant increase in these parameters compared with positive control group. These data was adapted by [30] they reported that *A. vulgaris* L. are mainly the flavonoids reported to increase the metabolic rate in cold environments, regulate digestive enzymes, and metabolic stimulation.

As seen in **Table 5**, AST, ALT, ALP and total bilirubin in serum were elevated significantly by CCl₄ administration while, there was significant decrease in serum albumin compared to negative control. Significant reduction was observed in AST, ALT, ALP and bilirubin with *A. vulgaris* treatment in all different groups except for 50 ppm aqueous extract group. The best result was in group treated with 100 ppm ethanol extract and 2% powder. In contrast rats fed on lion's foot leaves dried and aqueous or ethanol extract were significant increase in serum albumin compared with positive control. The enhancement of our results on liver function may be due to that *A. vulgaris* contains antioxidant,

Table 2. Polyhenolic compounds profile in dried lion's foot leaves (ppm).

Phenolic compounds	ppm
Gallic acid	85.65
4-Amino-benzoic acid	33.19
Protocatchuic acid	444.43
Catechin	566.53
Chlorogenic acid	70.10
Catechol	580.54
Epicatachin	264.32
Caffeine	59.32
P-OH-benzoic acid	182.68
Caffeic acid	50.46
Vanillic acid	285.94
P-coumaric acid	153.95
Iso-ferulic acid	69.95
Reversetrol	11.97
Ellagic acid	614.16
Alpha-coumaric acid	66.86
Benzoic acid	1084.63
3,4,5-methoxy-cinnamic acid	30.16
Coumarin	27.67
Salicylic acid	479.71
Cinnamic acid	21.32

Table 3. Flavonoids compounds profiles in dried lion's foot leaves (ppm).

Flavonoids Compounds	ppm
Luteo.6-arbinose 8-glucose	40.01
Luteo.6-glucose 8-arabinose	3.19
Apig. 6-arabinose 8-galactose	1.31
Apig. 6-rhamnose 8-glucose	15.04
Luteolin	6.42
Narengin	6.64
Rutin	0.44
Rosmarinic	0.30
Apig.7-O-neohespiroside	1.07
Kamp.3,7-dirhamoside	1.93
Apig.7-glucose	0.69
Quercetrin	0.22

Continued

Quercetin	0.75
Kaemp.3-(2-p-comaroyl)glucose	6.00
Naringenin	0.24
Hespirtin	0.63
Kampferol	0.33
Rhamnetin	0.56
Apegnin	0.14
Acacetin	8.07

Table 4. Body weight gain, feed intake and feed efficiency ratio in rats fed on dried lion's foot leaves and its extracts.

Parameters Groups	Body Weight Gain (%)	Feed Intake (g/d)	Feed efficiency ratio (FER)
Normal group	20.22 ^a ± 2.84	18.98 ^a ± 1.38	0.59 ^a ± 0.016
Control positive group (PG)	11.03 ^c ± 1.94	13.50 ^b ± 1.65	0.22 ^b ± 0.008
Ethanol extract 50 ppm	15.00 ^b ± 1.52	18.89 ^a ± 1.19	0.53 ^a ± 0.011
Ethanol extract 100 ppm	16.00 ^b ± 1.62	18.66 ^a ± 1.92	0.56 ^a ± 0.017
Aqueous extract 50 ppm	15.00 ^b ± 1.99	19.30 ^a ± 1.50	0.58 ^a ± 0.009
Aqueousextract 100 ppm	16.13 ^b ± 1.15	19.05 ^a ± 1.30	0.59 ^a ± 0.013
Dried lion's foot 1%	16.00 ^b ± 1.70	18.50 ^a ± 1.4	0.55 ^a ± 0.017
Dried lion's foot 2%	17.18 ^b ± 2.39	19.00 ^a ± 1.19	0.58 ^a ± 0.019

Data are presented as mean (n = 7 rats) ± standard deviation, values with different superscripts within the column are significantly difference at $P < 0.05$, while those with have similar or partially are not significant.

Table 5. Effect of dried lion's foot leaves and its aqueous and ethanolic extracts on liver function of rats.

Parameters Groups	AST (IU/L)	ALT (IU/L)	ALP (IU/L)	Albumin (g/dl)	Total Bilirubin (mg/dl)
Normal group	53.42 ^c ± 5.88	24.50 ^c ± 4.00	160.57 ^c ± 17.83	3.85 ^a ± 0.11	1.70 ^b ± 0.09
Control positive group (PG)	66.57 ^a ± 9.24	37.50 ^a ± 6.69	219.42 ^a ± 29.37	2.05 ^b ± 0.48	2.18 ^a ± 0.18
Ethanol extract 50 ppm	58.28 ^b ± 9.64	29.85 ^b ± 3.09	183.28 ^b ± 10.50	3.83 ^a ± 0.20	1.75 ^b ± 0.17
Ethanol extract 100 ppm	56.57 ^{bc} ± 8.36	24.14 ^c ± 5.10	175.14 ^{bc} ± 15.09	3.45 ^a ± 0.08	1.75 ^b ± 0.14
Aqueous extract 50 ppm	60.00 ^{ab} ± 13.85	34.42 ^{ab} ± 6.27	195.42 ^{ab} ± 16.51	3.75 ^a ± 0.26	2.07 ^a ± 0.19
Aqueousextract 100 ppm	58.28 ^b ± 9.15	30.85 ^b ± 5.79	186.00 ^b ± 11.92	3.39 ^a ± 0.20	1.90 ^b ± 0.15
Dried lion's foot 1%	55.00 ^{bc} ± 5.90	29.71 ^b ± 4.13	187.14 ^b ± 15.92	3.71 ^a ± 0.35	1.82 ^b ± 0.10
Dried lion's foot 2%	52.70 ^c ± 6.49	24.28 ^c ± 4.06	180.00 ^b ± 10.69	3.82 ^a ± 0.44	1.78 ^b ± 0.14

Data are presented as mean (n = 7 rats) ± standard deviation, values with different superscripts within the column are significantly difference at $P < 0.05$, while those with have similar or partially are not significant.

Table 6. Effect of dried lion's foot leaves and its water and ethanolic extracts on renal function of rats.

Parameters Groups	mg/dl		
	Creatinine	Urea	Uric Acid
Normal group	0.65 ^d ± 0.10	35.00 ^d ± 2.44	1.80 ^d ± 0.25
Control positive group (PG)	1.30 ^a ± 0.02	68.20 ^a ± 7.08	3.98 ^a ± 0.42
PG treated with ethanol extract 50 ppm	0.78 ^c ± 0.08	43.43 ^c ± 4.99	2.73 ^{bc} ± 0.11
PG treated with ethanol extract 100 ppm	0.66 ^d ± 0.04	39.52 ^{cd} ± 3.12	2.25 ^c ± 0.25
PG treated with aqueous extract 50 ppm	0.93 ^b ± 0.07	62.30 ^{ab} ± 5.12	3.10 ^{ab} ± 0.19
PG treated with aqueous extract 100 ppm	0.85 ^{bc} ± 0.10	58.60 ^b ± 4.83	2.82 ^{bc} ± 0.94
PG fed on Lion's foot dried 1%	0.69 ^d ± 0.08	40.55 ^{cd} ± 6.45	2.90 ^c ± 0.92
PG fed on Lion's foot dried 2%	0.61 ^d ± 0.08	38.52 ^{cd} ± 7.47	2.29 ^c ± 0.80

All results are expressed as mean ± SD. Values in each column which have different letters are significantly different ($p < 0.05$).

polyphenols, tannins composed of some gallic and mostly ellagic acid, flavonoids such as orientin, quercetin, quercitrin, isoquercetin, vitexin, rutin, hyperoside, with others, including luteolin and pro-anthocyanidins to which the main pharmacological activities of the plant [31] Also, [32] reported that *A. vulgaris* contain flavonoids which important for the treatment of inflammation and wound healing. Our results are agree with [33] which reported that medicinal plant *A. vulgaris* serve as a vital source of potentially useful new compounds for the development of effective therapy to combat liver problems.

Results in **Table 6** showed a significant decrease in creatinine and urea in the groups fed on 1% and 2% dried lion's foot leaves compared with other groups which rats fed on 50 and 100 ppm ethanol extracts orally, then in rats fed on water extracts compared with positive group. Also, uric acid was decreased significant in rats fed on 1% and 2% dried lions foot (2.90 and 2.29 mg/dl, respectively), then rats groups fed on ethanol extracts (2.73 and 2.25 mg/dl) followed by rats fed on water extracts (3.10 and 2.82 mg/dl) 50 ppm and 100 ppm, respectively compared with positive group (3.98 mg/dl). It appears from results that lion's foot was safe on renal functions. These data were adapted by [34] they found that reduction in serum uric acid level may be attributed to the increased utilization of uric acid against increased production of the free radical since it has a capable especially of reacting with free radicals.

3.3. Histopathological Examination of Liver

Liver of rat from group 1 revealed the normal histological structure of hepatic lobule (**Figure 1**). Meanwhile, liver of rats from group 2 revealed congestion of central vein (**Figure 2**). Examined sections from group 3 revealed congestion of central vein and hepatic sinusoids as well as vacuolar degeneration of hepatocytes (**Figure 3**) and Kupffer cells activation. Moreover, liver of rats from group

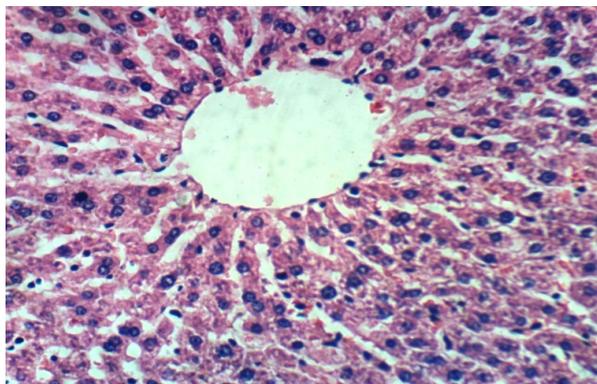


Figure 1. Liver of rat from group 1 showing the normal histological structure of hepatic lobule (H & E \times 400).

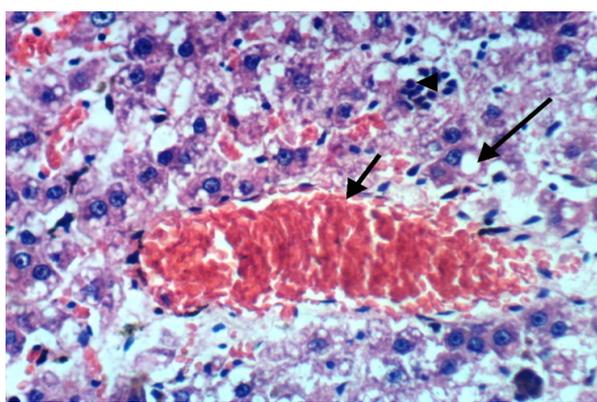


Figure 2. Liver of rat from group 2 showing congestion of central vein, fatty change of hepatocytes and focal inflammatory cells infiltration (H & E \times 400).

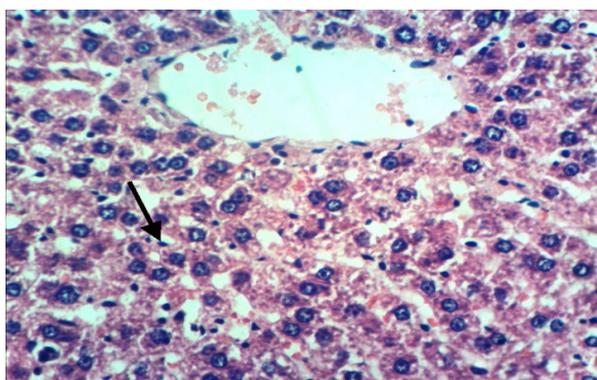


Figure 3. Liver of rat from group 3 showing Kupffer cells activation (H & E \times 400).

4 showed slight vacuolar degeneration of hepatocytes (**Figure 4**). However, liver from group 5 showed Kupffer cells activation and strands of fibroblasts proliferation in the portal triad (**Figure 5**). Liver of rats from group 6 revealed sinusoidal leukocytosis (**Figure 6**). Slight Kupffer cell activation was the only histopathological change observed in liver of rats from group 7 (**Figure 7**). Moreover, liver of rats from group 8 revealed few leucocytes in the hepatic sinusoids (**Figure 8**).

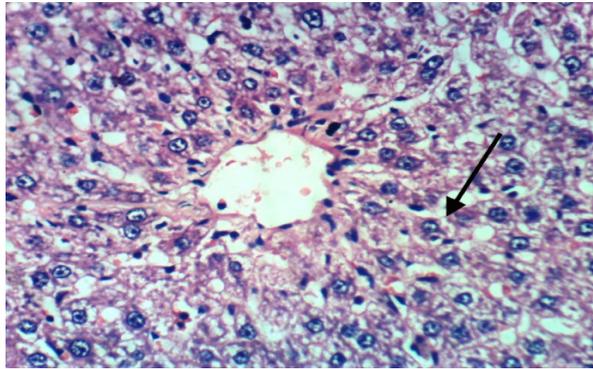


Figure 4. Liver of rat from group 4 showing slight vacuolar degeneration of hepatocytes (H & E \times 400).

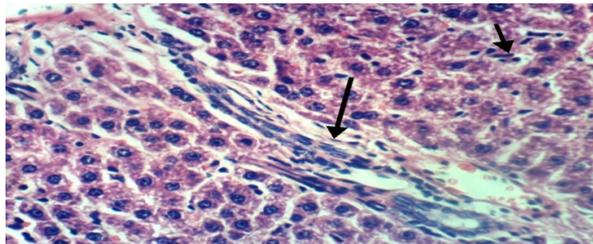


Figure 5. Liver of rat from group 5 showing Kupffer cells activation and strands of fibroblasts proliferation in the portal triad (H & E \times 400).

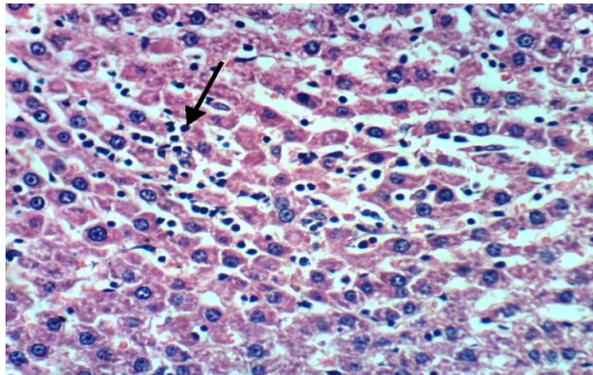


Figure 6. Liver of rat from group 6 showing sinusoidal leucocytosis (H & E \times 400).

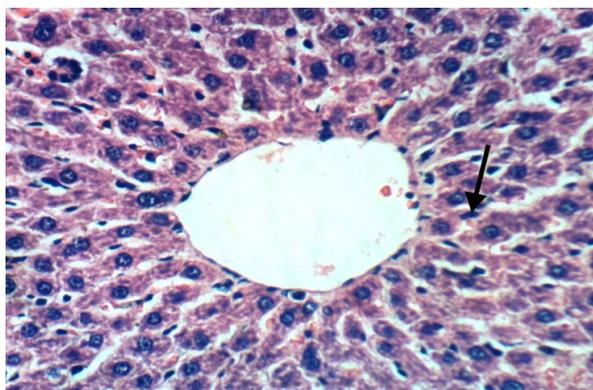


Figure 7. Liver of rat from group 7 showing slight Kupffer cell activation (H & E \times 400).

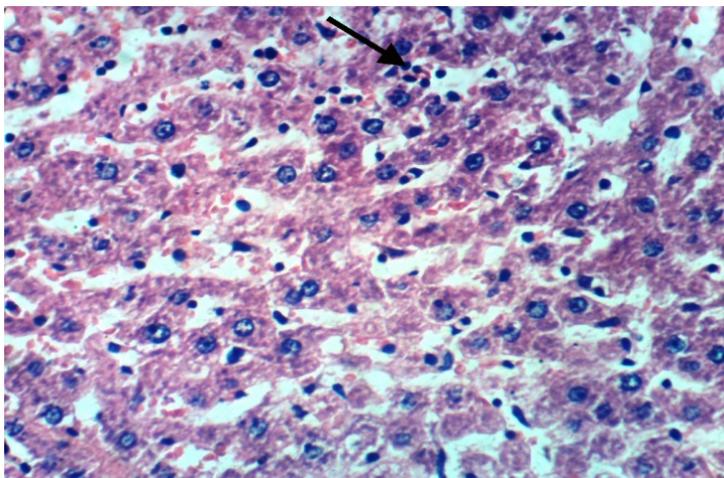


Figure 8. Liver of rat from group 8 showing few leucocytes in the hepatic sinusoids (H & E \times 400).

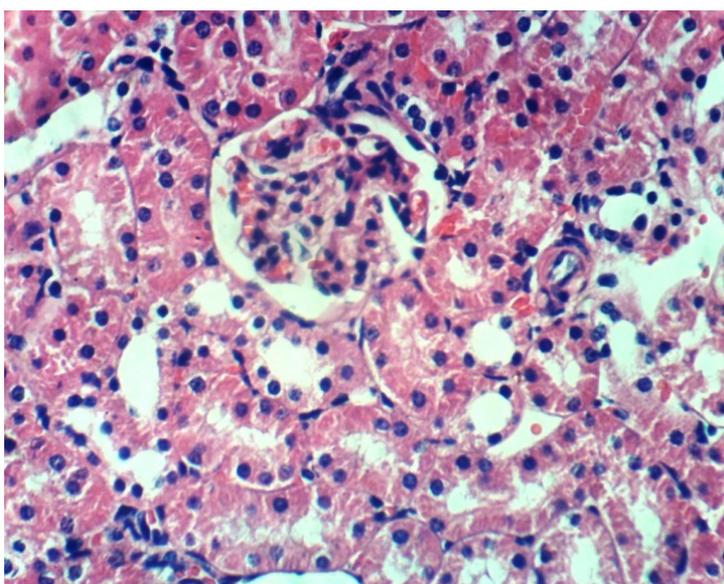


Figure 9. Kidney of rat from group 1 showing the normal histological structure of renal tubules (H & E \times 400).

3.4. Histopathological Examination of Kidneys

Microscopically, kidneys of rat from group 1 showed the normal histological structure of renal tubules (**Figure 9**). Meanwhile, kidneys of rat from group 2 revealed vacuolation of epithelial lining renal tubules as well as congestion of glomerular tuft and renal blood vessels (**Figure 10**). Meanwhile, kidneys of rats from groups 3 and 4 revealed no histopathological changes (**Figure 11** and **Figure 12**, respectively). On the other hand, kidneys of rats from group 5 showed vacuolation of renal tubular epithelium (**Figure 13**). Some sections from group 6 revealed no histopathological changes (**Figure 14**). However, kidneys of rats from groups 7 and some sections from group 8 revealed no histopathological changes (**Figure 15** and **Figure 16**, respectively).

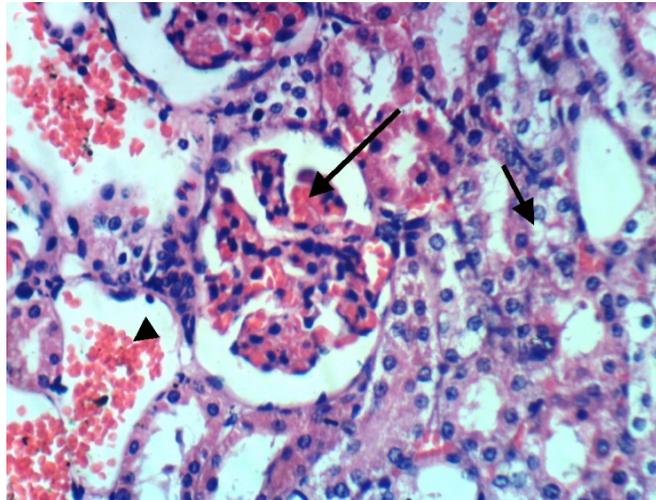


Figure 10. Kidney of rat from group 2 showing vacuolation of epithelial lining renal tubules, congestion of glomerular tuft and renal blood vessels (H & E \times 400).

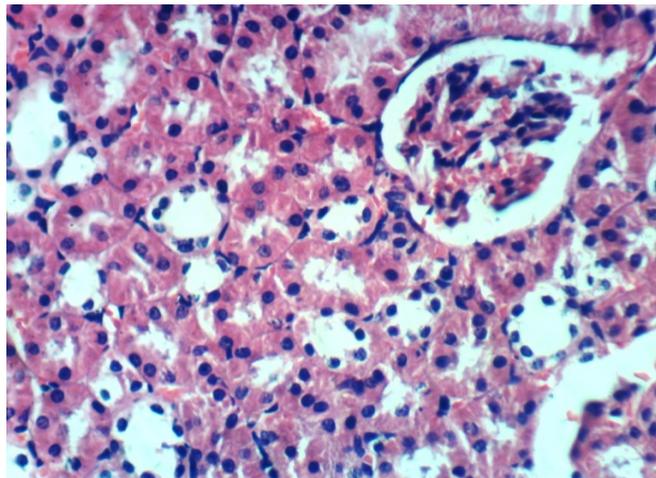


Figure 11. Kidney of rat from group 3 showing no histopathological changes (H & E \times 400).

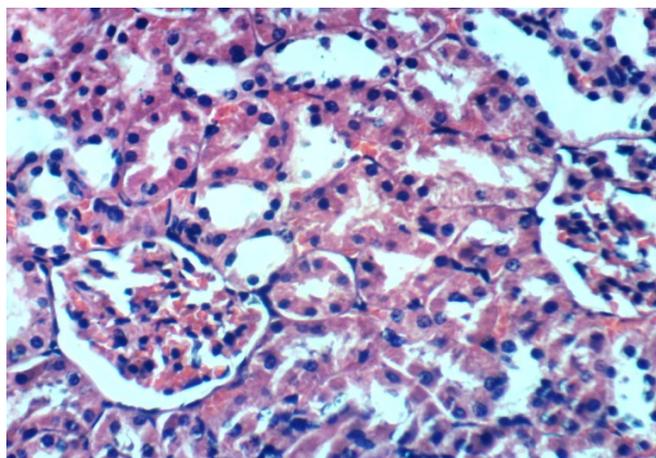


Figure 12. Kidney of rat from group 4 showing no histopathological changes (H & E \times 400).

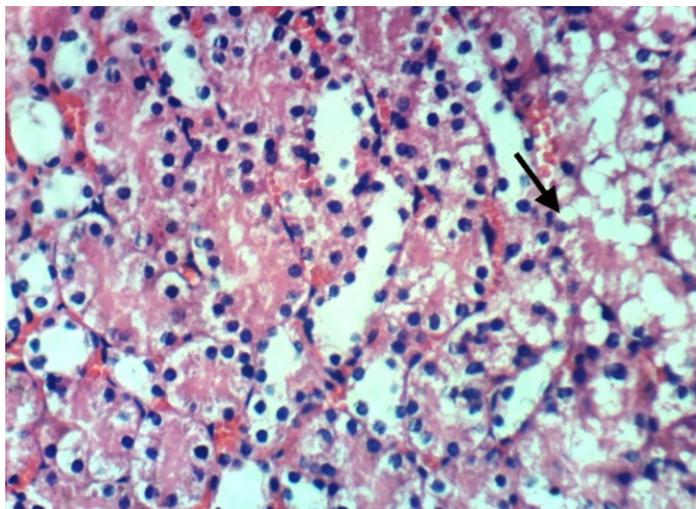


Figure 13. Kidney of rat from group 5 showing vacuolation of renal tubular epithelium (H & E \times 400).

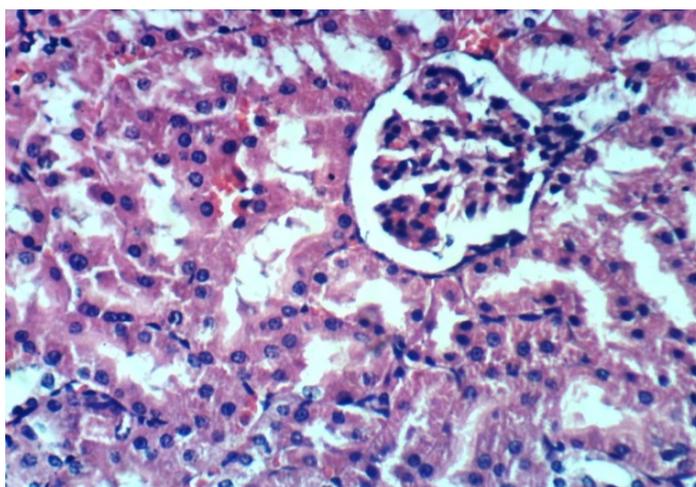


Figure 14. Kidney of rat from group 6 showing no histopathological changes.

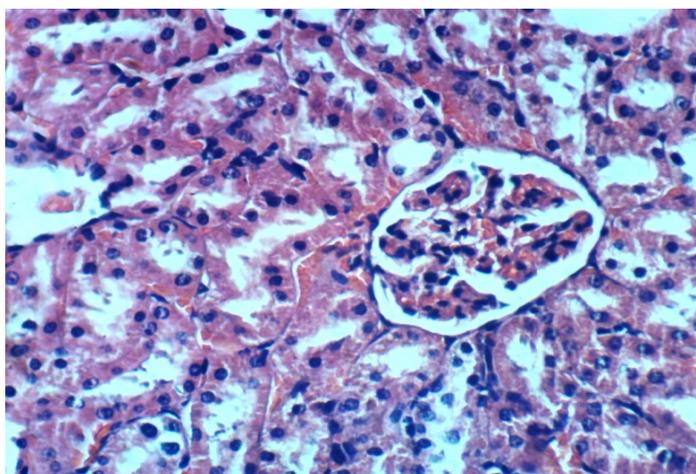


Figure 15. Kidney of rat from group 7 showing no histopathological changes (H & E \times 400).

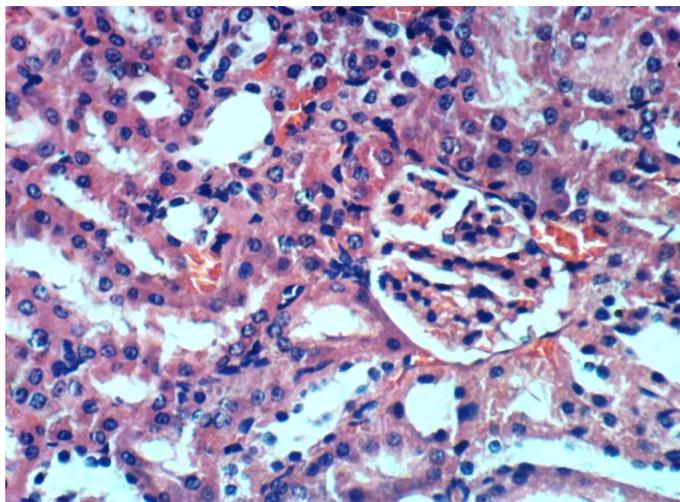


Figure 16. Kidney of rat from group 8 showing no histopathological changes (H & E \times 400).

4. Conclusion

There is evidence of a hepatoprotective activity of *A. vulgaris* on the polyphenolic and flavonoids compounds of plant leaves, which have potent antioxidant properties.

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