

Stereological Assessment of Nephroprotective Effects of *Trachyspermum ammi* Essential Oil against Carbon Tetrachloride-Induced Nephrotoxicity in Mice

Evaluación Estereológica de los Efectos Nefroprotectores del Aceite Esencial de *Trachyspermum ammi* Contra la Nefrotoxicidad Inducida por Tetracloruro de Carbono en Ratones

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SUMMARY: *Trachyspermum ammi* (*T. ammi*) has been used in folk medicine as anti-inflammatory, antipyretic, antibacterial, antifungal agent. The present study was conducted to investigate the protective effect of *Trachyspermum ammi* (*T. ammi*) essential oil against CCl_4 induced nephrotoxicity in mice. Thirty-five mice were divided into five groups as follows; positive control received olive oil 1 mL/kg/ip, negative control received CCl_4 1 mg/kg/ip + 0.5 mL distilled water orally and three treatment groups which received CCl_4 similar to the negative control and 200, 800 and 1600 μ g/kg of *T. ammi* essential oil, respectively. All treatments were done twice a week (Saturday and Wednesday) for 45 days. On the last day, blood was sampled for urea and creatinine assessment and the left kidney was removed for stereological estimations. Essential oil of *T. ammi* at high dose significantly ($p \leq 0.05$) decreased serum levels of creatinine and urea in comparison with CCl_4 -treated group. Total volume of the kidney, cortex, proximal convoluted tubules (PC), glomerulus, vessels and interstitial tissue as well as total length of PC and vessel were significantly ($p \leq 0.05$) increased following CCl_4 administration and were restored toward normal levels at high dose of *T. ammi*. Also, high dose of *T. ammi* improved glomerular loss significantly ($p \leq 0.05$) as compared with CCl_4 -treated group. Due to the chemical composition of *T. ammi* essential oil such as tymol, *p*-cymene, γ -terpinene which are antioxidant, it can be concluded that the essential oil of *T. ammi* can ameliorated renal injury induced following CCl_4 toxicity via its antioxidant components.

KEY WORDS: *Trachyspermum ammi*; Carbon tetrachloride; Essential oil; Stereology; Kidney.

INTRODUCTION

The kidneys participate in adjustment of endocrine system, blood pressure, osmolality situation, reabsorption of vital micronutrients, extracellular fluid volume, whole-body homeostasis, acid-base balance, electrolyte concentrations, and excretion of wastes (Musabayane, 2012). Some of the renal disorders such as glomerulonephritis, interstitial nephritis are mainly caused by toxic chemicals. Carbon tetrachloride is a toxic chemical that can cause damage to many tissues including kidney through free radicals generation and lipid peroxidation (Rechnagel *et al.*, 1989; Kumar *et al.*, 2005; Khan & Ahmed, 2006; Masuda, 2006). It seems that free radicals-induced lipid peroxidation to be one of the major causes of cell membrane damage resulting in a series of pathological situations by causing acute and chronic renal injuries (Satyanarayana *et al.*, 2001;

Manna *et al.*, 2006; Adewole *et al.*, 2007). Furthermore, there are many reports of documented case studies which indicate that CCl_4 can produce renal diseases through alteration of antioxidant status in humans (Javier Perez *et al.*, 1987; Manna *et al.*). Therefore, in the present study, the CCl_4 has been used to induce acute nephrotoxicity.

Recently, medicinal plants as a source of useful chemical compounds received much attention for treatment of many diseases and promotion of human health (Zangeneh *et al.*, 2016). Due to recent developments in methodology, medicinal herbs prepared and examined in various types such as essential oils (Tahvilian *et al.*, 2016). Essential oil is a condensed hydrophobic liquid including aromatic compounds from herbs. Essential oils could be extracted

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from several parts like leaves, stems, flowers, and roots (Faramarzi *et al.*, 2017). Essential oils can act as antioxidant and anti-inflammatory agents through inhibiting lipid peroxidation, scavenging free radicals and chelating metal ions. However, part of plant used, climatic condition and time of harvesting may contribute to their chemical composition and consequently their chemical activities (Miguel, 2010).

Trachyspermum ammi (*T. ammi*) commonly known as *Ajowan caraway*, is a wild bush that is widely distributed in Iran and India (Wadikar & Premavalli, 2012). It contains many substances which can act together to prevent several diseases. *T. ammi* genus's anti-oxidative and anti-inflammatory properties make it a logical adjuvant to improve wound healing (Thangam & Dhananjayan, 2003; Bera *et al.*, 2004). Based on the literatures, *T. ammi* has been used in folk medicine as an anti-inflammatory, antipyretic, antibacterial, anti-fungal, antiviral, anti-diabetic, antinociceptive, and analgesic agent (Dashti-Rahmatbadi *et al.*, 2007; Rasooli *et al.*, 2008; Hejazian *et al.*, 2008).

As far as we know, there is a very little data about chemical composition and nephroprotective properties of *T. ammi* essential oil grows in Kermanshah province, west of Iran. Hence, the aim of the present study was to specify the chemical composition of *T. ammi* essential oil obtained from Kermanshah city, west of Iran and also to investigate its nephroprotective effects against CCl_4 -induced nephrotoxicity. Histological change such as volume and length of renal tubules and glomerular number were estimated stereologically. Renal function was assessed thorough analysis of serum biomarkers.

MATERIAL AND METHOD

Plant sample collection. In the empirical-experimental study, medicine plant collected from Kermanshah city, west of Iran.

Table I. The components of *T. ammi* Essential oil that analyzed by GC/MS.

No	Compound	Area (%)	RI (Retention Index)
1	-Thujene	0.6	927
2	-Pinene	0.3	934
3	-Pinene	1.8	976
4	-Myrcene	0.6	990
5	<i>p</i> -Cymene	25.7	1029
6	γ -Terpinene	25.1	1064
7	Thymol	44.2	1299
8	Carvacrol	0.3	1302
	Total	98.6	

Essential oil extraction. Essential oil from aerial part of *T. ammi* extracted by Clevenger apparatus. Briefly, in first 100 to 150 g of plant was add to the distillation flask (1L) which was join to a steam producer via a glass tube and to a condenser to resume the essential oil in a funnel tube. Components of the essential oil was purified from the plant material and evaporated into hot steam without burning the plant material itself. Then, steam containing the essential oil was compressed through a cooling system for 3 h and essential oil was withdrawn. The essential oil was purged through anhydrous Na_2SO_4 to dehumidified essential oil. Then, the essential oil was accumulated in small and dull vials and stored in a refrigerator.

Gas chromatography / mass spectrometry (GC/MS). GC/MS (Shimadzu capillary GC-quadrupole MS system QP 5000 (with two fused silica capillary column DB-5 (30 μ m, 0.25 μ m i.d, film thickness 0.25 mm) and a flame ionization detector (FID) run in EI mode at 70 eV were used. Here on, injector temperature was 220 $^{\circ}C$ and detector temperature was set at 250 $^{\circ}C$. Also in the device, helium was employed as carrier gas (1 μ l/min). 1 ml of the essential oil was injected and analyzed with the column held initially at 60 $^{\circ}C$ for 2 min. Then, the amount of components of the essential oil is obtained. NIST standard reference database (AMDIS version 2.70) was used to interpret the mass spectral data. The constituents of essential oil is present in Table I.

Animals and treatments. Thirty five healthy male Balb/c mice weighing between 30 and 40 g were provided by laboratory animal center of Kermanshah University of Medical Sciences. The animals were kept under constant humidity and temperature. All animals were allowed free access to food and water *ad libitum* during the experiment. The animals were treated according to the standard directive as recommended in the Guide for Care and Use of Laboratory Animals and approved by the research authorities of Kermanshah University of Medical Sciences. The mice were divided randomly into five groups ($n=7$):

Group I (control): received 1 mL/kg olive oil intraperitoneally and 0.5 mL distilled water through gavages.

Group II: received 1 mg/kg CCl_4 mixed with olive oil in the ratio of 5:5, intraperitoneally + 0.5 mL distilled water through gavages.

Group III: received CCl_4 mixed with olive oil in the ratio of 5:5, intraperitoneally + ethanolic extract of *T. ammi* 200 μ g/kg through gavages.

Group IV: received CCl_4 mixed with olive oil in the ratio of 5:5, intraperitoneally + ethanolic extract of *T. ammi* 800 μ g/kg through gavages.

Group V: received CCl_4 mixed with olive oil in the ratio of 5:5, intraperitoneally + ethanolic extract of *T. ammi* 1600 $\mu\text{g}/\text{kg}$ through gavages.

All treatments were done twice a week (Saturday and Wednesday) for 45 days. On the last day of the experiment, blood samples were obtained from animal's heart and centrifuged for collecting serum. Then the subjects weighed and sacrificed using chloroform inhalation. The left kidney of each animal was removed, weighed and fixed in 10 % neutral buffered formaldehyde. Tubular length estimation needs isotropic uniform random sections. Therefore, after 72 h fixation, the kidneys were cut using orientator method. Totally, 7–10 slabs were collected from each kidney. The slabs were embedded in paraffin and sections (5 μm thicknesses) were prepared and stained by Periodic Acid Schiff (PAS) method.

Due to the tissue shrinkage following fixation and tissue processing, this should be considered for estimating reference volume. A circle was punched by a trocar from a kidney slab and its area was calculated before (AB) and after (AA) tissue processing. Finally, the tissue shrinkage was estimated using following formula (Nyengaard, 1999):

$$\text{Volume shrinkage} := 1 - \left(\frac{AA}{AB}\right)^{1.5}$$

Total volume of kidney (reference volume) was estimated using:

$$V_{\text{final}} := V_{\text{primary}} \times (1 - \text{volume shrinkage})$$

Stereological study

Volume estimation. Each sampled section was analyzed using a videomicroscopy system equipped with a microscope (Olympus CX2, Japan) linked to a video camera (Dinocapture ver.5, dino-lit.com 30.5 mm), a P4 PC computer, and a flat monitor to determine the parameters. The point probe (composed of 20 points) was superimposed upon the images of the tissue sections viewed on the monitor, and a volume density (V_v) of renal cortex, medulla, glomeruli (GLOM), proximal convoluted tubule (PC), distal convoluted tubule (DC), collecting ducts (CD), Henle's loop (LH), vessels (V), and interstitial tissue (IT) were estimated using point-counting method and the following formula (Fig. 1) (Gundersen *et al.*, 1988):

$$V_v := \frac{P_{\text{structure}}}{P_{\text{reference}}}$$

Where " $P_{\text{structure}}$ and $P_{\text{reference}}$ " were the number of test points falling on the structure's profile and on the reference space, respectively. 10-14 microscopic fields were examined in each kidney. The absolute volume of the parameters was estimated by multiplying the fractional volume by the final volume of the kidney to prevent the reference trap (Nyengaard; Mandarim-de-Lacerda, 2003).

Length estimation. The length density of the renal tubules and vessels, was estimated using an unbiased counting frame (740 x 740 μm) (Nyengaard; Mandarim-de-Lacerda). The counting frame was superimposed on the monitor live images and tubule profiles completely inside the counting frame or partly inside the counting frame but only touching the top and right lines were counted. The length density (L_v) of the each tubule was calculated as:

$$L_v := 2 \times \frac{\Sigma Q}{a(\text{frame}) \times \Sigma \text{frame}}$$

Where ΣQ denotes the total number of the tubule profiles counted per mouse kidney, $a(\text{frame})$ equals the area associated with a frame, 547600 μm^2 , and Σ is the total number of frames counted. Finally, the total length of each tubule, L , was calculated by multiplying the length density (L_v) by the final volume of the kidney (Fig. 2).

Number estimation. Total number of glomeruli per kidney was estimated using physical dissector method. From each kidney, section pair 20 μm apart (the first and fifth sections) was obtained. Two separate projecting systems with similar equipment were used. Two dissector probe (740 x 740 μm) with exclusion lines (the left and lower margins) and inclusion lines (the right and upper margins) were superimposed on the images of the first section as reference section (Fig. 3a) and fifth section as look-up section (Fig. 3b) at the total magnification 135x. A glomerulus was counted if it was presented in the reference section but not in the look up section and didn't touch the exclusion lines. At least 100 glomeruli per kidney were counted. The numerical density of the glomeruli was estimated using:

$$N_v := \frac{\Sigma Q^-}{a(\text{frame}) \times h \times \Sigma P}$$

Where ΣQ^- denotes the number of counted glomeruli, $a(\text{frame})$ is the area of the dissector frame, ΣP is the sum of studied field and h is the dissector height. Total glomerular number was estimated by multiplying the numerical density (N_v) by the reference volume (renal cortex).

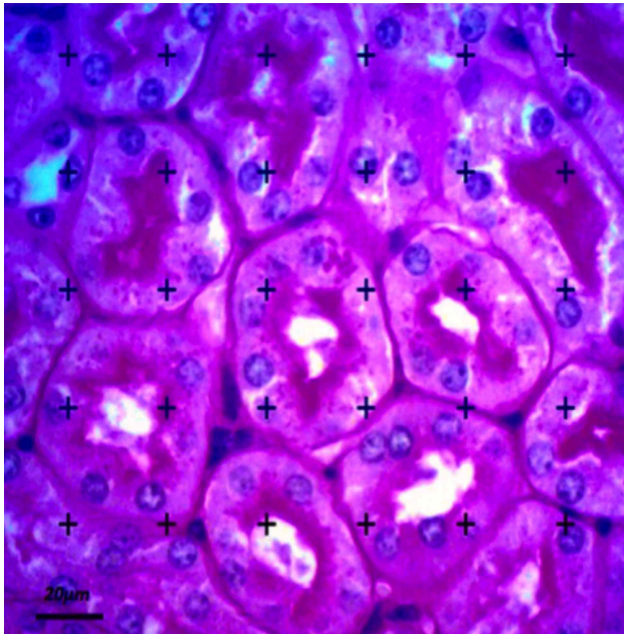


Fig. 1. Estimation of volume density using a point probe. The sum of points hitting each component in 15 microscopic fields was divided by the sum of points hitting the reference space (PAS, 400x).

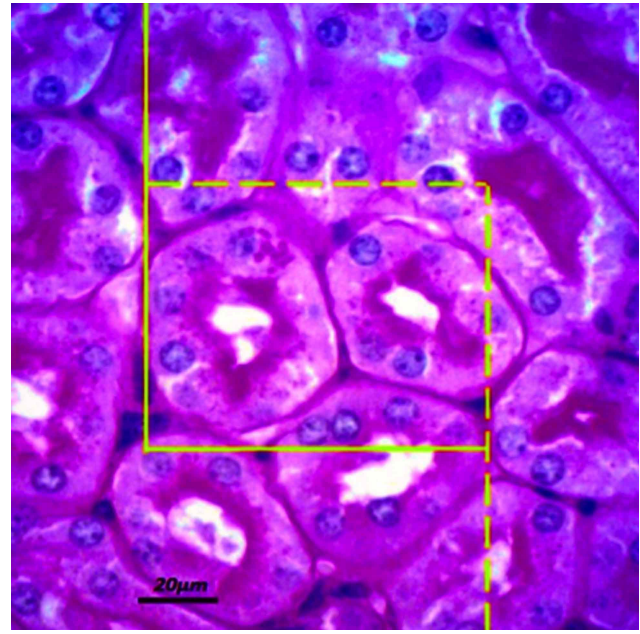


Fig. 2. Estimation of length density of the renal tubules using a counting probe. The tubule structures completely or partly inside the counting frame but only touching the top and right lines are considered (here four proximal convoluted tubules) (PAS, 400x).

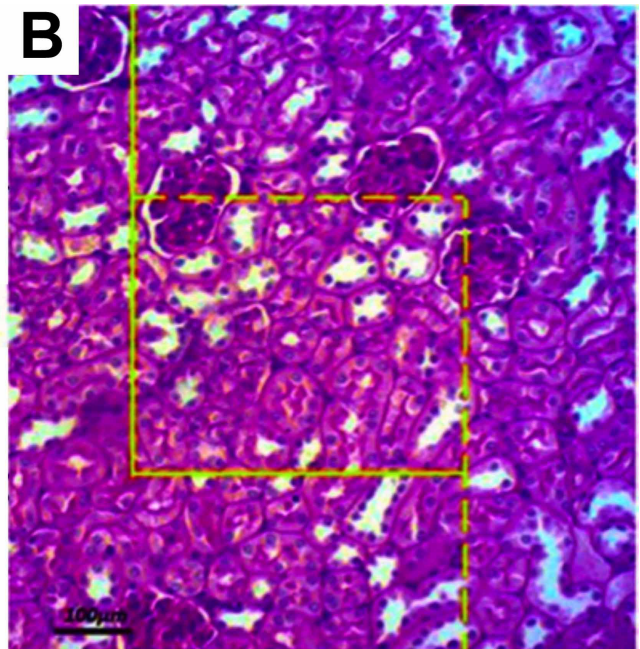
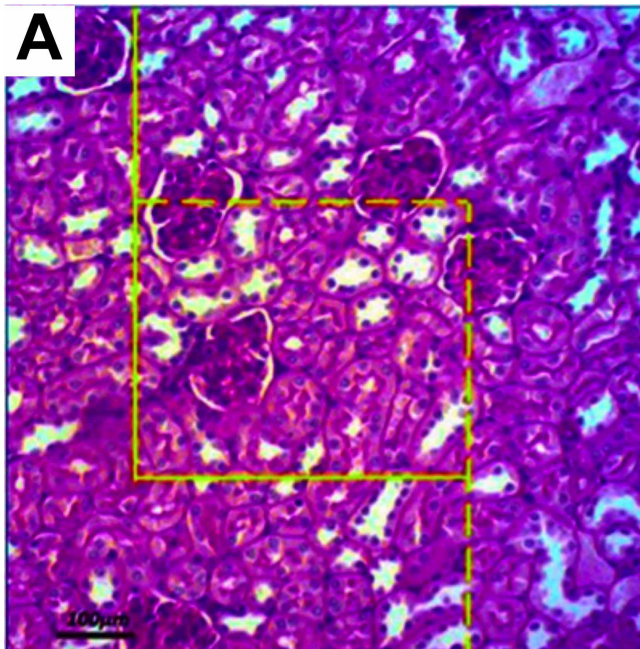


Fig. 3. Physical dissector method and estimation of numerical density of glomeruli. A first section as reference plane and b fifth section as look-up plane with 20 μm distance. A glomerulus was counted if it was located completely or partly in the frame and was not hit by exclusion (continuous) lines in the reference plane as well as if it was not seen in the look-up plane (here 1) (PAS, 100x).

Statistical analysis. All data are expressed as mean and standard deviation. Statistical comparison between group means

were done through one-way ANOVA followed by Tukey's post-hoc test. $P \leq 0.05$ was considered as significant.

RESULTS

Chemical composition of *T. ammi* via GC/MS. Chemical composition of *T. ammi* essential oil is presented in Table I. The main constituents of *T. ammi* essential oil are Tymol (44.2 %), p-Cymene (25.7 %) and g-Terpinene (25.1 %) and β -Pinene (1.8 %). Other compounds including α -Thujene, α -Pinene, b-Myrcene and Carvacrol were found to be less than 1 % of the oil.

Effects of CCl₄ and *T. ammi* on the weight and volume. The data of the kidney weight, mean absolute volume of kidney and its subcomponents in control and treated groups are shown in Tables II, III and IV. The results showed that the kidney weight and volume were increased 44 % and

55 % ($p \leq 0.001$) respectively in - treated mice in comparison with the control group. Volume of the cortex increased 62 % ($p \leq 0.001$) in this group but the medulla increased 40 % which was not significant ($p > 0.05$) compared to the control group. Treatment of - treated mice with high dose (1600 $\mu\text{g}/\text{kg}$) of *T. ammi* significantly ($p \leq 0.05$) improved the kidney weight and consequently kidney volume in comparison with low and moderate dose (200 and 800 $\mu\text{g}/\text{kg}$). Further, the volume of the cortex was decreased significantly ($p \leq 0.05$) in group which received high dose compared to the - treated group, whereas, medulla volume shows no significant decrease ($p > 0.05$).

Table II. The kidney weight (mg), absolute volume of the kidney (mm^3), and absolute volume (mm^3) of cortex and medulla of the control and experimental groups treated with *T. ammi* essential oil. Results are given as means \pm standard deviation.

Groups (n=7)	Parameters			
	Kidney weight	Kidney volume	Cortex volume	Medulla volume
Control	135.2 \pm 1.4	110.5 \pm 2.9	77.77 \pm 4.3	25.3 \pm 3.2
CCl ₄	195 \pm 15.6*	171 \pm 21.5*	125 \pm 11.8*	30.9 \pm 13.7
200 T + CCl ₄	191 \pm 18*	160 \pm 14.7*	125.2 \pm 8.6*	30.6 \pm 5.8
800 T + CCl ₄	184 \pm 22.5*	151 \pm 11.8 *	123 \pm 12*	28 \pm 7.2
1600 T + CCl ₄	153 \pm 35**	125.8 \pm 17**	101.2 \pm 14**	24.6 \pm 4.3

* $p \leq 0.05$ v.s control group. ** $p \leq 0.05$ v.s CCl₄treated group

Table III. Absolute volume (mm^3) of the proximal and distal convoluted tubules (PCT, DCT), collecting ducts (CD), loop of Henle (LH), vessels (VES) and interstitial tissues (IT) in the control and experimental groups treated with *T. ammi* essential oil. Results are given as means \pm standard deviation.

Groups (n=7)	Parameters					
	PC	DC	CD	LH	VES	IT
Control	68.5 \pm 4	16.5 \pm 3	20.9 \pm 4	1.2 \pm 0.4	6.1 \pm 1.2	11.4 \pm 2
CCl ₄	122.2 \pm 12*	22.5 \pm 5.7	25.4 \pm 5.1	1.36 \pm 0.65	11.2 \pm 4.2*	18.7 \pm 4.5*
200 T + CCl ₄	115 \pm 18	20.1 \pm 5.1	21.2 \pm 6.3	1.2 \pm 0.3	11.8 \pm 3.5*	19.5 \pm 2.2*
800 T + CCl ₄	112.8 \pm 8.9**	17.5 \pm 2.8	23.7 \pm 3.4	1.25 \pm 0.26	9.8 \pm 2.9*	16.1 \pm 5.1*
1600 T + CCl ₄	88 \pm 13**	14.8 \pm 3.1	21.7 \pm 5.2	1.17 \pm 0.38	7.5 \pm 1.8**	12.4 \pm 3**

* $p \leq 0.05$ v.s control group ** $p \leq 0.05$ v.s CCl₄ treated group

Table IV. Absolute volume (mm^3) and number of the glomeruli (GLOM) in the control and experimental groups treated with *T. ammi* essential oil. Results are given as means \pm standard deviation.

Groups (n=7)	Parameters	
	Volume	Number
Control	0.002 \pm 0.0001	28990.4 \pm 1851.5
CCl ₄	0.005 \pm 0.0003*	22474.8 \pm 856.3*
200 T + CCl ₄	0.004 \pm 0.0001*	22675 \pm 1055
800 T + CCl ₄	0.004 \pm 0.0002*	23556 \pm 1168**
1600 T + CCl ₄	0.002 \pm 0.0002**	26881 \pm 1014**

* $p \leq 0.05$ v.s control group. ** $p \leq 0.05$ v.s CCl₄ treated group.

Table V. Absolute length (m) of the proximal and distal convoluted tubules (PCT, DCT), collecting ducts (CD), loop of Henle (LH) and vessels (VES) in the control and experimental groups treated with *T. ammi* essential oil. Results are given as means \pm standard deviation.

Groups (n=7)	Parameters				
	PC	DCT	CD	LH	VES
Control	33.8 \pm 5.7	23 \pm 3.3	42.3 \pm 5.7	19.5 \pm 4.4	56.6 \pm 11.7
CCl ₄	51.2 \pm 9.1	32 \pm 5.4	51.1 \pm 6.6	22.3 \pm 4.3	82 \pm 13.3*
200 T + CCl ₄	49 \pm 7.7*	28 \pm 2.5	49 \pm 5.2	21.4 \pm 4.5	80 \pm 8.6*
800 T + CCl ₄	44.4 \pm 6.5*	29 \pm 3.8	52 \pm 10.5	20.2 \pm 3.9	75.8 \pm 11.2*
1600 T + CCl ₄	32.5 \pm 4.1 **	27.5 \pm 6.8	46.1 \pm 7.4	19.8 \pm 3.1	61.2 \pm 7.7 **

* p \leq 0.05 v.s control group. ** p \leq 0.05 v.s CCl₄ treated group

Table VI. Serum profile parameters in the control and experimental groups treated with *T. ammi* essential oil. Results are given as means \pm standard deviation.

Groups (n=7)	Parameters (mg/dl)	
	Urea	Creatinine
Control	30 \pm 3.4	0.26 \pm 0.05
CCl ₄	43.25 \pm 3.7*	0.37 \pm 0.05*
200 T + CCl ₄	33.5 \pm 1**	0.22 \pm 0.05**
800 T + CCl ₄	31 \pm 2.8**	0.20 \pm 0.01**
1600 T + CCl ₄	29 \pm 7**	0.20 \pm 0.01**

* p \leq 0.05 v.s control group. ** p \leq 0.05 v.s CCl₄ treated group

The volume of PC, GLOM, vessels and interstitial tissue were increased 80 %, 150 %, 83 % and 64 % (p \leq 0.05), respectively in - treated mice compared to the controls (Tables III and IV). The volume of CD and LH did not show significant differences (p > 0.05). Treatment with high dose (1600 μ g/kg) of *T. ammi* significantly (p \leq 0.05) decreased the volume of PC and GLOM compared to the - treated group.

Effects of and *T. ammi* on glomerular number. The obtained results showed that glomerular numbers per kidney in treated group were significantly (22.5 %) lower than that of the control animals. Co-administration of 1600 μ g/kg *T. ammi* and prevented the decrease of glomerular numbers significantly (p \leq 0.05) in comparison with the -treated group (Table IV).

Effects of and *T. ammi* on length of renal tubules and vessels. The length of PC and vessel increased 51 % and 45 %, respectively (p \leq 0.05) after administration. However, the increase in length of DC, CD and LH were not significant (p > 0.05) in -treated mice compared to the controls. High dose of *T. ammi* could significantly improve the length of PC and vessels toward normal values (Table V).

Effects of and *T. ammi* on serum profile. Serum concentration of urea and creatinine are presented in Table VI. Concentration of urea and creatinine was increased significantly (p \leq 0.05) in serum with -induced nephrotoxicity as compared to the control group. Co-administration of and different doses of *T. ammi* significantly improved the changed levels of urea and creatinine causing

a subsequent recovery towards normalization. However, there was no significant difference between different doses of *T. ammi*.

DISCUSSION

The present study showed the ameliorative potential of *T. ammi* essential oil against - induced acute nephrotoxicity through stereological assessments and serum profile analysis. It has been documented that renal cortex contains higher amounts of cytochrom P450 than other organs and this increase the affinity of kidney for. Hence, has been commonly used for acute renal failure induction in experimental animals (Ronis *et al.*, 1998).

Although, renal functional impairment following treatment can be recognized by high serum levels of urea and creatinine (Ozturk *et al.*, 2003), it should be noted that creatinine concentration is a more potent indicator as it increase in the initial stages of renal disease. Furthermore, increase in serum level of creatinine can lead to the structural damage of nephrons (Gilbert *et al.*, 1989). In the study, administration of (1 mg/kg body weight) result in significant increase of serum urea and creatinine as it was previously reported by other studies (Ogeturk *et al.*, 2005; Khan & Ahmed, 2009; Khan & Zehra, 2013; Sherkatolabbasieh *et al.*, 2017). The increased level of serum urea and creatinine were significantly improved toward normal levels in the high dose (1600 μ g/kg *T. ammi*) treated group when compared with the only treated animals. Similar studies have been

reported that various plant can improved -induced renal injury intoxication (Khan *et al.*, 2010; Khan & Siddique, 2012; Sherkatolabbasieh *et al.*). These results indicate protective effect of *T. ammi* against nephrotoxicity.

Our results showed that treated animals experienced noticeable renal hypertrophy which was mainly due to the cortical enlargement. Accordingly, proximal convoluted tubules and vessels were affected in respect of their volume and length. These alterations were alleviated significantly in the fifth group which received high dose of *T. ammi*.

In the present study, only treated mice showed glomerular hypertrophy. This event could be related to the vasoconstriction and congestion of capillary tufts in the renal corpuscles. Glomerular hypertrophy was prevented in high dose group in comparison with the only treated group. There are some reports that another plant extract such as *Oxalis corniculata* (Khan & Zehra), *Citharexylum spinosum* (Khan & Siddique) and *Sonchus asper* (Khan *et al.*, 2010) can inhibit glomerular hypertrophy induced through nephrotoxicity.

Another nephroprotective effect of *T. ammi* is its prevention of glomerular loss at high dose (1600 µg/kg). Embryologically, nephrogenesis stops after birth. Therefore, glomerular loss is a irreversible event. - induced nephrotoxicity has glomerular effect that can led to loss of filtration rate, mesangial cell proliferation and apoptosis (Tavifi & Ahmadvand, 2011).

It is well established that induce Reactive Oxygen Species (ROS) which later can damage antioxidant barriers and start the process of lipid peroxidation (Halliwell & Gutteridge, 2007). Therefore, use of certain plant extract rich in antioxidant agents can ameliorate toxicity. The results of GC/MS analysis showed that Tymol (44.2 %), p-Cymene (25.7 %) and g-Terpinene (25.1 %) constitute the main components of *T. ammi* essential oil. Free radicals scavenging ability of these compounds were established previously. The antioxidant activity of *Thymus marschallianus* and *Thymus proximus*' essential oils which are mainly constituted by thymol, p-cymene and g-terpinene have been examined earlier by safranin method (Jia *et al.*, 2010). The activity of both essential oils were reported to be dose dependent which is consistent with the present results. Furthermore, antioxidant activity for essential oils of some other plants containing thymol, p-cymene and g-terpinene such as *Thymus vulgaris*, *Salvia officinalis*, *Origanum vulgare* (Viuda-Martos *et al.*, 2010), *Satureja intricata* (Jordan *et al.*, 2010) and *Lavandula angustifolia* (Yang *et al.*, 2010) have been approved. Therefore, it may said that the nephroprotective activity of essential oil of *T. ammi* is attributed to the presence of thymol, p-cymene and g-terpinene.

CONCLUSIONS.

Based on the obtained results, essential oil of *T. ammi* at high dose ameliorated renal structural changes and serum biomarkers disturbance induced following intoxication. Thymol, p-cymene, g-terpinene and other antioxidant contents may justify its nephroprotective and therapeutic properties. Therefore, *T. ammi* can be considered as a new nephroprotective agent against toxicity.

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RESUMEN: En la medicina popular se ha utilizado el aceite esencial de *Trachyspermum ammi* (*T. ammi*) como agente antiinflamatorio, antipirético, antibacteriano y anti fúngico. El presente estudio se realizó para investigar el efecto protector de *Trachyspermum ammi* (*T. ammi*) aceite esencial contra la nefrotoxicidad inducida en ratones. Treinta y cinco ratones fueron divididos en cinco grupos de la siguiente manera; el control positivo recibió 1 mL / kg / ip de aceite de oliva, el control negativo recibió 1 mg / kg / ip + 0,5 mL de agua destilada por vía oral y grupos de tratamiento arbóreo que recibieron un control similar al negativo y 200, 800 y 1600 mg / kg de T. aceite esencial de *T. ammi*, respectivamente. Todos los tratamientos se realizaron dos veces por semana (sábado y miércoles) durante 45 días. En el último día de tratamiento, se tomaron muestras de sangre para evaluar la urea y la creatinina, y se extrajo el riñón izquierdo para realizar estimaciones estereológicas. El aceite esencial de *T. ammi* a dosis altas significativamente ($p \leq 0,05$) disminuyó los niveles séricos de creatinina y urea en comparación con el grupo tratado. El volumen total del riñón, la corteza, los túbulos contorneados proximales (PC), el glomérulo, los vasos y el tejido intersticial, así como la longitud total de la PC y el vaso aumentaron significativamente ($p \leq 0,05$) después de la administración y se restablecieron a niveles normales con dosis altas de *T. ammi*. Además, una dosis alta de *T. ammi* mejoró significativamente la pérdida glomerular ($p \leq 0,05$) en comparación con el grupo tratado. Debido a la composición química del aceite esencial de *T. ammi* como timol, p-cimeno, γ-terpineno con propiedades antioxidantes, se puede concluir que el aceite esencial de *T. ammi* puede mejorar la lesión renal inducida después de la toxicidad a través de sus componentes antioxidantes.

PALABRAS CLAVE: *Trachyspermum ammi*; Tetracloruro de carbono; Aceite esencial; Estereología; Riñón.

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