Dietary Importance of Lycopene Against Carbon Tetrachloride Induced Hepatotoxicity in Rats

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Abstract

Chronic liver disease is a clinically silent condition that causes significant morbidity and mortality around the world. This study aimed to investigate the dietary importance of lycopene against Carbon Tetrachloride inducing hepatotoxicity in rats. Thirty five albino rats were divided randomly for two groups. The first group G1(7 rats), its diet was only basic diet, considering it negative control group. The remaining of rats injected with a subcutaneous of carbon tetrachloride (2ml/ kg b.w./ week) for two weeks to induce hepatic damage. After injected animals, they divided for 4 subgroups (7 rats/ once). Rats in G2 considered as positive control. Rats in G3, G4, G5 fed on the basal diet contained different levels of dried tomato and ketchup 5%, 7.5% and 10%, respectively. After eight weeks, liver and kidney functions were evaluated. Antioxidant activity was estimated, in addition to histological examination of liver tissues. The results indicated that there were significantly increasing in the levels of ALT, AST, ALP, albumin, total and direct bilirubin in G2 when compared with G1, while G3, G4 and G5 showed significant decreasing in the levels compared to positive control group. Urea nitrogen and creatinine levels in G2 showed significant increasing comparing with negative control group, the improvement were noticeable in all examined groups comparing to positive control group. Furthermore, the levels of GSH and CAT showed significant improvement in all tested groups comparing to the positive control one. The histological findings of liver tissues were consistent and confirmed the changes in the biochemical and oxidant/antioxidant parameters of the experimental groups. It could conclude, that there were noticeable improvements in the biochemical and histopathological changes resulting from exposure

to CCl_4 in groups of rats whose diet contained dried tomatoes and ketchup. The results of the study scientifically proved that lycopene has significant therapeutic effects against liver damage caused by CCl_4, due to its antioxidant activity and flavonoid contents. Therefore, the recommendation of the study is increasing dietary lycopene intake may have a benefit for patients with liver disease.

Key words: lycopene, liver functions, liver injury, antioxidant mechanism**.**

Introduction

Lycopene is a red-fat-soluble carotenoid. There is great interest of lycopene, as the information obtained from epidemiological and clinical studies hav shown an inverse relationship between the amount of lycopene in the blood, its dietary intakes (i.e. tomatoe) and the incidence of various types of cancer, like lung, prostate, and breast cancer. With its great antioxidant potential, which is much greater than that of alpha-tocopherol and beta-carotene, lycopene has gained great interest **(Gulay *et al.*, 2023).**

Lycopene is a carotenoid found in high levels in tomato and its products. Lycopene has anti-inflammatory and antioxidant properties, making it has therapeutic role for many chronic diseases. There is scientific evidence that lycopene may protect against development and progression of cardiovascular diseases, cancer, osteoporosis, and asthma. Furthermore, there is numerous evidence for the therapy using of lycopene in diabetes mellitus, colitis, hepatic diseases, and neurodegenerative disorder **(Wood, 2013).**

Hepatic dysfunction is due to many problems such as exposure to frequent doses of medications, drug therapy and compounds in environment caused toxicity **(Attallah *et al.*, 2022).** Liver injury may occur due to many diseases such as non-insulin dependent diabetes and renal disease **(Byrne and Targer, 2022).** Liver disease cause about two million deaths annually worldwide, one million because of complications of cirrhosis and one million because of viral hepatitis and hepatocellular carcinoma. Liver cirrhosis considered the eleventh most common causes of death worldwide, liver cancer considered the sixteenth leading cause of death, they

represents 3.50% of all deaths on a global level **(Asrani *et al.*, 2018).**

Carbon tetrachloride is one of the liver toxins, which frequently used in experimental studies of liver disease. Administration of CCl_4 causes severe liver damage similar to natural causes. It mediates the alterations in liver functions that ultimately causes the destruction of the hepatic cell membrane. The mechanism occurs during liver metabolism, as cytochrome P450 (CYP) enzymes activates CCl_4 to constitute various free radicals like trichloromethyl radical (CCl_3), this process causes impairment of important cellular processes and causes widespread cells damage and apoptosis **(Weber *et al.*, 2003)**.

This study aimed to investigate the dietary importance of lycopene against carbon tetrachloride-induced hepatotoxicity in experimental rats.

Materials and methods

Materials

Chemicals were bought from El gomhoria company, Cairo, Egypt. Tomato and ketchup (Heinz tomato ketchup) were bought from domestic supermarket. Thirty five albino rats weighing (150 ± 5) gm were obtained from Helwan farm, Cairo, Egypt.

Methods

Preparing of dried tomato and ketchup

Preparation of tomatoes powder was at solar energy center, National Research Center, Giza, Egypt. Fresh tomatoes were washed, peeled off, cut into thin slices and dried in the sun at 50°C for ٢ days. And then grinded to obtain the powder. Moderate temperature 45-55°C enables the dried product to keep its nutrients including vitamins, lycopene and flavors as explained by **Andritsos *et al.* (2003).** Ketchup was dried in the sun at 50 °C, this temperature was a suitable method and alternative to keep carotenoids compounds and antioxidant activity in ketchup according to **Donatella *et al.* (2014).**

Phenolic compounds of dried tomato and ketchup

Phenol contents were determined following **Brand *et al.* (1995)**.

Prepare the basal diet

Basal diet prepared as determined by **Reeves *et al.* (1993)**, consisting of 20.0% proteins, 10.0% sucrose, 4.70% corn oil, 2.0% choline chloride, 3.50% salts mixture, 1.0% vitamins mixtures and 5.0% fiber, remaining amount was cornstarch.

Experimental animal design

After adaptation period, the rats divided to two groups. The first group G1 (7 rats), was considered the negative control group, as its diet was only basic diet. The remaining of the rats injected with a subcutaneous of carbon tetrachloride (2ml/ kg b.w./ week) for two weeks to induce hepatic damage according to **Seethalakshmi *et al.* (1982).** After injected animals by CCL_4, they divided for 4 subgroups (7 rats / once) as following:

Subgroup(G2): rats fed a basal diet as a positive control group

Subgroup(G3): rats fed a basal diet + 5% dried tomato and ketchup

Subgroup(G4): rats fed a basal diet +7.5% dried tomato and ketchup

Subgroup(G5): rats fed a basal diet + 10% dried tomato and ketchup

After eight weeks, all rats were fasted all the night, then anesthetized by ether. Samples of blood were drawn in clean plastic tubes, centrifuged to obtain serum, and stored at -20^{o}c for analysis.

Biochemical analyses

Levels of liver enzymes, Alanine aminotransferase, Aspartate aminotransferase and Alkaline phosphatase measured in the serum following the method described by **Sherwin (1984), Young (1990) and Roy (1970)** respectively**.** The levels of albumin, total bilirubin and direct bilirubin were evaluated following the method of **Young (2001).** Urea nitrogen and Creatinine in the serum were measured according to **Fossati *et al.* (1980)** and **Henry (1974)** respectively**.** Levels of glutathione (GSH) was measured following the method

by **Beutler *et al*. (1963).** Levels of catalase (CAT) activity was determined following the method of **Aebi (1984).**

Histopathologica examination

After dissection, rat liver samples are obtained, washed in slain solution, dried by filter papers and preserved in 10% formalin solution for histological examinations, following the method used by **Bancroft and Gamble (2008).**

Statistical analysis

Study data are presented as (mean ± SE). The statistical analysis was done using SPSS program, (verion 18.0 SPSS Inc., Chieago, USA). Dunk test multiple range post-hoc test was used. The results were analyzed using one-way analysis variance (ANOVA). The data considered significant differences in $P \leq 0.05$ **(Snedecor and Cochran, 1980)**.

Results and Discussion

Assessment of phenolic compounds of dried tomato and ketchup

Phytochemical determinations results revealed that total polyphenolic compounds in dried tomato had more powerful in antioxidants activity as presented in Table (1). It contains phenolics (31.23mg gallic acid/g extract), anthocyanins (3.45mg/g extract), flavanols (6.36 mg Quercetin/g extract), carotenoids (lycopene 9.49 mg/100 g and β-carotene 0.51mg/100g). While, dried tomato ketchup contains carotenoids (lycopene 17.0 mg/100 g) and vitamin C (15.1 mg/100g).

Evaluation the effect of Lycopene on liver enzymes in experimental rats

Data in Table (2) presented the effect of dried tomato and ketchup on serum activity of liver enzymes. The results revealed that level of alanine aminotransferase (ALT) was significantly increasing of rats in G2, the value was (53.33 U/L) comparing to G1 as a value was (38.33 U/L). The results showed, the rats were fed on dried tomato and ketchup in the diet revealed significantly decreasing in the levels of ALT comparing to G2. The level of

ALT in G4 showed a noticeable improvement and is considered better than the rest of groups, as the value was (38.66U/L).

Table (1): Phenolic compounds of dried tomato and ketchup

Nutrients	Tomato (mg /100g)	Ketchup (mg /100g)
Phenolics	31.23	NM
Lycopene	9.49	17.0
Flavonols	6.36	NM
Anthocyanins	3.45	NM
β-carotene	0.51	NM
Vitamin C	NM	15.1

NM = Not measured

Data in Table (2) indicated that the level of aspartate aminotransferase (AST) activity was significant increasing in G2 (23.33 U/L) comparing to G1 (16.00 U/L). The data showed that groups of rats which diet contained dried tomato and ketchup revealed significantly decreasing in the levels of AST comparing to G2. It is noted that rats in G5 were the best group in decreasing the elevation of AST level as (13.33 U/L).

Considering the levels of alkaline phosphatase (ALP), the results showed that rats in G2 revealed significantly increasing of serum ALP levels (275.33U/L) comparing with G1 (198.00 U/L). Moreover, rats in the groups which fed on dried tomato and ketchup revealed significantly decreasing in the ALP comparing to the rats in G2.

Liver enzymes are important markers of hepatic injury in clinical outcomes. ALP, ALT and AST secrete in blood when liver cells are infected and their concentrations were rise. Alterations in the levels of enzymes may vary depending on the duration of exposure and the amount of dose. Which leads to the release of the enzymes in plasma. Therefore, if the damage in the cells is chronic, then enzymes levels will still increase **(Rao, 2006**).

Results of our study are consistent with **(Elias *et al.*, 2020),** when cisplatin caused hepatotoxicity and renal dysfunction, which was demonstrated by high levels of biochemical analyzes of liver and kidney functions in the serum, treatment with lycopene led to significant reduction in the serum levels. Also, **(Asmaa *et al.*, 2021)** and **(Abuzinadah and Ahmad, 2020),** demonstrated that the concentrations of AST, ALT, and ALP activities were substantially decreased as a result of treating rats suffering from liver and kidney dysfunction with lycopene compared to those of the control rats.

Lycopene revealed a liver protection effects versus bisphenol A inducing toxicity and reduced HSC activations in vitro **(Abdel-Rahman *et al.*, 2018).** Also, **(Ahmed and Mahdi, 2014)**, reported that there were significantly increasing in alanine aminotransferase and aspartate aminotransferase levels, which associated with exposure to toxicities compared to the other groups. While the diet supplemented with lycopene achieved significant decreasing in the activities of serum AST and ALT to the control level.

Our results in this study agree with (**Ibrahim and Banaee, 2014),** which findings that lycopene supplementation play a positive role in detoxification of diazinon (DZN) toxicity, they observed that supplementation of lycopene decrease the toxic effect of diazinon. In the same line, **(Haidong *et al.*, 2012**) and **(Almogren, 2011)** demonestrated that lycopene showed significantly reduction of serum ALP activity in rats.

Assessment the effect of Lycopene on total bilirubin, direct bilirubin and albumin levels in experimental rats

Data in Table (3) presented the effect of dried tomato and ketchup on levels of total bilirubin in serum. The data demonstrated that the levels of total bilirubin were significant increasing for the rats in G2 (0.79 mg/dl) when comparing to the rats in G1 (0.58 mg/dl). Data showed, that rats in G5 fed on 10 % dried tomato and ketchup in the diet, the level of total bilirubin significant decreased (0.62 mg/dl) comparing to the rats in G2.

In the same table, the results showed that direct bilirubin level was significantly increasing for rats in G2 (0.25 mg/dl) comparing with the rats in G1 (0.19 mg/dl). Data showed that when rats fed on

dried tomato and ketchup in the diet revealed significant reducing in the levels of direct bilirubin comparing with G2. In addition, there are no noticeable differences between G4 and G5 (0.20 mg/dl) and (0.20 mg/dl), respectively comparing with G1.

Table (2): Effect of Lycopene on liver enzymes in experimental rats

Parameter / Group	ALT (U/L)	AST (U/L)	ALP (U/L)
G1 (-ve control)	38.33 ± 3.78^{b}	16.00 ± 4.58^{ab}	198.00 ± 15.48^{d}
G2 (+ve control)	53.33 ± 2.51^{a}	23.33 ± 3.75^{a}	275.33 ± 39.54^{a}
G3 (5% dried tomato & ketchup)	41.32 ± 1.52^{b}	19.33 ± 8.08^{ab}	211.33 ± 17.51^{c}
G4 (7.5% dried tomato & ketchup)	38.66 ± 8.73^{b}	18.01 ± 4.35^{ab}	251.00 ± 28.83^{b}
G5 (10% dried tomato & ketchup)	44.00 ± 8.18^{ab}	13.33 ± 3.21^{b}	204.33 ± 5.50^{cd}

Data are shown as (Mean ±SE).Values in the same column with different letters are significantly differences $P \leq 0.05$. ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, ALP: Alkaline phosphatase.

The results of albumin levels in Table (3) demonstrate that rats in G2 showed significantly elevation of their albumin levels (4.87 g/dl) when comparing to rats fed on only basal diet, G1 (3.31g/dl). While, rats fed on diet contained dried tomato and ketchup revealed significantly decreasing in the albumin levels at G4 and G5, as (3.74 g/dl) and (3.36 g/dl) respectively, comparing to G2.

These results showed that there were enhancement in total bilirubin, direct bilirubin and albumin levels, whereas dried tomato and ketchup caused noticeable improvements of liver tissues. This agreed with (**Pelemo, 2023),** when rats supplemented with lycopene show a significantly reducing of albumin, globulin and total protein levels.

Table (3): Effect of Lycopene on total bilirubin, direct bilirubin and albumin levels in experimental rats

Parameter / Group	Total Bilirubin (mg/dl)	Direct Bilirubin (mg/dl)	Albumin (g/dl)
G1 (-ve control)	0.58 ± 0.12^{c}	0.19 ± 0.03^{c}	3.31 ± 0.15^{b}
G2 (+ve control)	0.79 ± 0.08^{a}	0.25 ± 0.01^{a}	4.87 ± 0.62^{a}
G3 (5% dried tomato & ketchup)	0.74 ± 0.03^{ab}	0.23 ± 0.01^{ab}	4.03 ± 0.67^{ab}
G4 (7.5% dried tomato & ketchup)	0.77 ± 0.04^{a}	0.20 ± 0.005^{bc}	3.74 ± 0.55^{b}
G5 (10% dried tomato & ketchup)	0.62 ± 0.03^{bc}	0.20 ± 0.02^{c}	3.36 ± 0.17^{b}

Data are shown as (Mean ±SE). Values in the same column with different letters are significantly differences $P \leq 0.05$.

Effect of Lycopene on kidney functions in experimental rats

Table (4) presented the effect of dried tomato and ketchup on kidney functions. The levels of urea nitrogen in serum of rats injected with CCl_4 in G2 were significant increasing (52.40 mg/dl) comparing to G1 (36.67mg /dl). Whereas rats fed on dried tomato and ketchup revealed a significantly reducing in the levels of urea nitrogen. Moreover, rats in G4 showed the best value of urea nitrogen levels as (34.20 mg/dl).

Results in table (4) also showed that the rats in G2 had significantly increasing in the creatinine levels (0.90 mg/dl) comparing to rats in G1 (0.63 mg/dl). While, rats fed on dried tomato and ketchup showed significantly reducing in the creatinine levels when compared to G2. Moreover, best value of creatinine were in G3 and G5 as (0.72 mg/dl) and (0.71 mg/dl) respectively.

Ahmed *et al.*, (2006) indicated that increasing in creatinine levels in serum was marker of renal dysfunction. Also **(Nabil *et al.*, 2013)**, clarified that there were significantly increasing in uric acid and creatinine levels in rats that have been poisoned.

The results in our study concerning the serum level of urea are agree with **(Eze *et al.*, 2015)**, who reported that there were significant reducing in serum urea levels in rats suffering from diabetes supplemented with lycopene comparing to control group. They illustrated that lycopene has a protection effect for diabetes inducing renal dysfunction via increasing of endogenous antioxidant enzymes and improves kidney injury.

In the same line, **(Karim, 2007)** indicated that rats treatment with lycopene showed improvement in renal tissues by protection of lipids indices and oxidative stress parameters versus carbon tetrachloride inducing nephrotoxicity. Supplementation with lycopene might has therapeutic effects in nephrotoxicity protection.

Table (4): **Effect of Lycopene on kidney functions in experimental rats**

Parameter / Group	Urea Nitrogen (mg/dl)	Creatinine (mg/dl)
G1 (-ve control)	36.67 ± 4.35^{bc}	0.63 ± 0.07^{c}
G2 (+ve control)	52.40 ± 2.65^{a}	0.90 ± 0.01^{a}
G3 (5% dried tomato & ketchup)	46.30 ± 5.72^{b}	0.72 ± 0.02^{bc}
G4 (7.5% dried tomato & ketchup)	34.20 ± 12.72^{c}	0.77 ± 0.03^{b}
G5 (10% dried tomato & ketchup)	42.76 ± 2.14^{b}	0.71 ± 0.05^{bc}

Data are shown as (Mean ±SE).Values in the same column with different letters are significantly differences $P \leq 0.05$.

Effect of Lycopene on antioxidant activity in experimental rats

Table (5) presented the effects of dried tomato and ketchup on the levels of antioxidant activity, like glutathione (GSH) and catalase (CAT). Results revealed a significantly decreasing in the levels of GSH and CAT in G2 with (2.15 µmol/dL) and (11.00 nmol/min/mg protein) respectively, comparing to G1 (3.06 µmol/dL) and (17.40 U/mg) respectively. While, levels of GSH and CAT showed a significant increasing in G3, G4 and G5 comparing to G2. In addition, the best result of GSH and CAT levels were showed in G3 as (3.73 µmol/dL) and (22.26 nmol/min/mg protein) respectively.

Many toxic compounds have been proven to inducing toxicity by causing oxidative damages of biomolecules. Superoxide dismutase and catalase are both endogenous antioxidant enzymes, its functions are to protect the body from oxidative stress **(Manoj *et al.*, 2006)**. Other study showed that there were significantly decreasing in GSH levels in cisplatin alone group comparing with control group. However, pretreatment groups with lycopene showed normal levels of GSH comparing to cisplatin alone group **(Ahmet *et al.*, 2005).**

The results of the study are consistent with **(Kujawska *et al.*, 2014)** that evaluated the preventive effect of tomato paste rich in lycopene against *N*-nitrosodiethylamine (NDEA). There were a significant reduction 16-73 % in the levels of antioxidant enzymes in animals treated with NDEA alone comparing with control group. While pre-treatment animal groups with the lowest dose of tomato paste showed a noticeable improvement of catalase and glutathione reductase activity as 74% and 97 % respectively, and mild insignificantly increasing as 17 % in glutathione peroxidase activity. Moreover, The highest dose of tomato paste showed a significantly increasing in catalase and glutathione reductase activity as 51% and 32 % respectively.

Table (5): Effect of Lycopene on antioxidant enzymes in Experimental Rats

Parameter / Group	GSH (µmol/dL)	CAT (nmol/min/mg protein)
G1 (-ve control)	3.06 ± 0.48^{b}	17.40 ± 0.75^{b}
G2 (+ve control)	2.15 ± 0.47^{c}	11.00 ± 2.50^{c}
G 3 (5% dried tomato & ketchup)	3.73 ± 0.60^{ab}	22.26 ± 2.82^{a}
G4 (7.5% dried tomato & ketchup)	3.50 ± 0.24^{ab}	21.46 ± 3.58^{ab}
G5 (10% dried tomato & ketchup)	3.26 ± 0.16^{b}	21.73 ± 1.56^{ab}

Data are shown as (Mean ±SE).Values in the same column with different letters are significantly differences $P \leq 0.05$.

Histopathological examination of liver

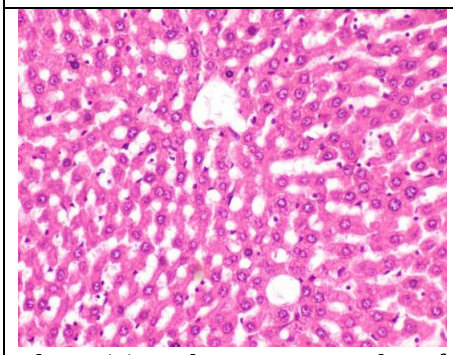
Light microscopic inspection of liver sections from rats in G1 showed normal histological architecture of hepatic lobules (Pho.1). In contrariwise, liver of rats from G2 exhibited histopathological damage characterized by Kupffer cells activation, portal infiltration with inflammatory cells and fibroplasia in the portal triad (Pho.2). Meanwhile, liver of rats from G3 showed slight fibroplasia in the portal triad (Pho.3). Otherwise, some examined parts from G4 revealed Kupffer cells activations (Pho.4). Moreover, liver of rats from G5 described Kupffer cells activation and focal hepatocellular necrosis related to infiltrations of inflammatory cells (Pho.5).

The histological findings are consistent and confirm the changes in the previous biochemical analyses results. Chronic oxidative stress is the main cause of liver fibrosis **(Nieto *et al.*, 2002).** Exposure to CCl_4 can damage many tissues, especially liver tissues **(Park *et al.*, 2015).** CCl_4 causing oxidative stress and

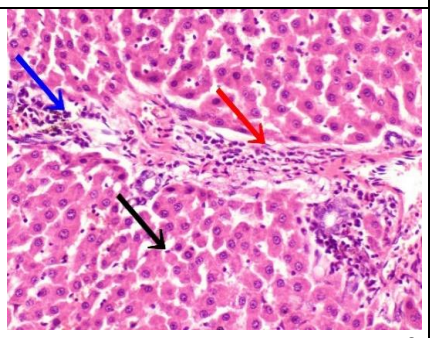
inflammatory responses, it could be transform to free radicals in liver tissues after ROS generation, a mechanism that weakens the hepatocyte membrane **(Khan *et al.*, 2012).**

Results of noticeable improvements of hepatocytes in the treated groups were consistent with **(Wei *et al.*, 2023**), showed that lycopene caused in reduction of collagen fibers deposed in rats liver. The result recommended that lycopene attenuate fibrosis in liver by decreasing HSC activations. Furthermore, **(Abdel-Rahman *et al.*, 2018)** and (**Elias *et al.*, 2019**) confirmed that lycopene had protection effects versus bisphenol A inducing toxicity, and reduce HSC activations in vitro. Lycopene can improve the development of many disorders like neurodegenerative disorders **(Yu et *al.*, 2017)**, through its strong antioxidative and antiinflammatory effects due to its high unsaturated double-bonds **(Luedde and Schwabe, 2011)**. The results of study revealed that lycopene improve the hepatic fibrosis by its antioxidant and antiinflammatory effects.

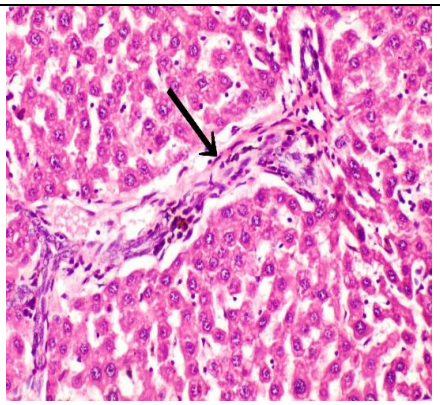
Histological Examination of Liver



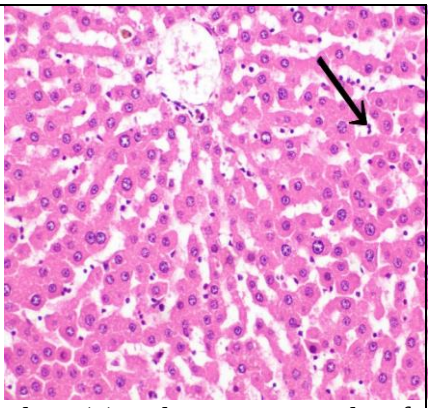
Pho. (1): Photomicrograph of liver of rat in G1, showed normal histological architecture of hepatic lobules (H & E X 400).



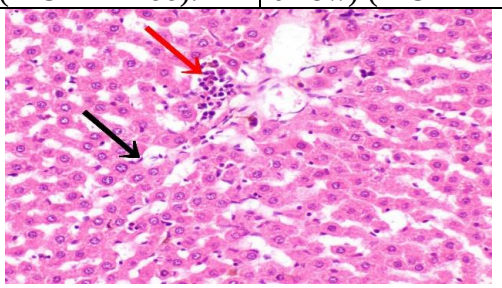
Pho. (2): Photomicrograph of liver of rat in G2, showed Kupffer cells activation (black arrow), fibroplasia in the portal triad (red arrow) and portal infiltration with inflammatory cells (blue arrow) (H & E X 400).



Pho. (3): Photomicrograph of liver of rat in G3, showedg slight fibroplasia in the portal triad (black arrow) (H & E X 400).



Pho. (4): Photomicrograph of liver of rat in G4, showed Kupffer cells activation (black arrow) (H & E X 400).



Pho. (5): Photomicrograph of liver of rat in G5, showed Kupffer cells activation (black arrow) and focal hepatocellular necrosis related to inflammatory cells infiltration (red arrow) (H&E X 400).

Conclusion

There was a noticeable improvement in the biochemical and histopathological changes resulting from exposure to CCl_4 in groups of rats whose diet contained dried tomatoes and ketchup. The groups that consumed different levels of dried tomatoes and ketchup 5%, 7.5% and 10% achieved satisfactory results, but G5 **(**10% dried tomato & ketchup) had the best effect. The results of the study scientifically proved that lycopene has significant therapeutic effects against liver damage caused by carbon tetrachloride, due to its antioxidant activity and flavonoid contents. The recommendation of the study is increasing dietary lycopene intake may have a benefit for patients with liver disease.

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الأهمية الغذائية لليكوبين ضد السمية الكبدية التى يسببها رابع كلوريد الكربون فى الفئران

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الملخص العربى

أمراض الكبد المزمنة هي حالة صامتة سريريًا، تسبب معدلات إعتلال ووفيات كبيرة في جميع أنحاء العالم. هدفت هذه الدراسة لتقييم الأهمية الغذائية لليكوبين ضد التسمم الكبدي الناجم عن رابع كلوريد الكربونCCl_4 . تم استخدام خمسة وثلاثون فأرا من ذكور الفئران البالغة ، وتم تقسيمهم عشوائيا بعد فترة التأقلم الى مجموعتين رئيسيتين ، المجموعة الاولى G1 (العدد = ٧ فئران) تغذت على النظام الغذائي الأساسي وتعتبر المجموعة الضابطة السالبة، بينما تم حقن العدد المتبقى من الفئران (العدد = ٢٨ فأرا) برابع كلوريد الكربون تحت الجلد (٢مل/كجم من وزن الجسم/الإسبوع) لمدة أسبوعين لاحداث الاصابة. بعد حقن الفئران برابع كلوريد الكربون تم تقسيمهم الى أربع مجموعات فرعية كل مجموعه بها ٧ فئران. المجموعه الفرعية الاولى تعتبر مجموعه ضابطة موجبة G2. تم تغذية باقى المجموعات G3, G4, G5 على نسب مختلفة من الطماطم والكاتشب المجففين ٥٪ ، ٧,٥٪ ، ١٠٪ على التوالى. فى نهاية فترة التجربة (٨ أسابيع) تم قياس وظائف الكبد، وظائف الكلى. كما تم تقييم نشاط مضادات الأكسدة، بالإضافة إلى الفحص النسيجي لأنسجة الكبد. أشارت النتائج إلى وجود ارتفاعا معنويا في مستويات أنزيمات الكبد ALT,AST,ALP ، بالإضافة إلى مستويات الألبومين والبيليروبين الكلي (البيليروبين المباشر والغير مباشر) في المجموعة الضابطة الموجبة G2 مقارنة بالمجموعة الضابطة السالبة، بينما أظهرت مجموعات G3، G4، G5 انخفاضاً ملحوظاً في مستوياتها مقارنة بالمجموعة الضابطة الموجبة. أظهرت مستويات اليوريا نيتروجين والكرياتينين في المجموعة الضابطة الموجبة ارتفاعاً معنوياً مقارنة بالمجموعة الضابطة السالبة، بينما كان التحسن ملحوظاً في جميع المجموعات المختبرة مقارنة مع المجموعة الضابطة الموجبة. علاوة على ذلك، أظهرت مستويات نشاط مضادات الأكسدة GSH ، CAT تحسناً ملحوظاً في جميع المجموعات المختبرة مقارنة مع المجموعة الضابطة الموجبة. أكدت نتائج الفحص الهستوباثولوجي لأنسجة الكبد التغيرات التي حدثت في القياسات البيوكيميائية في مصل الدم بين المجموعات المختبرة. يمكن الاستنتاج أن هناك تحسنا ملحوظا في التغيرات البيوكيميائية والنسيجية المرضية الناتجة عن التعرض لـ CCl_4 في مجموعات الفئران التي احتوى نظامها الغذائي على الطماطم المجففة والكاتشب. وأثبتت نتائج الدراسة علمياً أن لليكوبين تأثيرات علاجية كبيرة ضد تلف الكبد الناتج عن مركب CCl_4، وذلك من خلال نشاطه المضاد للأكسدة ومحتواه من الفلافونويد. ولذلك توصي هذه الدراسة بزيادة تناول الليكوبين الغذائي، حيث يمكن أن يكون مفيدا للمرضى الذين يعانون من تلف الكبد.

الكلمات المفتاحية: الليكوبين، وظائف الكبد، التلف الكبدي، آلية مضادة للأكسدة