Effect of Date Palm (Phoenix dactylifera L.) seeds Mixed with Burger on CCl4-induced Hepatotoxicity and Oxidative Stress in Rats

By

Nanees Y.E. AWAD
Home Economics Department,
Faculty of Specific Education,
Mansoura University, Egypt

Rehab Ibrahim Tag El-Deen
Home Economics Department,
Faculty of Specific Education,
Zagazig University, Egypt

Research Journal Specific Education
Faculty of Specific Education
Mansoura University

ISSUE NO. 66, APRIL , 2022

مجلة بحوث التربية النوعية - جامعة المنصورة
العدد السادس والستون - أبريل ٢٠٢٢

Effect of Date Palm (Phoenix dactylifera L.) seeds Mixed with Burger on CCl4-induced Hepatotoxicity and Oxidative Stress in Rats

*Nanees Y.E. AWAD** *Rehab Ibrahim Tag El-Deen***

Abstract

Background: Date palm has been shown to have excellent antioxidant activity as a result of containing high flavonoids and phenolic. It has been cited in several studies for the treatment of liver problems, as well as gastric and intestinal disorders. Aim of the study: The present study was administrated to inspect the hepatoprotective activity of burgers mixed with date palm seeds on carbon tetrachloride (CCl4)-induced Hepatotoxicity in rats. Materials and Methods: Thirty-six rats were divided into two main groups, the first group (n= 6 rats) was G (1): control (-ve), rats of second main group (n= 30 rats) were injected CCl4 twice a week for two weeks to induce hepatotoxication. After that, divided into 5 groups (each 6 rats) as follow: G (2): Hepatotoxicated rats as a control (+ve) and fed on basal diet only. G (3): Injected rats by CCl4 were fed on basal diet with burgers control, G (4, 5 and 6): Injected rats by CCl4 were fed on basal diet with burgers mixed with date palm seeds (10, 20 and 30g /kg), respectively. Results: Results demonstrated that burgers mixed with date seeds revealed significant improvement blood indicaors of CCl4-induced hepatotoxicated rats, hemoglobin (HB) and packed cell volume (PCV), (AST, ALT and ALP) liver function parameters. Also, both serum creatinine and uric acid levels were significantly decreased and nitric oxide (NO). In addition, it restored the antioxidant enzymes activities (glutathione S-transferase (GST), Catalase (CAT) and superoxide dismutase (SOD) that were deficient after

* Professor of Nutrition and Food Science, Faculty of Specific Education, Department of Home Economics,acting dean of Faculty Specific Education previously, Damietta University.

** Assistant Professor of Nutrition and Food Science, Department of Home Economics, Faculty of Specific Education, Damietta University.

CCl4 induction. Conclusions: The Date Palm (Phoenix dactylifera L.) seeds DM might be a promising alternative for CCl4-induced liver intoxication protection, and this hepatoprotective activity could be linked to antioxidant activities. It can be utilized as a natural preservative additive in suggestive formulations as a functional food and dietary supplement through biotechnological processes.

Key words: Phoenix dactylifera L., polyphenols, antioxidant, CCL4 and Hepatotoxicity

INTRODUCTION

The Liver is vital organ responsible for metabolic processes. Hepatic damage is correlated to dysfunction of these metabolic processes. Liver dysfunction occurs mainly because of extreme consuming of alcohol, viral infections, xenobiotic exposure and medicine adverse effects or medication interactions. The treatment of liver diseases is still a contentious discussed topic **(Kumar et al., 2011 and Kokhdan et al., 2017)**. Moreover, hepatotoxicity caused by drug-induced is common in developed countries, including Egypt, where people suffer from a variety of liver disorders **(Omar et al., 2013)**. Drug induced liver damage is not preventable during along utilizing drugs in management of chronic diseases which is considered an absolute necessity, for example analgesic anti-inflammatories and anticonvulsants **(Hong, 2019)**. Consequently, increasing liver cell restoration through immune enhancement and avoiding the chain oxidation process as a contributor to liver injury is critical. The concept of employing natural products as antioxidant supplements is based on the synergistic effect of several different types of antioxidant components found in closely related plants **(Abdelaziz and Ali, 2014 and Koumbi, 2017).**

Liver damage induced by CCl4 (Carbon tetrachloride) is one of the most often used animal models for investigation of hepatoprotective efficiency of numerous substances (**Cabre et al., (2000); Kokhdan et al., 2017; Erdemli et al., 2018 and Abu et al., 2021)**. It stimulated hepatic injury through generating reactive oxidative stress by inducing reactive oxidative stress via biological activation of the cytochrome P-450 system,

which produces the toxic reactive trichloromethyl peroxyl radical, this radical new attack on membrane lipids sets off a chain reaction results in membrane lipid peroxidation, which causes hepatocellular damage and carcinoma **(Weber et al., 2003; Basu, 2003; Li et al., 2015 and Abu et al., 2021).**

Date palm seeds (DM) are a by-product that comes out in a great amount during the date's manufacture process **(Al Farsi et al., 2005)**. Date fruits represent approximately 15% of the total weight of dates **(Hussein et al., 1998)**, it is a good source of high nutritive value food as a result of its high content of fiber, minerals, vitamins, lipids and protein. The phytochemical analysis of date palm showed the presence of qualitative and quantities of total polyphenolic compounds and flavonoids such as tannins and anthraquinone glycoside, moreover, it has total polyphenol content higher than in the edible flesh. Therefore, it is believed that it has the ability to restore liver cells and protect it due to containing high amounts of polyphenolic compounds and flavonoids **(Al Farsi and Lee, 2008; Habib and Ibrahim, 2009; Habib et al., 2014A; Bentrad et al., 2017; Sundar et al., 2017; Metoui et al., 2019 and Chinelo et al., 2019)**. Conventionally, it used in traditional medicine as herbal medication because of its antidiabetic, antirhematic, choleretic, diuretic properties, gastrointestinal complaints, tumors and inflammation **(Al-Showiman, 1990; Gogt, 2000 and Schütz et al., 2006)**. Recently, literatures have revealed that date can act as antioxidants, anti-cholesterol, anti-inflammatory, immune-stimulant, antihyperglycaemic and renoprotective effects **(Saryono et al., 2018 and 2019 and Alghamdi et al., 2020) .**

Hence the date palm seeds (*Phoenix dactylifera L.*) (DM) are a substantial supply of biologically active constituents could be utilized as a component in meat products; Thus, burgers were mixed with dried date seeds powder (0, 10, 20 and 30g/kg). This study aims to determine chemical composition, phytochemical constituents of (DM), preserve burgers with DM and finally evaluate the protective ability of burgers mixed with palm date seeds against CCl4-induced hepatotoxicity in experimental rats.

MATERIALS AND METHODS

MATERIALS

- Date palm seeds (*Phoenix dactylifera L.*) (DM) were collected as a by-product from Vitrac Food and Drink Company, Cairo, Egypt. Afterwards, DM was washed using tap water, then dried at (50 °C) for a week in the oven. Afterwards, DM were crushed utilizing a commercial blender. It was ground and sieved until it became a fine powder.
- The beef meat was collected from local market Cairo, Egypt .
- Carbon tetrachloride (CCl4), as a toxic chemical substance for liver poisoning, was purchased from El-Gomhouria Company for Trading Grugs, Chemicals and Medical Requirements, Cairo, Egypt (**Passmore and Eastwood, 1986)**.
- Paraffin oil, for dilution during the induction, was purchased from a pharmacy in the local market

METHODS:

Preparation of Beef Burger Formula:

Beef Burger blend were prepared as describe by **(Abd-Elhak et al., 2014)** as follows: contained: 71.5, 7.0, 5.0, 5.0, 10.0, of and (g/100g mixed burger) of fat, fine ground onion, bread crust powder, whole egg, rehydrated soy and salt, respectively. The mentioned constituents were minced and divided into four equal quantities, as follows

- **The first sample:** control group (just the mixture of burger without adds).
- **The second sample:** mixed with DM (10 g /kg burger).
- **The third sample:** mixed with DM (20 g /kg burger).
- **The fourth sample:** mixed with DM (30 g /kg burger).

Determination of chemical composition:

Moisture content, crude protein, crude fiber, crude fat and ash of DM were determined according to **(AOAC 2007)**. Carbohydrates were also calculated by difference.

Determination of total phenolic compounds:

The phenolic compounds of DM were determined in DM ethanolic extract by HPLC according to **Goupy et al., (1999)** using HPLC Hewllet Packered (series 1050) equipped.

Preparation of beef burger for microbiological analysis:

About 50g of beef burger were aseptically weighed and grinded in sterilized hun. One gram of the grinded Beef Burger was transferred into another sterilized mortar for microbiological analysis where nine ml of sterilized saline solution was added and thoroughly mixed with the beef burgers and this represents 10 dilutions which were then used making further dilution according to **Karpinska *et al.*, (2001).**

Determination of total aerobic bacteria count:

The aerobic and anaerobic plate count were determined following the procedure proposed by **the International Commission on Microbiological Specifications for Foods (ICMSF, 1987)**. This medium was obtained from El-Gomhouria Pharmaceutical Company Ameriea, Cairo, Egypt. Microbiological examination was carried out every seven days interval from storage at refrigerator temperature. All count were done in triplicates. At each sampling time, the stored bags were analyzed microbiologically according to the procedure recommended by **(ICMSF, 1987)**. Also, Serial dilutions were prepared as described by **(ICMSF, 1987)**.

Experimental animals and diet:

Thirty-six rats weighing an average of (165 +5g) were obtained from The Laboratory Animals of Helwan Farm. The animals were observed for five days prior to the experiment and fed a standard diet and water ad libitum. The standard diet was performed according to **NRC, (1995).** The ethical conduct for use and care of animals in this research had been approved by the Research Ethics Committee.

Experimental design:

The experiment was performed in Animal House in the Institute of pathology, Giza. Directly after adaptation, rats were divided into two main

groups: The first group consisted of (n= 6 rats) was fed on the basal diet only and considered as negative control (C-ve) or normal rats. The main second group of rats consisted of (n= 30 rats) in which every rat was injected by 0.5 ml CCl4 diluted by paraffin oil 50 % (3 ml/kg of body weight), and to induce hepato-intoxicition, subcutaneous injection was administered by back twice a week in period of two weeks, according to **Jayasekhar et al., (1997)**. Then, blood samples were collected by the method of hepatic portal vein to liver injury be ensured and liver functions be estimated. After that the rats were divided into 5 groups (6 rats each) beside the first group as follow:

- **Group (1):** The normal rats as a negative control (C -ve group) which feed on basal diet.
- **Group (2):** The hepato-intoxicated rats which kept without any treatment and fed on basal diet.
- **Group (3):** Injected rats by CCl4 then fed on basal diet with burgers control 10g
- **Group (4):** Injected rats by CCl4 then fed on basal diet with DM burgers 10g (10 g /kg) .
- **Group (5):** Injected rats by CCl4 then fed on basal diet with DM burgers 10g (20 g /kg) .
- **Group (6):** Injected rats by CCl4 then fed on basal diet with DM burgers 10g (30 g /kg) .

Blood sampling:

At the end of the experiment, all the rats' groups were sacrificed and blood samples were collected. Blood mixed with heparin was analyzed for (HB) hemoglobin and (PCV) packed cell volume determination according to **Drabkin (1949)** and **Mc Inory, (1954)**, respectively .

According to **Reitman and Frankel (1957); Kind and King (1954); Hare (1950)** and **Fossati et al., (1980)** serum alanine transaminase (ALT), (AST) aspartate aminotransferase, alkaline phosphates enzymes (AP), creatinine and uric acid were determined, respectively.

According to **Habig (1974), Claiborne (1985); Beuchamp and Fridovich, (1971) and Green et al., (1981),** respectively, (GST) Plasma glutathione transferase, catalase, (SOD) superoxide dismutase enzymes and (NO) nitric oxide were determined.

Statistical analysis:

As reported by **Snedecor and Cochran (1967),** Dunnet's t-test were used for the analyzation of Differences between groups followed by significant indication analysis of variance (ANOVA) between different groups.

RESULTS AND DISCUSSION

Chemical composition of date palm seeds and burgers mixed with DM

The proximate chemical composition of DM and burgers mixed with DM (0, 10, 20 and 30g/kg burger) are presented in Table 1. The moisture, fat, protein, ash and carbohydrates % content of date DM were 3.44, 1.17, 5.98, 1.79 g and 87.62, respectively. It could be observed that the addition of palm to burgers result in increment of moisture, fat, protein and ash content when compared to the control burger. Such values are kind of consistent with those mentioned by **Al-farsi et al., (2007)** who estimated the Omani varieties date palm' chemical composition as 3.1–7.1%, 2.3–6.4%, 5.0–13.2%, 0.9–1.8% and 22.5–80.2% of moisture, protein, fat, ash and dietary fiber, respectively. However, the chemical composition of date seeds was reported as 16.06 - 33.61%, 5.23-7.02%, 4.88-7.81% and 73.83-82.3% of Moisture, protein, fat and Dietary fiber, respectively **(Metoui et al., 2019).**

Table (1): Chemical composition of date palm seeds and burgers mixed with DM

Samples	Moisture%	Fat	Protein	Ash	Carbohydrate
Date palm	3.44	1.17	5.98	1.79	87.62
burger control 0% DM	11.50	10.08	22.71	1.45	54.26
burgers with 10%DM	19.43	12.47	27.77	2.02	38.31
burgers with 20%DM	17.89	16.60	39.25	2.76	23.50
burgers with 30%DM	12.89	20.60	34.25	2.98	29.28

Phytochemical constituents of date palm seeds ethanolic extract

DM ethanolic extract showed the presence of various qualitative and quantities of polyphenolic compound table (2). The preliminary phytochemical investigation stated that it included significant amounts of vanillic, catechol, pyrogallol, protocatchchuic, epicatechein, e-vanillic, p-oh-benzoic, gallic, ellagic, salicylic, chlorogenic, catechein and caffeine, respectively. These results were consistent with **Abdelaziz and Ali (2014)** who reported that (*Phoenix dactylifera L.*) had high quantities of phenolic compounds (38.8 mg gallic acid equivalent g-1) and total flavonoids (87.86 mg rutin equivalent/g). Also, several reports stated that, date palm DM have large variables of antioxidants (phenolics and flavonoids) (**Al-Farsi et al., 2007; Al-Farsi and Lee, 2008 and Juhaimi et al., 2012). Al-Farsi et al., (2007) and Habib et al. (2014 B)** revealed that date palm is a rich source of polyphenolic compounds more than grapes, flaxseed, nut DM in comparison and even date fruit; thus, DM could be benefitial in functional food prospects. The flavan-3-ols representing the main class in almost percentage 99% of total polyphenolic compounds and were distributed as epicatechin and catechin. According to **Ardekani et al. (2010)** it could be utilized in medicinal as well as commercial fields for benefits as containing high amounts of antioxidant (37.42 mmol FeII /100 g dry plant) and (3541 mg gallic acid/100 g dry plant) as aphenolic content. Gallic acid, m-coumaric acid and p-hydroxybenzoic acid have been identified in date DM as same as vanillic acid protocatechuic acid and p-coumaric acid, besides ferulic acid, caffeic acid and o-coumaric acid **(Al-Farsi and Lee, 2008). Bijami et al., (2020)** identified six compounds which were gallic acid, chlorogenic acid, p-coumaric acid, sinapic acid, catechin, and vanillin as noticed and enumerated by HPLC during analysis of palm DM.

Table (2): Phytochemical constituents of date palm seeds extract

phenolic compound	date palm extract (ppm)
Chlorogenic	357.31
Gallic	704.34
Pyrogallol	3082.66
4-Amino-benzoic	28.30
Protocatchchuic	184.88
Elagic	539.51
Catechein	311.05
Catechol	10928.52
Epicatechein	1742.94
Caffeine	264.72
p-oh-benzoic	967.56
Caffeic	145.72
Vanillic	12819.49
Ferulic	126.40
Iso- ferulic	64.38
e-vanillic	1459.53
Benzoic	152.60
Salyciic	393.95
3,4,5Methoxy cinnamic	9.01
Coumarin	56.95
p- coumaric	102.18
Cinnamic	1.77

Determination of total aerobic bacteria count during storage period of burgers mixed with DM

The antibacterial (preserving) properties of studied burgers mixed with DM (0, 10, 20 and 30g/kg) against total aerobic bacteria is presented in Table 3. The data showed that there was high influence on the burgers antibacterial activity caused by DM quantities and storage period as it

increased by increasing the amount of DM powder and storage period. This was confirmed by the count of total aerobic bacteria.

The represented results are consistent with **Metoui et al., (2019) and Radfar *et al.*, (2020)** who stated that DM have antimicrobial properties, especially against Gram-positive bacteria. **Radfar et al., (2019)** revealed that DM extract included inhibitory effects against Staphylococcus aurous. The antibacterial efficiency of date extracts could be attributed to the presence of phenolic compounds and polyphenols during the protein precipitation process, as well as an inhibitory effect on microorganism enzymes **(Metoui et al., 2019)**. Recently, there were high increment in utilizing natural additive preservatives particularly from plant sources, as a result of the undesirable consequences of utilizing chemical preservative additives in the production of preserved foods **(Mir et al., 2018).**

Table (3): Determination of total aerobic bacteria count during burger storage period

Storage period	Zero time	7 days	15 days	30 days
Control burger	$4\times10^{6\,a}$	$7.3\times10^{6\,c}$	$13.6\times10^{6\,c}$	$15\times10^{6\,c}$
Burger preserved using DM (10 g /kg).	$1\times10^{6\,b}$	1.6×10^{6ab}	$1.3\times10^{6\,a}$	9×10^{5ab}
Burger preserved using DM (20 g /kg).	$2\times10^{6\,b}$	$1\times10^{6\,a}$	$3\times10^{5\,b}$	$6\times10^{5\,a}$
Burger preserved using DM (30 g /kg).	$2\times10^{6\,b}$	$1\times10^{6\,a}$	$1\times10^{6\,a}$	$1\times10^{6\,b}$

Each value represents the mean±SD. Means in the same raw with different superscript letters were significant different at $P\leq0.05$.

Effect of burgers mixed with date palm seeds on body weight, body weight gain, food intake and feed efficiency ratio (FER)

The body weight gain, food intake and feed efficiency ratio (FER) of all studied groups are shown in Table (4). Growth indicator of the experimental groups was performed according to the body weight gain just as the experiment ended. Administration of CCl4 for two weeks reduced the weight gain significantly (54.30 g) in (C+ve) group in comparison with the (C-ve) group (85.92g). The rats of group (3) injected by CCl4 then fed with the basal diet with burgers control gained more weight as compared to CCl4

group but fewer than the control group. However, rats of groups (4, 5 and 6) injected by CCl4 and then with the basal diet and burgers mixed with DM (10, 20 and 30 g/kg, respectively) markedly improved the growth performance. Regarding food intake, it could be noted that there were no significant changes between all treatment as compared to negative control. Meanwhile, feed efficiency ratio (FER) for positive control (G2) significantly decreased compared to control group and all treatment groups. This comes in accordance with **Abdelaziz and Ali (2014)** who reported that (*Phoenix dactylifera L.*) DM caused weight gain significantly increased in comparison with CCl4 group. On the contrary, non-significant differences in rats' body weight revealed in-between the experimental (normal, CCl4 treated only and pre-treated with plant extracts then after-treated with CCl4) groups **(Thanebal et al., 2021)**.

Table (4): Effect of burgers mixed with date palm seeds on body weight, body weight gain, food intake and feed efficiency ratio (FER)

Groups Variables	Negative control	Positive control	Control burger	Burger using DM10g/kg	burger using DM20g/kg	burger using DM30g/kg
Initial Weight	115.55 ± 3.17a	110.41 ± 2.50 a	113.14 ± 3.45 a	112.33 ± 2.99 a	110.22 ± 3.11 a	110.34 ± 3.14 a
Food Intake (g/d))	16.15 ± 2.11 a	14.58 ± 2.17 a	16.12 ± 2.11 a	16.25 ± 2.91 a	16.65 ± 2.18 a	16.25 ± 2.81 a
Final Weight (g)	200.47 ± 10.11 a	155.71 ± 15.6b**	174.71 ± 10.9 a	190.3 ± 13.80 a	205.5 ± 12.00 a	203.44 ± 15.8 a
Weight Gain (g)	85.92 ± 11.33 a	54.30 ± 7.71 b**	75.57 ± 8.17 a	88.08 ± 10.22 a	95.92 ± 11.11 a	93.77 ± 11.21 a
FER	0.093 ± 0.001 a	0.051 ± 0.002 b**	0.084 ± 0.003 a	0.092 ± 0.001 a	0.091 ± 0.001 a	0.094 ± 0.003 a

Each value represents the mean±SD. Means in the same raw with different superscript letters were significant different at P≤0.05.

Effect of burgers mixed with date palm seeds on blood hemoglobin (HB) and packed cell volume (PCV) on rats intoxicated by CCL4

From the obtained results, it could be observed that rats fed on control burgers and burgers mixed DM produced significant increase in (HB) values and (PCV) compared to positive control group (table 5). Meanwhile, non-significant changes revealed in-between control burgers and burgers mixed with DM treatment groups and negative control group. These results were in agreement with **Orabi and Shawky (2014)** who indicated that date caused significant increase in HG concentration, meanwhile, PCV%, WBCS% and RBCs% didn't record significant differences in-between the groups date and control which received basal diet.

Table (5): Effect of burgers mixed with date palm seeds on blood hemoglobin (HB) and packed cell volume (PCV)

Groups Variables	Negative control	Positive control	Control burger	Burger using DM10g/kg	burger using DM20g/kg	burger using DM30g/kg
HB (gm/dl)	13.39 ± 1.18 a	6.19 ± 0.39 b**	11.54 ± 1.4 a	10.95 ± 1.98 a	12.18 ± 2.01 a	12.54 ± 1.82 a
PCV %	40.01 ± 3.82 a	29.91 ± 3.55b*	34.79 ± 3.47 b*	35.24 ± 4.01 a b	36.61 ± 4.11 a	36.91 ± 3.17 a

Each value represents the mean±SD. Means in the same raw with different superscript letters were significant different at $P \leq 0.05$.

Effect of burgers mixed with date palm seeds treatment on liver and kidney functions

Liver and kidney parameters investigated in this research are represented in Table 6. It could be noted that induction with CCl4 for 2 weeks generated abnormal liver indicators as revealed by increment of serum values of hepatic enzymes AST, ALT and ALP. As well as, when compared to the control group, serum creatinine and uric acid levels increased significantly. However, administration of burgers mixed with DM retrieved normal levels of ALT, AST and ALP as compared to the CCl4

group, while caused a significant decrease in serum creatinine and uric acid levels in comparing with the same group. Additionally, the maximum enhancement of liver and kidney functions accomplished in group (6). Reduction of CCl4-induced in animals treated with burgers mixed with DM enhanced the activities of AST, ALT and ALP levels showing their impact on restoring normal liver functions that been poisoned, and protecting against consequences of CCl4 hepatotoxicity.

There are firm evidences in scientific research which indicated that CCl4 conduction induces hepatic injury experimented on animals revealed increment of serum levels of ALT, AST and ALP **(Al-Qarawi et al., 2004; Abdelaziz and Ali, 2014; Liu et al., 2018; Rizk et al., 2020; Abu et al., 2021** and **Thanebal et al., 2021). Abdelaziz and Ali (2014)** stated that using either the raw (*Phoenix dactylifera L.* DM) or the roasted significantly reduced the CCl4-induced increments of liver function indicators in serum blood (GOT, GPT and ALP). Moreover, **Ahmed et al., (2015)** showed that CCl4 induced mice revealed an increase in free radicals leading to kidney and liver injury. On the other hand, giving DM extract reduced levels of ALT, AST, ALP and creatinine and increased the body's antioxidant ability **(Al meqbaali et al., 2017)**. The reducing levels of these indicators as compared to the normal control values is evident on the stability of plasma membranes besides the liver damage restoration. **Kowalska et al., (1990)** mentioned that (*Phoenix dactylifera L.*) date's high content of flavonoids could be contributing element besides its hepatoprotective efficiency through cytochrome P-450 aromatase inhibition. **Khan et al., (2018)** stated that in mice suffering from hyperlipidemia, the mice consumed Ajwa extract revealed ALT and AST values were higher as compared to the treated mice with atorvastatin only. **Alghamdi et al., (2020)** reported that as compared to the ischemia/reperfusion (I/R) injury group, date palm extract resulted in significant reductions in serum creatinine and uric acid levels.

Table (6): Effect of burgers mixed with date palm seeds treatment on liver and kidney functions:

Groups Variables	Negative control G1	Positive control G2	Control burger G3	Burger using DM10g/kg G4	burger using DM20g/kg G5	burger using DM30g/kg G6
AST (µ /ml)	46.17± 5.81b	77.39± 9.61 a**	48.37± 6.01 b	52.14± 8.10 b	49.21± 6.15 b	42.21± 4.13 b
ALT (µ /ml)	13.35± 1.12b	28.55± 3.35 a**	16.71± 1.81 b	15.28± 2.01 b	15.13± 3.51 b	14.11± 3.65 b
Alk –Pho (µ /ml)	32.17± 5.66 b	50.38± 5.81 a**	39.80± 4.11 b	37.73± 4.37 b	36.34± 5.01 b	35.11± 3.11 b
Creatinine (mg/dl)	0.78± 0.01 b	1.96± 0.11 a**	0.98± .02 b	0.88± 0.12 b	0.75± 0.13 b	0.74± 0.15 b
Uric acid (mg/dl)	1.83± 0.26c	4.41± 1.01 a***	2.11± 0.81b*	2.52± 0.77 b*	2.29± 0.67 b*	1.95± 0.74 c

Each value represents the mean±SD. Means in the same raw with different superscript letters were significant different at P≤0.05.

Effect of burgers mixed with date palm seeds treatment on antioxidant enzymes levels (glutathione S-transferase (GST), Catalase and superoxide dismutase (SOD) and nitric oxide (NO)

As shown in Table 7, CCL4 administration caused an elevation of nitric oxide (NO) level and a demotion in glutathione S-transferase (GST), Catalase (CAT) and superoxide dismutase (SOD) compared to the control group. However, all groups treated with burgers mixed with DM restored normal levels of GST, Catalase and SOD and caused significant decrease in nitric oxide (NO) levels compared to CCl4 group. These results is agreement with **Liu et al., (2018); Rizk et al., (2020); Abu et al., (2021) and Thanebal et al., (2021)** established that the administration of CCL4 affected antioxidant enzymes (SOD, CAT and Glutathione peroxidase (GPx)) by decreasing their activities in liver tissue homogenate significantly, in contrast, the oxidative stress parameter Malonyl-di-Aldehyde (MDA) value in the homogenate was significantly increased. Malondialdehyde level (as a reactive substance of thiobarbituric acid) and endogenous antioxidant enzymes activities such as SOD, GPx and CAT are sensitive indices in free radical induced hepatocellular damage **(Mohajeri et al., 2011)**. Moreover, **Abu et al., (2021)** indicated that a significant decrease

of SOD, GPx and CAT in the hepatic tissues of rats induced by CCl4 may have been caused by high amounts of free radicals produced by CCl4 and possibly developed inactivation or inhibition of the synthetic pathways of these endogenous antioxidant enzymes thereby resulting in their low turnover. **Abdelaziz and Ali (2014)** and **Ahmed et al., (2015)** established that rats fed on an experimental diet contained (*Phoenix dactylifera L.*) DM powder resulted in higher levels of both SOD and GST besides NO level significantly decreased compared to CCl4 group in experimental rats. These indications showed that (*Phoenix dactylifera L.*) DM have antioxidant compound that controlled the CCl4-induced oxidative stress in liver tissues. Also, these results agree with **Paranthaman et al., (2012)** who revealed that flavonoid contents of (*Phoenix dactylifera L.*) DM have antioxidant properties. Phytochemicals such as phenolic acid and flavonoid may have antioxidant properties against the alterations of superoxide and hydroxide free radicals, as well as hydrogen peroxide, restoring the antioxidant status in the cells. **(Etim et al., 2008). Alghamdi et al., (2020)** stated that pre-treatment utilizing date palm fruit or date palm extracts resulted in significant increase in CAT activity and GSH concentration .

Table (7): Effect of burgers mixed with date palm seeds treatment on antioxidant enzymes levels (glutathione S-transferase (GST), Catalase and superoxide dismutase (SOD) and nitric oxide (NO)

Groups Variables	Negative control G 1	Positive control G2	Control burger G3	Burger using DM10g/kg G 4	burger using DM20g/kg G 5	burger using DM30g/kg G 6
GST (µ /l)	288.31± 33.27 a	77.85± 8.40 c***	188.35± 22.17 b*	211.31± 23.81 b*	240.21± 23.71 a	278.15± 31.71 a
Catalase (µ /l)	285.21± 55.14 a	102.55± 10.14 c***	230.77± 32.11 ab	291.61± 31.61 a	277.11± 30.91 a	284.11± 39.11 a
SOD (µ /l)	70.13± 5.22 a	46.25± 3.47 b***	63.14± 7.16 a	68.33± 6.35 a	71.31± 9.23 a	73.14± 7.81 a
NO (µmol /l)	2.17± 0.33 b	10.11± 1.44 a***	4.33± 1.11 b	3.22± 1.03 b	3.11± 1.05 b	2.01± 1.21 b

Each value represents the mean±SD. Means in the same raw with different superscript letters were significant different at P≤0.05.

Conclusions

In conclusion, the alimentation on burgers mixed and preserved with date palm seeds might be considered as a nutritive source rich in natural fibers and phytochemicals and could be a valuable approach to avoid the hepatotoxicity stimulates by carbon tetrachloride. These protective capabilities could be explained, at least in part, by the high levels of antioxidants compounds (polyphenols and flavonoids). Besides it would be an economically viable alternative to special healthy meat products. Nevertheless, additional research is needed to better understand the valuable components and mechanisms concerned in this protective effect of date palm.

REFERENCES

- **Abd-El Hak, N. A.; Ali, S. E and Zakna, N. L. (2014).** Innovative modification of traditional burger. Egypt. J. Agric. Res., 92 (3): 995-1008.
- **Abdelaziz, D. H. A. and Ali, S. A. (2014).** The protective effect of *Phoenix dactylifera L.* DM against CCl4-induced hepatotoxicity in rats. Journal of Ethnopharmacology. 155: 736–743.
- **Abu, M. S.; Yakubu, O. E; Imo, C.; Yohanna, R. E.; Okpe, O. and Mashi, R. L. (2021).** Effect of N-butanol Extract of Ficus glumosa Leaves on CCl4-induced Hepatotoxicity and Oxidative Stress in Rats. Open Science Journal of Bioscience and Bioengineering, 8(1): 12-18 .
- **Ahmed, A.F.; Al-qahtani, J. H.; Al-yousef, H. M.; Al-said, M. S.; Ashour, A. E. and Al-Sohaibani, M. (2015).** Proanthocyanidin-Rich Date Seed Extract Protects Against Chemically Induced Hepatorenal Toxicity. J Med Food, 18(3):1–10.
- **Al Farsi, M. A.; Alasalvar, C.; Morris, C.; Baron, M. and Shahidi, F. (2005).** Compositional and sensory characteristics of three native sun-dried date (*Phoenix dactylifera L.*) varieties grown in Oman. J Agric Food Chem 53:7586–7591.
- **Al Farsi, M.A. and Lee, C.Y. (2008).** Nutritional and functional properties of dates: A review. Crit Rev Food Sci 48:877–887.

- **Al-Farsi, M. A. and Lee, C. Y. (2008 B).** Optimization of phenolics and dietary fibre extraction from date DM. Food Chem., 108 (3): 977–985 .
- **Al-Farsi, M.; Alasalvar, C.; Al-Abid, M.; Al-Shoaily, K.; Al-Amry, M. and Al-Rawahy, F. (2007).** Compositional and functional characteristics of dates, syrups, and their by-products. Food Chem. 104 (3), 943–947 .
- **Al-Farsi, M.; Alasalvar, C.; Morris, A.; Baron, M. and Shahidi, F. (2005 B).** Comparison of antioxidant activity, anthocyanins, carotenoiDM, and phenolics of three native fresh and sun-dried date (*Phoenix dactylifera L.*) varieties grown in Oman. J. Agri. Food. Chem. 53 (19), 7592–7599 .
- **Alghamdi, M.A.; Hussein, A.M.; AL-Eitan, L.N.; Elnashar, E.; Elgendy, A.; Abdalla, A.M.; Ahmed, S. and Khalil, W.A. (2020).** Possible mechanisms for the renoprotective effects of date palm fruits and DM extracts against renal ischemia/reperfusion injury in rats. Biomedicine & Pharmacotherapy, 130: 110540.
- **Al meqbaali, F.; Habib, H.; Othman, A.; Al-Marzooqi, S.; Al-Bawardi, A.; Pathan, J.; Hilary, S.; Souka, U.; Al-Hammadi, S.; Ibrahim, W. and Platat, C. (2017).** The antioxidant activity of date seed: preliminary results of a preclinical in vivo study. Emirates Journal of Food and Agriculture, 29(11): 822-832 .
- **Al-Qarawi, A. A.; Mousa, H. M.; Ali, B. E. H.; Abdel-Rahman, H. and El-Mougy, S. A. (2004).** Protective Effect of Extracts from Dates (*Phoenix dactylifera L.)* on Carbon Tetrachloride–Induced Hepatotoxicity in Rats. Intern J Appl Res Vet Med., 2(3): 176-180.
- **Al-Showiman, S. S. (1990).** Chemical composition of date palm DM (*Phoenix dactylifera L.*) in Saudi Arabia. J. Chem. Soc., 12: 15–24.
- **AOAC (2007).** Official Method of Analysis of AOAC International. 18th ed. Association of Official Analytical Chemists, Washington, DC. USA.
- **Ardekani, M. R. S.; Khanavi, M.; Hajimahmoodi, M., Jahangiri, M., Hadjiakhoondi, A. (2010).** Comparison of antioxidant activity and total phenol contents of some date seed varieties from Iran. Iran J. Pharm. Res. 9 (2): 141–146.

- **Basu, S. (2003).** Carbon tetrachloride induced lipid peroxidation: eicosanoid formation and their regulation by antioxidant nutrients. Toxicol., 189 (1-2): 113–127.
- **Behija, A.E.A.; Beligh, S.E.; Lamia, M.; Manel, L.; Mohamed, I., and Lotfi, A., (2012).** Effects of the ripening stage on phenolic profile, phytochemical composition and antioxidant activity of date palm fruit. J. Agric. Food Chem. 60 (44), 10896–10902 .
- **Bentrad, N.; GAceb-terrak, R.; Benmalek, Y. and Rahmania, F. (2017).** Studies on Chemical Composition and Antimicrobial Activities of Bioactive Molecules from Date Palm (*Phoenix Dactylifera L.*) Pollens and Seed DM. African J Tradit Complement Altern Med.,14(3):242–56 .
- **Beuchamp, C. and Fridovich, J. (1971).** Superoxide dismutase. Improved assay an assyapplicable to acryloamide gels. Anal Biochem. 44: 276-287.
- **Bijami, A.; Rezanejad, F.; Hakimeh Oloumi, H. and Mozafari, H. (2020).** Minerals, antioxidant compounDM and phenolic profile regarding date palm (*Phoenix dactylifera L.*) seed development. Scientia Horticulturae,262:109017. https://doi.org/10.1016/j.scienta.2019.109017
- **Cabre, M.; Camps, J.; Paternain, J. L.; Ferre, N. and Joven, J. (2000).** Time-course of changes in hepatic lipid peroxidation and glutathione metabolism in rats with carbon tetrachloride-induced cirrhosis. Clin. Exp. Pharmacol. Physiol., 27: 694-699 .
- **Chinelo, C. E.; Ezinwanne, N. E.; Chizoba, A. O.; Martina, C. A.; Chineye, N. U. and Somtochukwu, A. E. (2019).** Evaluation of Antimicrobial Activities of Crude Methanol Extract of *Phoenix dactylifera* Seed DM on Clinical Isolates of Different Strains of E. coli. Int J Biochem Res Rev.,25(1):1–7 .
- **Claiborne, A., (1985):** Catalase activities. In: Greenwald, R.A. (Ed.), CRC Handbook of MethoDM in Oxygen Radical Research. CRC Press, Boca Raton, pp. 283–284.
- **Drabkin, D. (1949):** The standardization of hemoglobin measurements. Am. J. Med. Sci., 21 (7): 710.
- **Erdemli, M.; Gul, E.; Altinoz, Z.; Aksungur, S. and Gul, H.G. (2018).** Bag Can crocin play a preventive role in Wistar rats with carbon tetrachloride-induced nephrotoxicity? Iran J. Basic Med. Sci., 21: 382-387.

- **Etim, O. E.; Akpan, E. J. and Usoh, I. F., (2008).** Hepatotoxicity of carbon tetrachloride: protective effect of Gongronema latifolium. Pakistan Journal of Pharmaceutical Sciences, 21 (3): 269–274.
- **Fossati, P.; Prencipe, L. and Berti, G. (1980):** Use of 3,5dichloro-2-hydroxybenzene sulfonic acid /4-amlnophenazon chromogenic system in direct enzymatic assay of uric acid in serum and urine. Clin. Chem., 26: 227-231.
- **Gogt, V.M. (2000).** Ayurvedic Pharmacology & Therapeutic Uses of Medicinal Plants. first edition, Dravyagunavigyan press, Mumbai, India, pp. 405–406.
- **Goupy, P.; Hugues, M.; Boivin, P., and Amiot, M. (1999).** Antioxidant composition and activity of barley (Hordeum vulgare) and malt extracts and of isolated phenolic compounDM. Journal of the Science of Food and Agriculture, 79(12): 1625-1634.
- **Green, L. C.; Wagner, D. A.; Glokowski, J.; Skipper, P. L.; Wishnok, J. S. and Tannenbaum, S. R. (1981).** Analysis of nitrite, nitrate, and [15N] nitrite in biological fluiDM. Anal. Biochem1., 126: 131-138.
- **Habib, H. and Ibrahim, W. (2009).** Nutritional quality evaluation of eighteen date pit varieties. Int J Food Sci Nutr., 60:99–111 .
- **Habib, H.; Kamal, H.; Ibrahim, W. and Al Dhaheri, A.S. (2014 A).** Carotenoid, fat soluble vitamins and fatty acid profiles of 18 varieties of date oil. Ind Crops Prod 42:567–572.
- **Habib, H.M.; Platat, C.; Meudec, E.; Cheynier, V. and Ibrahim, W.H. (2014 B).** Polyphenolic compound DM in date fruit seed (*Phoenix dactylifera*): characterisation and quantification by using UPLC-DAD-ESI-MS. Journal of the Science of Food and Agriculture 94, 1084–1089 .
- **Habig, W. H.; Pabst, M. J. and Takob, W.B. (1974).** Glutathione S-transferase. The first enzymatic step in meracapturic acid formation. J, Biol. Chem., 249(22):7130-7139.
- **Hare, R.S. (1950):** Endogenous creatinine in serum and urine. Proc.Soc. Exp. Biol. Med. 74, 148.
- **Hong, Y.C. (2019).** Method of Ending Disease and the Future Medical System. The Changing Era of Diseases, 109-143 .
- **Hussein, A.S.; Alhadami, G.A. and Khalil, Y.H. (1998).** The use of dates and date pits in broilers starter and finishers diets. Bioresour Techol., 66: 219-223 .

- **ICMSF (1987).** International Commission on Microbiological Specifications for Foods.
- **Jayasekhar, P., Mohanan, P., and Rathinam, K. 1997.** Hepatoprotective activity of ethyl acetate extract of Acacia catechu. Indian journal of pharmacology, 29: 426.
- **Juhaimi, F. A. l.; Ghafoor, K. and Özcan, M. M. (2012).** Physical and chemical properties, antioxidant activity, total phenol and mineral profile of seed DM of seven different date fruit (*Phoenix dactylifera L.*) varieties. International Journal of Food Science and Nutrition, 63: 84–89.
- **Karpinska, M.; Borowski, J. and Danowska, O. M. (2001).** The use of natural antioxidants in ready to serve food. Food Chemistry, 72 (1): 5-9.
- **Khan, T.J.; Kuerban, A.; Razvi, S. S.; Mehanna, M. G.; Khan, K. A. and Q.Almulaiky, Y. (2018).** In vivo evaluation of hypolipidemic and antioxidative effect of 'Ajwa' (*Phoenix dactylifera L.*) date seed-extract in high-fat diet-induced hyperlipidemic rat model. Biomedicine & Pharmacotherapy, 107:675-680.
- **Khan, N. and Sultana, S., (2004):** Abrogation of potassium bromate induced renal oxidative stress and subsequent cell proliferation response by soy isoflavones in Wistar rats. Toxicology 201, 173–184.
- **Kind, P. R. and King, E. J. (1954).** Estimation of alkaline phosphatase activity by determination of hydrolyzed phenol with aminoantipyrene. J. Clin.Path, 7: 322.
- **Kokhdan, E. P.; Ahmadi, K.; Sadeghi, H.; Sadeghi, H.; Fahemeh Dadgary, F.; Danaei, N. and Aghamaalia, M. R. (2017).** Protective effect of Stachys pilifera ethanol extract in carbon tetrachloride-induce hepatotoxicity in rats. Pharmaceutical Biology 55(1):1389-1393.
- **Koumbi, L. (2017).** Dietary factors can protect against liver cancer development. World J Hepatol 2017; 9(3): 119-125 .
- **Kowalska, M. T.; Brandt, M. E. and Puett, D. (1990).** Inhibition of cytochrome P-450 aromatase activity by plant extracts. Planta Med.,56:675–677.
- **Kumar, C. H.; Ramesh, A.; Kumar, J. S. and Ishaq, B. M. (2011).** A review on hepatoprotective activity of medicinal plants. Int J Pharm Sci Res. 2:501.

- **Li, S.; Tan, H.-Y.; Wang, N.; Zhang, Z.-J.; Lao, L.; Wong, C.-W. and Feng, Y. (2015).** The role of oxidative stress and antioxidants in liver diseases. Intl. J. Mol. Sci. 16 (11): 26087–26124
- **Liu, Y.; Zheng, D.; Su, L.; Wang, Q. and Li, Y. (2018).** Protective effect of polysaccharide from Agaricus bisporus in Tibet area of China against tetrachlorideinduced acute liver injury in mice. International journal of biological macromolecules 118: 1488-1493.
- **Mc Inory, l. (1954):** Amicro heamatocrit for determining the packed cell and hemoglobin concentration on capillary blood. J. Clin., Path., (7): 32.
- **Metoui, M.; Essid, A.; Bouzoumita, A. and Ferchichi, A. (2018).** Chemical Composition, Antioxidant and Antibacterial Activity of Tunisian Date Palm Seed. Polish J Environ Stud., 28(1):267–74 .
- **Metoui, M.; Essid, A.; Bouzoumita, A. and Ferchichi, A. (2019).** Chemical composition, antioxidant and antibacterial activity of Tunisian date palm seed. Pol. J. Environ. Stud. 28 (1):267–274.
- **Mir, S. A.; Dar, B. N.; Wani, A. A.; Shah, M. A. (2018).** Effect of plant extracts on the technofunctional properties of biodegradable packaging films. TrenDM Food Sci. Technol., 80: 141–154.
- **Mohajeri, D.; Amouoghli, T. B.; Doustar, Y. and Nazeri, M. (2011).** Protective Effect of Turnip Root (*Brassica Rapa. L*) Ethanolic Extract on Early Hepatic Injury in Alloxanized Diabetic Rats. Australian Journal of Basic and Applied Science, 5 (7): 748-756.
- **NRC (National Research Council) (1995):** Nutrient requirement. Fourth reviser edition. Pp: 29-30 National Academy Press Washington, Animals, D.C. Environ. Sci. Health, 25: 487-494.
- **Omar, A.; Abou-Alfa, G. K.; Khairy, A. and Omar, H. (2013).** Risk factors for developing hepatocellular carcinoma in Egypt. Chinese clinical oncology, 2 (4): 43-52.
- **Orabi, S.H and Shawky, S.M. (2014).** Effect Of Date Palm (*Phoenix Dactylifera*) SeeDM Extracts on Hematological, Biochemical Parameters and Some Fertility Indices In Male Rats. International Journal of Sciences: Basic and Applied Research (IJSBAR), 17(1):137-147.

- **Paranthaman, R.; Kumar, P. and Kumaravel, S. (2012).** HPLC and HPTLC determination of caffeine in raw and roasted date seed (*Phoenix Dactylifera L.*). The Journal of Chromatography and Separation Techniques (1): 249–253.
- **Passmore, R. and Eastwood, M. A. (1986).** "Human Nutrition and Dietetics". Eight editions. Longman Group UKLTD. Churchill Livingstone
- **Radfar, R.; Hosseini, H.; Farhoodi, M.; Ghasemi, I.; Średnicka-Tober, D.; Shamloo, E. and Khaneghah, A.M. (2020).** Optimization of antibacterial and mechanical properties of an active LDPE/starch/nanoclay nanocomposite film incorporated with date palm seed extract using D-optimal mixture design approach. International Journal of Biological Macromolecules, 158:790–799.
- **Radfar, R.; Farhoodi, M.; Ghasemi, I.; Khaneghah, A.M.; Shahraz, F. and Hedayat Hosseini, H. (2019).** Assessment of Phenolic Contents and Antioxidant and Antibacterial Activities of Extracts from Four Varieties of Iranian Date Palm (*Phoenix dactylifera L.*) SeeDM. Applied Food Biotechnology, 6 (3):173-184.
- **Reitman, S. and Frankel, S. (1957):** Enzymatic determination of liver function. Am. J. Clin. path., 28:56-63.
- **Rizk, M.; El-Deberky,D.; Faten Elsayd, F.; Amin, A. and El-Mahmoudy, A. (2020).** Pharmacological impact of Agaricus bisporus extract in carbon tetrachloride-induced hepatotoxicity in rats. International Journal of Pharmacology and Toxicology, 8 (1): 107-116 .
- **Saryono, S.; Dardjito, E.; Proverawati, A.; Sumeru, A.; Setiyani, R. and Upoyo, A. S. (2019).** Date seeDM (*Phoenix dactylifera L.*) consumption as anti-inflammatory and immunostimulant: a systematic review. IOP Conf Ser Earth Environ Sci., 250:1–8.
- **Saryono, S.; Warsinah, W. and Isworo, A. (2018).** Anti-inflammatory effect of date seeDM (*Phoenix dactylifera L.*) on carrageenaninduced edema in rats. Trop J Pharm Res., 17(12): 2455–2461 .
- **Schütz, K.; Carle, R. and Schieber, A. (2006).** Taraxacum - a review on its phytochemical and pharmacological profile. J. Ethnopharmacol., 107 (3) (2006) 313–323 .
- **Snedecor, G. W. and Cochran, W. G. (1967).** Statistical MethoDM. Oxford and IBH Publishing Co., New Delhi.

- **Sundar, R.D.V.; Segaran, G.; Shankar, S.; Settu, S. and Ravi, L. (2017).** Bioactivity of *Phoenix dactylifera* seed and its phytochemical analysis. Int J Green Pharm.,(2):1–6 .
- **Thanebal, S.P.; Vun-Sang, S.; Iqbal, M. (2021).** Hepatoprotective effects of Pandanus amaryllifolius against carbon tetrachloride (CCl4) induced toxicity: A biochemical and histopathological study. Arabian Journal of Chemistry. 14(10):103390
- **Weber, L.W.; Boll, M.; Stampfl, A. (2003).** Hepatotoxicity and mechanism of action of haloalkanes: carbon tetrachloride as a toxicological model. Critical Rev. Toxicol. 33: 105–136 .
- **Weichselbaum, T. F. (1946).** An accurate and rapid method for the determination of protein in small amount of blood serum and plasma. Am.J. Clin. Pathol. 10:40-9.

تأثير البرجر المخلوط ببذور تمر النخيل
على سمية الكبد والإجهاد التأكسدى المستحث برابع كلوريد الكربون في الفئران

الملخص

تمر النخيل له نشاط ممتاز كمضاد للأكسدة نتيجة لاحتوائه على نسبة عالية من مركبات الفلافونويد والفينول. وقد تم الاستشهاد به في العديد من الدراسات لعلاج مشاكل الكبد ، وكذلك اضطرابات المعدة والأمعاء. أجريت الدراسة الحالية لفحص النشاط الوقائي للكبد من البرجر المخلوط ببذور التمر على السمية الكبدية والاجهاد التأكسدي المستحث برابع كلوريد الكربون (CCl4) في الفئران. قسمت ستة وثلاثون فأرًا إلى مجموعتين رئيسيتين ، المجموعة الأولى (ن = ٦ فئران) كانت المجموعة (١): فئران المجموعة الرئيسية الثانية (ن = ٣٠ جردًا) تم حقنها برابع كلوريد الكربون مرتين في الأسبوع لمدة أسبوعين للحث على التسمم الكبدي. بعد ذلك قسمت إلى ٥ مجموعات (كل مجموعة ٦ فئران) على النحو التالي: المجموعة (٢): الفئران المصابة بالسمية الكبدية وتغذت على الوجبة الأساسية فقط. المجموعة (٣): تغذت الفئران المحقونة بواسطة رابع كلوريد الكربون على الوجبة الأساسية مع البرجر الأساسي ، المجموعات (٤ ، ٥ و ٦): تغذت الفئران المحقونة برابع كلوريد الكربون على الوجبة الأساسية مع البرجر المخلوط ببذور التمر (١٠ ، ٢٠ ، ٣٠ جم / كجم) ، على التوالي. أظهرت النتائج أن البرجر المخلوط ببذور التمر أظهر تحسنًا ملحوظًا في مؤشرات الدم في الفئران المصابة بالسمية الكبدية،الهيموجلوبين و (PCV) و (AST و ALT و ALP). كما أن مستويات الكرياتينين في الدم وحمض البوليك انخفضت معنويا وأكسيد النيتريك (NO). كذلك استعاد نشاط الإنزيمات المضادات للأكسدة (الجلوتاثيون S- ترانسفيراز (GST) ، كاتاليز (CAT) وفوق أكسيد الديسموتيز الفائق (SOD)) التي كانت منخفضة بعد الإصابة المستحثة بـ CCl4. الاستنتاجات: بذور تمر النخيل قد تكون بديل واعد للحماية من السمية الكبدية والإجهاد التأكسدي المستحث بـ CCl4 ، وذات نشاط وقائي للكبد مرتبط بنشاطه المضادات للأكسدة ، كما يمكن استخدامها كمادة حافظة طبيعية في التركيبات المقترحة كغذاء وظيفي وفي المعاملات الغذائية من خلال العمليات التكنولوجية الحيوية.

الكلمات المفتاحية: بذور التمر، الفينولات، مضادات الأكسدة، رابع كلوريد الكربون ، السمية الكبدية.