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The Beneficial Effects of Turmeric Plant on the Biochemical Changes in Rats Injected with Carbon Tetrachloride "CCl_4"

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ABSTRACT

Medicinal plants have traditionally provided a suitable source for combating diseases of preparing new medicines. Various investigations have shown that Curcuma longa L. or turmeric is highly regarded as a universal panacea in herbal medicine with a wide spectrum of pharmacological effects. This study aimed to determine the beneficial effects of the turmeric plant on the biochemical changes in rats injected with carbon tetrachloride (CCl_4) The experiment was performed in an animal house. All animals were fed on a basal diet for 1 week before starting the experiment, then divided into 2 main groups. The first group (control negative) containing six normal rats received the basal diet only, for 28days. The second group with 18 rats was injected with (CCl_4). The second group was divided into three sub-groups, including 2 groups fed with different concentrations of (10% and 15%) turmeric, and one control positive group infected with the disease and did not feed on the experimental diet. the results showed that the total lipid of all groups was significantly more ($P<0.05$) when compared with control negative. Also, no significant difference was observed in liver function between the groups received 10% and 15% turmeric when compared with the control positive group.

Key words: *Turmeric, Biochemical changes, Hepatic rats, CCl_4*

INTRODUCTION

Turmeric is a plant that has about 4000-years history of medicinal use. It is used as a major spice and as a component in religious ceremonies in Southeast Asia. Turmeric is also known as "Indian saffron" due to its brilliant yellow color. More than 3000 articles have been published dealing with turmeric within the last 25years, and so modern medicine has begun to understand its importance. In this review, in vitro studies as well as studies performed on animals and humans with turmeric, will be discussed with emphasis on its efficacy and safety [1]. Turmeric contains 69.4% carbohydrates, 13.1% moisture, 6.3% protein, 5.1% fat, and 3.5% minerals. The essential oil (5.8%) of this plant obtained by steam distillation contains zingiberene (25%), sesquiterpenes (53%), cineol (1%), sabinene (0.6%), α-phellandrene (1%), and borneol (0.5%). Curcumin (3–4%) comprises curcumin I (94%), II (6%), and III (0.3%) and is responsible for the yellow color [2]. Bisdemethoxy and demethoxy derivatives of curcumin have also been isolated from turmeric. Curcumin melts at 176-177°C, forming a reddish-brown salt with alkali, and is soluble in chloroform, ketone, alkali, ethanol, and acetic acid [3]. Turmeric has various pharmacologic and therapeutic effects as follows: Antioxidant and oxygen free radicals scavenging activity, which is comparable to vitamins E and C. It can protect lipids or hemoglobin from oxidation. It significantly inhibits the generation of reactive oxygen species (ROS) such as H_2O_2, superoxide anions, and nitrite radical by activated macrophages. Its derivatives, demethoxycurcumin and bisdemethoxycurcumin also have antioxidant activities. Pre-treatment with curcumin can decrease ischemia-induced oxidative stress and changes in the heart. An in vitro study evaluated the effect of curcumin on an inducible stress protein, resulted in increased cellular resistance to oxidative damage [4-6]. renoprotective effects of turmeric on hepatotoxicity induced by various insults, which is similar to silymarin [7]. These effects are mainly due to its ability in reducing pro-

inflammatory cytokines formation, as well as its antioxidant effects. Turmeric and curcumin have also reversed fatty changes, biliary hyperplasia, and aflatoxin-induced necrosis. Sodium curcuminate, a salt of curcumin, has choleretic effects by increasing bile solubility, as well as elevating biliary excretion of bilirubin, cholesterol, and bile salts, so it may prevent and treat cholelithiasis [8].

Chronic liver damage is a prevalent pathology characterized by a progressive evolution from steatosis to hepatocellular carcinoma, cirrhosis, fibrosis, and chronic hepatitis. As oxidative stress plays a key role in liver diseases' pathogenesis and progression, the use of antioxidants has been suggested as therapeutic agents, as well as drug coadjuvants, to combat liver damage [9, 10].

Aim of study

This work aimed to show the probable benefit of turmeric plant on the biochemical changes in rats injected with carbon tetrachloride (CCl_4).

MATERIALS AND METHODS

Materials

Preparation of Turmeric: Turmeric was obtained in powder from the local market of Jeddah, Saudi Arabia

Experimental animals: 24 male albino rats of Sprague Dawley strain, (150±10g) were used in the study.

Used chemicals: was obtained as a 10% liquid solution from El-Gomhoryia Company for Chemical Industries, Cairo, Egypt for liver poisoning [11]. It was mixed with paraffin oil obtained from the pharmacy for dilution during the induction.

Methods

Biological experiment

Basal diet composition of rats

The basal diet in the test contained starch (69.5%), com oil (10%), casein (10%), vitamin mixture (1%), salt mixture (4%), choline chloride (0.2%), methionine (0.3%), and cellulose (5%) [12] **(Table 1)**.

Table 1. Composition of basal diet

Ingredients	Amounts
Protein (casein)	10%*
Corn oil	10%
Mineral mixture	4%
Vitamin mixture	1 %
Cellulose	5%
Choline chloride	0.2 %
Methionine	0.3 %
Corn starch	Up to 100%

Source: Reeves *et al.*, (1993).

Data in **Table 2** The basal diet in the test contained $CaCO_3$ (600 mg), K_2HPO_4 (645 mg), $Ca\ HPO_4.2H_2O$ (150 mg), $MgSO_4.2H_2O$ (204 mg), Nacl (334 mg), $Fe\ (C_6H_5O_7)_2 6H_2O$ (55 mg), Kl (1.6 mg), $MnSO_4.4H_2O$ (10 mg), $Zncl_2$ (0.5 mg) and $Cu\ SO_4.5H_2O$ (0.06 mg) [13] **(Table 2)**.

Table 2. The composition of salt mixture (g/100 g)

Compounds	Amount
$CaCO_3$	600 mg
K_2HPO_4	645 mg
$Ca\ HPO_4.2H_2O$	150 mg
$MgSO_4.2H_2O$	204 mg
Nacl	334 mg

Fe ($C_6H_5O_7$) $_2$6H_2O	55 mg
Kl	1.6 mg
$MnSO_4$.4H_2O	10 mg
Zncl$_2$	0.5 mg
Cu SO_4. 5H_2O	0.06 mg

Source: [13]

Table 3 showed the basal diet in the test contained Vitamin E (10 Iu), Vitamin K (0.50 Iu), Vitamin A (200 Iu), Thiamin (0.50 mg), Pyridoxine (1.00 mg), Niacin (4.00 mg) Calcium panthothenic acid (0.40 mg), Vitamin D (100 Iu), Choline chloride (200 mg), Folic acid (0.02 mg), Inositol (24 mg), Para-amino – benzoic acid (0.02 mg), Vitamin B12(2.00 µg) and Biotin (0.02 mg) [12] **(Table 3)**.

Table 3. The composition of vitamin mixture

Vitamin	**Amount**
Vitamin E	10 Iu
Vitamin K	0.50 Iu
Vitamin A	200 Iu
Thiamin	0.50 mg
Pyridoxine	1.00 mg
Niacin	4.00 mg
Calcium panthothenic acid	0.40 mg
Vitamin D	100 Iu
Choline chloride	200 mg
Folic acid	0.02 mg
Inositol	24 mg
Para-amino – benzoic acid	0.02 mg
Vitamin B12	2.00 µg
Biotin	0.02 mg

Source: [12]

Induction of liver intoxication in rats

28 rats were injected with subcutaneous CCl_4 in paraffin oil 50% V/V (2ml/kg BW) 2times a week for 2weeks to induce chronic liver damage as described by Jayasekhar *et al.*, (1997). Then, blood samples were collected by the retro-orbital method to estimate liver function and ensure liver injury [14].

Induction of liver intoxication in rats

20 male albino rats were injected with subcutaneous (CCl_4). in paraffin oil 50% V/V (2ml/kg BW) twice a week for 2weeks to induce chronic liver damage as described by Jayasekhar *et al.*, (1997) [14]. Then, blood samples were collected by the retro-orbital method to ensure liver injury and to estimate liver function.

Animal groups and experimental design

Rats were placed in wire cages under normal laboratory condition and fed on a basal diet for one week as an adaptation period. Diet was given in non-scattering feeding cups to avoid contamination or loss of food, water was given using glass tubes projecting through the wire cage from an inverted bottle supported to one side of the cage.

The animals were divided into 4groups each of 6 rats. The groups of rats were as follows:

- Group (1) was kept with no treatment as a control negative group and fed on a basal diet for 28 days.
- Group (2) was kept with no treatment as a control positive and fed on a basal diet for 28 days**.**
- Group (3) was fed on basal diet plus 10% of turmeric.

- Group (4) was fed on basal diet plus 15% of turmeric.

Biological evaluation

During the experimental period, the consumed feed and body weight were recorded weekly. The body weight gain (BWG %), food efficiency ratio (F.E.R), and organs weight were determined according to [15].

Blood sampling

Blood samples were collected after 12h fasting at the end of the trial. Blood samples were collected by the retro-orbital method using microcapillary glass tubes, into a dry clean centrifuge tube and left to clot in a water bath (37ºC) at room temperature for 30min. The blood was centrifuged for 10 minutes at 3000rpm to separate the serum for glucose determination and the rest was aspirated and transferred into clean quit fit plastic tubes and stored at (-20ºC) until analysis. The organs (spleen, heart, kidney, and liver) were removed and washed in saline solution, weighted and kept in (10%) formalin solution [16].

Biological evaluation

Food intake (consumption), BWG (%), and feed efficiency ratio (FER) were calculated according to [15] using the following equations.

$$BWG\% = \frac{Final\ weight - Initial\ weight}{Initial\ weight} \times 100 \quad (1)$$

$$FER = \frac{Gain\ in\ body\ weight\ (g/day)}{Food\ Intake\ (g/day)} \quad (2)$$

$$\text{Relative weight of organs} = \frac{\text{Organs weight}}{\text{Animal body weight}} \times 100 \quad (3)$$

Biochemical analysis

Determination of the activity of liver enzymes

Determination of aspartate aminotransferase (AST): activity was carried out by spectrophotometer using kit [17].

Determination of the activity of serum alanine aminotransferase (ALT) was done using the colorimetric procedure described by [17].

Determination of the activity of serum alkaline phosphatase (ALP) was conducted according to the colorimetric method of Roy (1970) [18].

Determination of serum total bilirubin was colorimetrically carried out as described by Doumas *et al*., (1973) using a spectrophotometer at 578nm.

Determination of total cholesterol in serum was done according to Ratliff and Hall (1973) [19].

Determination of triglycerides was carried out using the enzymatic and colorimetric method according to Jacobs and Van Denmark (1960) [20].

Determination of HDL was carried out according to the method of Jacobs and Van Denmark (1960) [20].

Determination of VLDL and LDL was carried out according to the method of Lee and Nieman (1996) as follows [21]:

Statistical analysis

The data were statistically analyzed using SPSS software (SAS Institute, Cary, NC). The effects of different treatments were analyzed by one-way ANOVA test using Duncan's multiple range test and $p<0.05$ was considered statistically The following formulas were used [22].

RESULTS AND DISCUSSION

This work aimed to show the probable benefit of the turmeric plant on the biochemical changes in rats injected with (CCl_4).

Biological results

Effect of (CCl_4) intoxicated rats with different levels of turmeric on feed intake (FI), (FER), and (BWG).

- **Table 4** shows the effect of different turmeric levels on BWG% of rats with liver disorder. Data in **Table 4** indicate BWG in both normal rats and those with liver disorder after 4 weeks. BWG in the normal rat group was (52.4±11.46) gm/100gm. While liver disorder rat groups with turmeric at different levels (positive control, 10%, and 15%) showed an increase in BWG (35.8±10.84), (38.7±10.38), and (51±6.06) gm/100gm, respectively. The results showed no significant differences between all groups.
- Food intake value in the normal rat group was (48.8±31.86) gm/100gm. While in liver disorder rat groups with turmeric at different levels (positive control, 10%, and 15%) it was (503.6±7.5, 417±4.12, and 447±25.02) gm/100gm, respectively. The results showed high significance ($P<0.05$) between groups with (10% and 15%) turmeric when compared with control negative.
- FER value in the normal rat group was (0.19±0.03). While in liver disorder rat groups with oral turmeric at different levels (positive control, 10%, and 15%) it was (0.304±0.22, 0.17±0.205, and 0.218±0.04), respectively. The results showed no significant differences between all groups.

Table 4. Effect of feeding different level of pumpkin seeds on FI, FER, and BWG of (CCl_4) -intoxicated rats.

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	sig	LSD
	Mean±SD	Mean±SD	Mean ± SD	Mean ± SD		
(BWG%)	52.3 ^{a}± 11.4	35.8 ^{a}± 10.8	38.7 ^{a}± 10.3	51 ^{a}± 6.06	**NS**	**13.275**
Food intake (fi)(g/28day)	478.8 ^{a}± 31.8	503.6 ^{a}± 7.5	417 ^{c}± 4.12	447 ^{b}± 25.0	**NS**	**0.158**
(FER)	0.19 ^{a}± 0.03	0.304 ^{a}± 0.2	0.17 ^{a}± 0.20	0.21 ^{a}± 0.04	*****	**27.761**

Data in **Table 5** indicate the effect of different levels of turmeric on organ weight and organ weight/body weight in both normal and liver disorder rats after 4 weeks of feeding. The liver in the normal rat group with turmeric was 2.78±2.76 gm/100gm. While liver disorder rat groups at different levels of turmeric (positive control, 10%, and 15% turmeric) showed a decreased relative weight of liver of (2.86±0.04), (2.92±0.22), and (3.12±0.09) gm/100gm, respectively. The results showed no significant difference in all groups.

- Relative kidney weight value in the normal rat group was (0.85±0.05). While in liver disorder rat groups at different levels of turmeric (positive control, 10 %, and 15 % turmeric) were (0.65±0.06, 0.59±0.06, and 0.06±0.03). The result showed no significant difference between all groups.
- Relative heart weight value in the normal rat group was (0.32±0.01) gm/100gm. While it was (0.34±0.02, 0.33±0.03, and 0.36±0.04) gm/100gm, respectively in liver disorder rat groups at different levels of turmeric (positive control, 10%, and 15%), which showed a non-significant difference between all groups.
- Relative lung weight value in the normal rat group was (0.55±0.08). While it was (0.5±0.05, 0.524±0.03, and 0.55±0.1) in liver disorder rats groups fed a diet at different levels of turmeric (positive control, 10 %, and 15 % turmeric, respectively). The result showed no significant difference between all groups.
- Relative spleen weight value in the normal rat group was (0.45±0.1) gm/100gm. While it was (0.46±0.01, 0.54±0.11, and 0.49±0.2 gm/100gm) in liver disorder rat groups fed diet at different levels of turmeric (positive control, 10%, and 15%, respectively), which showed no significant difference between all groups.

Table 5. Effect of feeding different levels of turmeric on the weight of $CC1_4$-intoxicated organs of rats.

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	sig	LSD
	Mean + SD	Mean + SD	Mean + SD	Mean + SD		
LUNG	0.55 ^{a}+ 0.08	0.5 ^{a}+ 0.05	0.52 ^{a}+ 0.03	0.55 ^{a}+ 0.1	NS	0.097
LIVER	2.78 ^{a}+ 0.38	2.86 ^{a}+ 0.04	2.92 ^{a}+ 0.22	3.12 ^{a}+ 0.09	NS	0.305

HEART	0.32 [a]+ 0.01	0.34 [a]+ 0.02	0.33 [a]+ 0.03	0.36 [a]+ 0.04	NS	0.034
KIDNEY	0.85 [a]+ 0.05	0.65 [a]+ 0.06	0.59 [a]+ 0.06	0.06 [a]+ 0.03	NS	0.070
SPLEEN	0.45 [a]+ 0.1	0.46 [a]+ 0.1	0.54 [a]+ 0.11	0.49 [a]+ 0.2	NS	0.158

Table 6 represents the effect of feeding different levels of turmeric on T-Lipids, PH-Lipids, and T-Cholesterol in both normal and liver disorder rats after 4 weeks of feeding. The total lipid in the normal rat group was 241±10.17 mg/dl. While it was (277.4±3.71, 251.2± 1.79, and 236±3.19 mg/dl) in liver disorder rat groups at different levels of turmeric (positive control, 10%, and 15%, respectively).

PH. Lipids value in the normal rat group was (101.6±2.3) mmol/L. While it was (107.8±0.45), (103.4±0.55), and (100.8±1.09) mg/dl in liver disorder rat groups with different levels of turmeric (positive control, 10%, and 15%), respectively. **Table 5** shows the effect of different levels of turmeric on total Lipids and Ph. Lipids and concerning total lipids, the results showed that all groups had significantly high PH. Lipid values ($P<0.05$) when compared with control negative.

The cholesterol value in the normal rat group was (82±4.8) mmol/L. While in liver disorder rat groups fed a diet with different levels of turmeric (positive control, 10%, and 15%) it was (101.8±3.03), (85.6±2.19), and (80±1.4) mg/dl, respectively. The results showed that rats fed on 10% turmeric had significantly higher ($P<0.05$) cholesterol values when compared with control positive.

In line with [23], the present results showed that curcumin and turmeric may protect patients at risk of CVD by improving serum lipid levels. Curcumin may be used as a suitable dietary adjunct to conventional drugs. Additional investigations are needed to resolve uncertainties related to medication frequency, dose, and dosage form of curcumin.

Table 6. Effect of feeding different levels of turmeric on T. LIPIDS, PH. LIPIDS and total cholesterol of CCl_4-intoxicated rats.

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	Sig	LSD
	Mean ± SD	Mean ± SD	Mean ± SD	Mean± SD		
T.LIPIDS	241 [c]± 10.17	277.4 [a]± 3.71	251.2 [b]± 1.79	236.2 [c]± 3.1	*	7.664
PH.LIPIDS	102.2 [bc]± 2.1	107.8 [a]± 0.45	103.4 [b]± 0.55	100.8 [bc]± 1.09	*	1.695
CHOLESTEROL	82 [bc]± 4.8	101.8 [a]± 3.03	85.6 [b]± 2.19	80 [c]± 1.4	*	4.186

Table 7 represent the effect of feeding different levels of turmeric on TG, HDL, LDL, and VLDL in both normal and liver disorder rats after 4 weeks of feeding. The TG in the normal rat group was (53.2±5.85) mg/dl. While it was (68.2±1.3, 60.4± 0.89, and 54.6±2.61) mg/dl in liver disorder rat groups at different levels of turmeric (positive control, 10 %, and 15%), respectively.

HDL value in the normal rat group was (46±1.41) mmol/L. While it was (42.4±0.56), (45.8±0.56), and (45.4±1.34) mg/dl in liver disorder rat groups fed on a diet with different levels of turmeric (positive control, 10 %, and 15%) mg/dl, respectively. The result showed no significant difference between 10%, 15%, and control negative groups when compared with control positive.

LDL value in the normal rat group was (26.56±3.24) mmol/L. While it was (54.6±2.69), (28.68±1.2), and (24.88±0.72) mg/dl in liver disorder rat groups at different levels of turmeric (positive control, 10%, and 15%), respectively. Groups of 10% and 15% turmeric showed a significantly ($P<0.05$) high LDL value when compared with the control negative.

VLDL value in the normal rat group was (10.62±1.17) mmol/L. While it was (13.44±0.7), (12.24±0.22), and (10.92±0.524) mg/dl in liver disorder rat groups with different levels of turmeric (positive control, 10%, and 15%)mg/dl, respectively. The result showed significantly high differences ($P<0.05$) between all groups when compared with control negative.

The present results are going in the same line with [24] showed that an increase in HDL levels was observed for high-, medium-, and low- polyphenol turmeric: mean change, 0.045 mmol/L (CI, 0.02-0.06 mmol/L), 0.032 mmol/L (CI, 0.005-0.05 mmol/L), and 0.025 mmol/L (95% CI, 0.003-0.05 mmol/L), respectively. The total cholesterol-HDL ratio linearly decreased with the phenolic content of the turmeric. TG level decreased by an average of 0.05mmol/L in turmeric. Oxidative stress markers linearly decreased with increasing phenolic content.

The mean changes for oxidized LDL levels were 1.21 U/L (CI, –0.8 to 3.6 U/L), –1.48 U/L (–3.6 to 0.6 U/L), and –3.21 U/L (–5.1 to –0.8 U/L) for the low-, medium-, and high-polyphenol turmeric respectively.

Table 7. Effect of feeding different levels of turmeric on T.G, HDL, LDL, and VLDL of CCl4-intoxicated rats

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	Sig	LSD
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
T.G	53.2 ^{c}± 5.85	68.2 ^{a}± 1.3	60.4 ^{b}± 0.89	54.6 ^{c}± 2. 61	*	4.424
HDL	44.8 ^{a}± 1.3	42.8 ^{b}± 0.45	45.4 ^{a}± 1.34	44.6 ^{a}± 0.54	*	1.340
LDL	25.62 ^{c}± 3.1	45.4 ^{a}± 2.66	28.68 ^{b}± 1.2	24.88 ^{c}± 0.72	*	2.934
VLDL	10.64 ^{c}± 1.17	13.44 ^{a}± 0.69	12.24 ^{b}± 0.22	10.92 ^{c}± 0.52	*	0.988

Table 8 reflects the effect of different levels of turmeric on creatinine, urea, and uric acid values in both normal and liver disorder rats fed on a diet with different level of turmeric. Urea value was recorded (27.6±4.77) mg/100ml in the normal rat group. While in liver disorder rats fed on the turmeric at values of (positive control, 10%, and 15%) showed serum urea levels of (30±2.83, 27.2±2.17, and 26.2±1.64) mg/100ml, respectively. As for urea, the results revealed no significant difference in all groups.

According to the same table, the normal rat group showed a serum creatinine level of (0.598±0.07) mg/100ml. While turmeric supplemented with different levels of the diet (positive control, 10%, and 15%,) presented the values of (0.598±0.008, 0.66±0.03, and 0.64±0.03) mg/100ml, respectively.

Also, normal rat group recorded U. acid level of (1.68±0.34) mg/100ml. While turmeric supplemented with different levels of the diet (positive control, 10%, and 15%,) presented the values of (1.54±0.09, 1.5±0.27, and 1.26±0.09) mg/100ml, respectively. As for uric acid, the results revealed no significant difference in all groups.

Table 8. Effect of feeding different levels of turmeric on some renal functions of CCl_4-intoxicated rats

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	sig	LSD
	Mean ± SD	Mean ±SD	Mean ± SD	Mean ± SD		
UREA	27.6 ^{a}± 4.77	30 ^{a}± 2.83	27.2 ^{a}± 2.17	26.2 ^{a}± 1.64	NS	4.14
CREATININ	0.598 ^{a}± 0.07	0.604 ^{a}± 0.008	0.66 ^{a}± 0.03	0.64 ^{a}± 0.03	NS	0.05
U.ACID	1.68 ^{a}± 0.34	1.54 ^{a}± 0.09	1.5 ^{a}± 0.27	1.26 ^{a}± 0.09	NS	0.33

- **Table 9** reveals the effect of turmeric on enzyme activity (GOT, GPT, and ALP) on both normal and liver disorder rats groups. GOT level in normal rats group was (104.4±6.54) u/l. While liver disorder rat groups fed on a diet containing (positive control, 10% and 15% turmeric) recorded (178.4±11.26), (106.2±1.79), and (100.8±2.88) u/l, respectively. The results showed no significant difference between control negative, 10%, and 15% turmeric when compared with the control positive group.
- Normal rats group represented GPT level (42.8±3.89) u/l. While liver disorder rats groups were fed a diet supplemented with turmeric containing (positive control, 10%, and 15%) showed a value of (79.4±9.09, 47±1.41, and 44.42±2.19) u/l
- As shown in **Table 10** for enzyme activity, the normal rat group represented the ALP level of (104.6±7.96) u/l. While liver disorder rat groups fed a diet supplemented with turmeric (positive control, 10%, and 15%) showed a value of (116.8±2.17), (111.6±2.61), and (103.2±1.79) u/l, respectively. The results showed no significant difference between control positive, and 15% turmeric when compared with the control negative group.

Our finding is in accordance with [25] who showed that (CCl_4) poisoning of the liver of male F-344 rats was modified by dissolving CCl_4 in different plants (turmeric, sunflower, corn). After 8weeks of treatment (3×0.2 ml/kg BW every other day, dissolved in aliquots of 0.5 ml of each type of plant), the rats were sacrificed and the ratio of connective tissue in the liver was determined by morphometry after picrosirius staining. The collagen fiber percentage increased in all CCl_4-treated groups whien compared with the control group. This increase was nearly the same (6-8%) in the case of CCl_4 in sunflower and corn but when turmeric was applied, the collagen

ratio was only 2-4 percent. This finding showed that olive oil is less harmful to the liver in acute CCl4 poisoning than others.

Table 9. Effect of feeding different levels of turmeric on Liver Functions of CCl4-intoxicated rats

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	Sig	LSD
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
S.GOT	104.4 ^{b}± 6.54	178.4 ^{a}± 11.26	106.2 ^{b}± 1.79	100.8 ^{b}± 2.88	*	8.994
S.GPT	42.8 ^{b}± 3.9	79.4 ^{a}± 9.09	47 ^{b}± 1.41	44.4 ^{b}± 2.19	*	6.862
ALP	104.6 ^{b}± 7.96	116.8 ^{a}± 3.03	111.6 ^{a}± 2.61	103.2 ^{b}± 1.79	*	6.089

- **Table 10** revealed the effect of turmeric on enzymes activity (T.PRO, ALB, GLOB, BLIL.T, and BILID) on both normal and liver disorder rat groups. T.PRO level in normal rat group was (5.69±0.23) u/l. while liver disorder rats groups fed on a diet containing (positive control, 10% and 15% turmeric) recorded (5.79±0.12), (5.71±0.41), and (5.54±0.04) u/l, respectively.
- Normal rat group represented ALB level (3.78±0.07) u/l. While liver disorder rat groups fed a diet supplemented with turmeric (positive control, 10%, and 15%) showed a value of (3.8±0.05, 3.74±0.05, and 3.77±0.07) u/l.
- With regard to **Table 10** for enzymes activity, the normal rat group represented the ALP level of (1.87±0.24) u/l. While liver disorder rat groups were fed a diet supplemented with turmeric containing (positive control, 10%, and 15%) showed a value of (1.93±0.06), (2.94±0.18), and (1.77±0.005) u/l. The results showed no significant differences between 10%, and 15% turmeric when compared with the control positive.

Normal rat group represented BLIL.T level (0.402±0.02) u/l. While liver disorder rats groups fed on a diet supplemented with turmeric containing (positive control, 10%, and 15%) showed a value of (0.43±0.02, 0.376±0.05, and 0.13±0.03) u/l, respectively.

With regard to **Table 10** for enzymes activity, normal rat group represented BILI.D level of (0.126±0.02) u/l. While liver disorder rat groups fed on a diet supplemented with turmeric containing (positive control, 10%, and 15%) showed a value o f (0.15±0.02), (0.12±0.02), and (0.13±0.02) u/l, respectively. The results showed no significant differences between all groups. The results are in line with [26] who showed that turmeric has hepatoprotective and renoprotective features similar to silymarin. Animal investigations have shown the hepatoprotective and renoprotective effects of turmeric from various hepatotoxic insults. The hepatoprotective and renoprotective effects of turmeric are mostly due to its antioxidant properties, and also its ability to reduce the formation of pro-inflammatory cytokines. Curcumin and turmeric also reversed necrosis, biliary hyperplasia, and fatty changes induced by aflatoxin production. Sodium curcuminate, also shows choleretic impacts by increasing increasing bile solubility, as well as biliary excretion of bilirubin, cholesterol, and bile salts, thus, possibly prevents and treats cholelithiasis.

Table 10. Effect of feeding different levels of turmeric on Some Liver Functions of CCl_4-intoxicated rats

Groups / Parameters	Control (-)	Control (+)	10% Turmeric	15% Turmeric	sig	LSD
	Mean ±SD	Mean ±SD	Mean ± SD	Mean ± SD		
T.PRO	5.698 ^{a}± 0.23	5.79 ^{a}± 0.12	5.71 ^{a}± 0.41	5.54 ^{a}± 0.04	NS	0.325
ALB	3.78 ^{a}± 0.07	3.8 ^{a}± 0.05	3.74 ^{a}± 0.33	3.77 ^{a}± 0.07	NS	0.232
GLOB	1.87 ^{a}± 0.24	1.93 ^{a}± 0.06	1.94 ^{a}± 0.18	1.77 ^{a}± 0.005	NS	0.203
BLIT.T	0.40 ^{ab}± 0.02	0.43 ^{a}± 0.02	0.37 ^{b}± 0.05	0.13 ^{c}± 0.03	*	0.042
BILI.D	0.126 ^{a}± 0.02	0.15 ^{a}± 0.02	0.12 ^{a}± 0.02	0.13 ^{a}± 0.02	NS	0.03

CONCLUSION

The results showed that turmeric plant has a strong effect in improving the liver function of mice injected with carbon tetrachloride, and the improvement rate increased in the group containing 15% turmeric, due to the

presence of flavonoids in turmeric, which is a factor that contributes to the protective ability of the liver by inhibiting cytochrome P-450 aromatase A.

Recommendations

1. It is suggested to use turmeric powder for hepatic patients.
2. different levels of turmeric powder, especially that of 10% may be suggested for lowering LDL and atherogenic index levels.

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