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ORIGINAL ARTICLE

Antioxidative Properties of *Thymus vulgaris* on Liver Rats Induced by Paclitaxel

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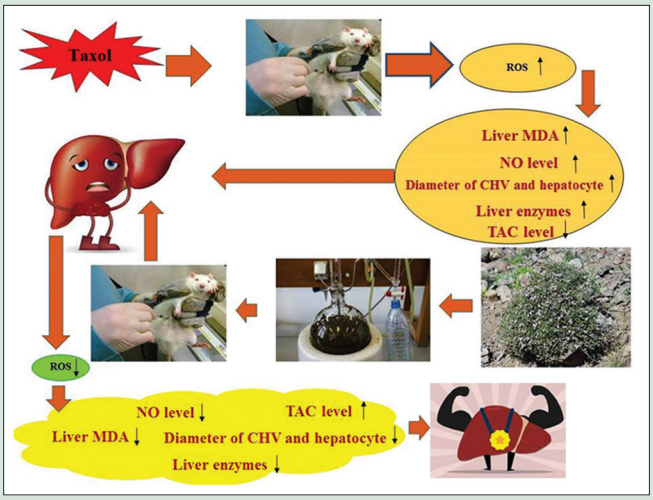
ABSTRACT

Background: *Thymus vulgaris* (Thym) is a species of flowering plant in the mint family *Lamiaceae* with potent antioxidant, and it has been beneficial effects during short-term administration. Paclitaxel sold under the brand name Tax (Tax) is chemotherapy drug which capable to produce free radicals. **Objective:** This study was designed to evaluate the effects of Thym against toxic effects of Tax to the liver of rats. **Materials and Methods:** Sixty-four male rats were assigned to eight groups: Control normal and Tax control groups (20 mg/kg); Thym groups (4.5, 9, 18 mg/kg), and Tax + Thym-treated groups (4.5, 9, 18 mg/kg). Treatments were administered intraperitoneally daily for 2 weeks. Griess technique was assessed for determined serum nitrite oxide (NO) level. Aspartate aminotransferase, ALANINE aminotransferase, and alkaline phosphatase concentrations were determined for liver functional disturbances. In addition, liver malondialdehyde (MDA), total antioxidant capacity (TAC), the diameter of hepatocytes, and the central hepatic vein (CHV) were investigated. **Results:** Tax administration significantly improved liver MDA and NO level, the mean diameter of CHV and hepatocyte, liver enzymes, and decreased TAC level compared to the normal control group ($P < 0.001$). The Thym and Thym + Tax treatments at all doses significantly reduced the mean diameter of hepatocyte and CHV, liver enzymes, liver MDA, and NO levels and increased TAC level compared to the Tax control group ($P < 0.001$). **Conclusion:** It seems that Thym administration improved liver injury induced by Tax in rats.

Key words: Liver, oxidative stress, paclitaxel, *thymus vulgaris*

SUMMARY

- Tax administration significantly reduced the serum levels of the liver malondialdehyde, nitrite oxide, the mean diameter of central hepatic vein and hepatocyte, liver enzymes, and decreased total antioxidant capacity level at the end of the 2 weeks in Tax control group rats
- *Thymus vulgaris* treatments had a significant effect on the improvement of liver parameters in Thyme and Thym + Tax group rats at the end of the 2 weeks
- *Thymus vulgaris* might be a good candidate for liver treatment, especially improved liver injury induced by Tax
- This finding is important due to the increased incidence of liver injury due to the chemotherapy drug.



Abbreviations Used: NO: Nitrite oxide, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, ALP: Alkaline phosphatase, MDA: Malondialdehyde, TAC: Total antioxidant capacity, CHV: Central hepatic vein, ROS: Reactive Oxygen Species, i.p.: Intraperitoneally, Thym: *Thymus vulgaris*, Tax: Tax.

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INTRODUCTION

Tax is mainly metabolized in the liver by p450 cytochrome and is excreted through bile.[1] Anticancer drugs increase the longevity of many cancer patients but may have adverse effects on other body tissues over time, irrespective of their therapeutic and beneficial effects.[2,3] The liver is a vital body organ that plays a pivotal role in detoxification of toxic agents, environmental pollutants, and chemical drugs as the first line of defense.[4] Cresteil *et al*. reported Tax administration in human significantly elevated the liver enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST).[5] Treatment with Tax has also been reported to induce the production of lipid ceramide through *de novo* pathway and lipid membranes as well as the production of reactive oxygen species (ROS) from the mitochondrial matrix.[6]

Free radicals are active atoms or molecules that, owing to their atomic layer, have a strong desire to combine with other surrounding molecules such as cell membrane lipids, lipoproteins, proteins, carbohydrates, DNA, and RNA and can cause tissue destruction and diseases such as cardiovascular and hepatic disorders and cancer if their combining activity is not inhibited.[7] One of the most important destructive effects of free radicals is lipid peroxidation, which causes cell membrane impairment.[8] These free radicals can induce the production of lipid peroxidase and cellular damages, especially in haptic cells by alkylating

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the protein groups and other cellular macromolecules and attacking unsaturated fatty acids.[9]

Oxidative stress plays a key role in the liver tissue damage induced by drugs and toxins.[10] Karaduman *et al.* found that Tax-induced liver tissue necrosis and destruction caused fibrosis and increased sinusoidal space, inflammation, and lymphocytic infiltration in the liver tissue of mice.[11] Many plants with antioxidant properties exert protective effects against chemoprotective agents. One of these plants is *Nigella sativa* L., which has a medical and religious history.[12] *N. sativa* L., with white and light blue flowers that turn black in contact with air, is native to East Europe, North Africa, and Asia and belongs to the *Ranunculaceae* family.[13]

Thym is the main compound of the aqueous extract of *N. sativa*, constituting about 61.48% of the weight of its oil.[14] This plant has been reported to have numerous pharmacologic effects such as attenuation of glucose, lipid and hypertension, excretion of bile and uric acid, protection of kidney, heart and liver tissues, and antimicrobial and antifungal effects owing to its antioxidant, anti-inflammatory and immune system boosting properties.[15] Daba and Abdel-Rahman reported the antioxidant effects of *N. sativa* against liver toxicity induced by tert-Butyl hydroperoxide, carbon tetrachloride, and Cisplatin.[16] Moreover, administration of *N. sativa* oil for lead-induced liver toxicity has been reported to prevent pathologic disorders in the liver.[17]

Given the antioxidant properties of Thym, it seems that this material can protect the liver against Tax-induced oxidative damage. A review of the literature also reveals no study has investigated the effect of Thym against Tax-induced oxidative stress on hepatic parameters in male rats. Hence, the present study was conducted to evaluate the effects of Thym against Tax-induced oxidative stress on some hepatic parameters in male rats.

MATERIALS AND METHODS

Experimental protocol

The rats were randomly divided into eight groups (n = 8), including; First group, the normal control group, which received normal saline (intraperitoneally [i.p.] injection) equivalent to the amount of experimental groups. Second group, the control group of Tax, in this group, the rats were given Tax at a dose of 20 mg/kg (1/50 LD_{50}) body weight per day (single dose) through i.p. injected for 2 weeks. The mice in the both Tax and normal control groups were not given any treatment after Tax and normal saline injection until sacrifice. Third to fifth groups, the Thym administration groups, in these groups, each animal respectively received (4.5, 9 and 18 mg/kg) of Thym i.p. for 2 weeks at 10 am. Sixth to eighth groups, Thym + Tax administration groups, in this group, each animal received a single dose (20 mg/kg) of Tax via i.p. in order to induce liver damage, then (after Tax injection) they respectively received (4.5, 9 and 18 mg/kg) of Thym i.p. for 2 weeks at 10 am.[7,11]

Animals

Animal studies were conducted according to the guidelines for the care and handling of animals prepared by the Iranian Ministry of Health. Sixty-four male Wistar rats (weighing 220–250 g) were purchased from Pastor Institute of Iran. The animals were housed in standard cages (three per cage) and control conditions at 23°C ± 2°C and exposed to 12-h light/dark cycle, in Medical Sciences University's animal care facilities for 1 week before testing and exposing to environmental and climatic conditions. The animals had free access to water and food during this period. All investigations conformed to the ethical and humane principles of research and were approved by the Ethics Committee of Medical Sciences (ethics certificate No. 97618).[4]

Dissection and sampling

At the end of the treatment period, all rats were deeply anesthetized by i.p. injection of Ketamine HCl (100 mg/kg) and Xylazine (10 mg/kg). The sampling included blood from the hearts (at least 1 ml per animal) for evaluating the total antioxidant capacity (TAC) and nitrite oxide (NO) levels. The animals were then sacrificed. The liver was removed and divided into two equal halves.Tax Tax, half Tax Tax for histological and morphometric examinations and the half left for the malondialdehyde (MDA) and liver enzymes level estimations, in the respect of the groups.[7]

Evaluation of liver marker

Half left TaxTax of the liver was split and turned into a uniform solution. To separate the biological enzymes, the obtained solution was centrifuged at 10,000 rpm for 15 min twice. The supernatant was separated to measure the enzymes (marker). ALT and AST actions were examined by the method of Reitman and Frankel. Alkaline phosphatase (ALP) actions were determined according to the procedure set out in the practical laboratory manual.[9]

The tissue preparing, staining, and histopathological and morphometric examinations

The inferior 1-cm-long part of the Tax TaxTax of the liver in transverse pieces was removed. The nonparenchymal tissues (fat, fascia, and vessels) of removed and preparing paraffin embedded blocks were gotten using Automatic Tissue Processor. The steps of this process was consequently included fixation with 10% formal saline (for 72 h), washing thoroughly under running water, dehydrating by raised a doses of ethanol (50%, 60%, 70%, 80%, 90%, and 100%, which included 3 min for each step and 100% ethanol step was repeated for three times), clearing by xylene (three times and 10 min in each) and embedding in soft paraffin (three times and 15 min in each). At this stage, 4-μm coronal histological thin sections were cut from paraffin-embedded blocks, undertaken by a microtome instrument (Leica RM 2125, Leica Microsystems Nussloch GmbH; Germany) and 5 sections per animal were chosen. For the unification of the section selection, the first section was the 4th, and the last was the 24th (5 sections interval), and finally, the routine protocol for Hematoxylin and Eosin staining was implemented. At the end of tissue processing, the stained sections were mounted by *et al.* on glue. For each hepatocyte, the full cellular area was measured. The hepatocyte outline was measured after capturing an image with a ×40 objective. The maximum and minimum axis was measured in the drawing of each hepatocyte for measuring the mean axis. At least 50 hepatocytes from each zone were measured in each liver. A separate measurement for the central hepatic vein (CVH) was performed using the same assay. The planning was examined with an Olympus BX-51T-32E01 research microscope connected to a DP12 Camera with 3.34-million pixel resolution and Olysia Bio-software (Olympus Optical Co. LTD, Tokyo, Japan).[8]

Measurement of liver malondialdehyde

MDA levels in the other half of the TaxTax liver tissues were evaluated as an index of lipid peroxidation. In this regard, homogenizing of the samples were carried out by homogenization buffer containing 1.15% KCl solution and the specimens centrifuged at 1500 g for 10 min, respectively. Then, the homogenized subjects were added to a reaction mixture containing sodium dodecyl sulfate (SDS), acetic acid (pH 3.5), thiobar-bituric acid, and distilled water. Following boiling the mixture for 1 h at 95°C and centrifuging at 3000 g for 10 min, the absorbency

of the supernatant was measured by spectrophotometry at 550 nm light length.[18]

Estimation of renal total antioxidant capacity

To measure the TAC, an acquisition kit (Cat No: TAC-96A) ZellBioGmbH-Germany was purchased, which was the basis for the oxidation colorimetry resuscitation. The kit contains 1 reagent ready to use, buffer ×100, dye powder, reaction suspension solution, standard and a microplate of 96 wells. In this assay, the TAC was equivalent to some antioxidant in the sample that was compared with ascorbic acid as standard. The kit's sensitivity was equal to 0.1 mM, and the diagnostic range was mM 2–125/0 and final absorbance was read at 490 nm, and unit conversion was performed.[18]

Estimation of nitrite oxide

Griess technique uses zinc sulfate powder to eliminate the serum protein of the samples. Accordingly, zinc sulfate powder (6 mg) was mixed with serum samples (400 µl) and vortexed for 1 min. The samples were centrifuged at 4°C for 10 min at 12,000 rpm and supernatant was used to measure the NO. Briefly, 50 µl of the sample was added to 100 µl of griess reagent (Sigma; USA), and the reaction mixture was incubated for about 30 min at room temperature. According to manufacturer protocol, the samples concentration was measured by ELISA reader (Hyperion; USA) at a wavelength of 450 nm.[4]

Statistical analyses

The data were analyzed by SPSS software for windows (New York: IBM, SPSS version 20.0) using one-way ANOVA postulation followed by Tukey's *post hoc* test, and $P < 0.05$ was considered statistically significant. The variables were represented as mean ± standard error of mean.

RESULTS

Liver marker

Tax led to a significantly increased in ALT, AST, and ALP enzymes in comparison with the normal control group ($P < 0.001$). The mean ALT, AST, and ALP enzymes concentration was not significant in all Thym groups compared to the normal control group ($P > 0.05$). In addition, Thym and Tax + Thym in all doses to a significantly decreased in the mean of ALT, AST, and ALP enzymes in comparison with the Tax control group ($P < 0.001$) [Table 1].

Morphometric measurements

The mean diameter of hepatocytes and CHV in experimental groups showed a significant difference between the normal control group and Tax control group ($P < 0.001$). The mean diameter of hepatocytes and CHV was not significant in all Thym groups compared to the normal control group ($P > 0.05$). Further, Thym and Tax + Thym significantly reduced the mean diameter of hepatocytes and CHV in all treated groups in comparison with Tax control group ($P < 0.001$) [Figure 1].

Histopathological changes

Histological analysis showed normal liver structure in the normal control and Thym treatment group. After treatment with Tax in Tax control group, the liver showed evident changes and injury. These

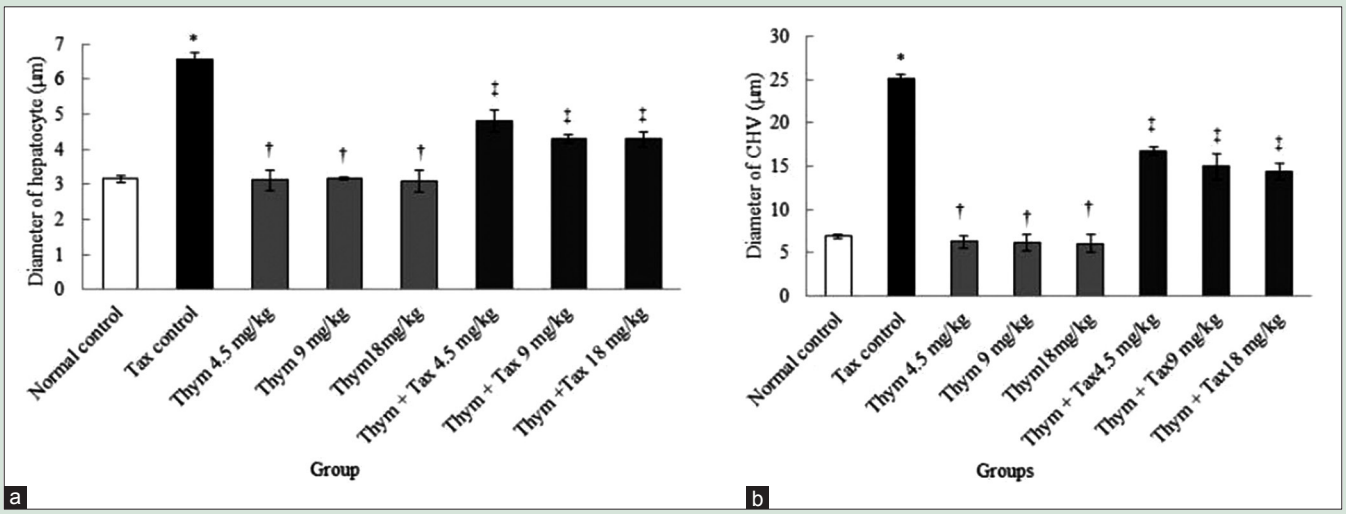

Figure 1: Effect of Tax, Thym and Thym + Tax administration on the Hepatocyte (a) and CHV (b) diameters. *Significant increase of the mean hepatocytes and CHV diameters compared to the normal control group ($P < 0.001$). †Significant decrease comparted to the Tax control groups ($P < 0.001$). ‡Significant decrease compared to the Tax control group ($P < 0.001$). CHV: Central Hepatic Vein; Thym: *Thymus vulgaris*; Tax: Tax

Table 1: Different liver enzymes between treatment groups

Enzymes (ng/ml)	Normal control	Tax control	Thym (mg/kg)			Thym+tax (mg/kg)		
			4.5	9	18	4.5	9	18
AST	76.93±2.20	121.8±5.10*	76.33±3.40†	74±2.010†	73±0.010†	95.4±5.20‡	90.8±6.00‡	85.8±3.00‡
ALT	35.49±2.50	59.14±4.10*	34.91±2.50†	33.7±1.10†	34±2.010†	38.7±5.01‡	38.8±2.60‡	36.8±6.00‡
ALP	2.14±0.10	5.28±0.20*	2.05±0.30†	2.1±0.50†	2.01±2.010†	3.05±0.30‡	3.0±0.10‡	2.81±6.00‡

Data were presented as mean±SD. *P<0.001 compared to the normal control group. †P<0.001 compared to tax control group; ‡P<0.001 compared to the tax control group. Thym: *Thymus vulgaris*; ALP: Alkaline phosphatase; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; SD: Standard deviation

anomalies included increased white blood cells (inflammation), increased irregularities, sinusoidal dilatation, and the vacuolization hepatocyte (necrosis). Treatment with Tax + Thym at all doses reduced the liver damage caused by Tax toxicity [Figure 2].

Malondialdehyde levels

Serum levels of MDA showed a significant increase in the Tax control group compared to the normal control group ($P < 0.001$). In addition, a significant decrease in MDA levels was showed in all Thym and Thym + Tax groups compared to the Tax control group ($P < 0.001$) while had no significant effect on the levels of MDA in all Thym groups compared to the normal control group ($P > 0.05$) [Figure 3].

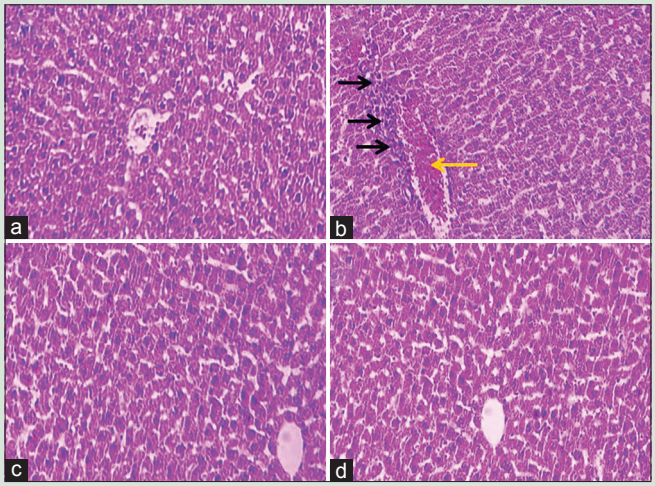

Figure 2: Microscopic images of liver tissue in mature rats in different groups (Five-micron thick sections, H and E, ×100). Micrograph of the liver section in the control normal groups (a), normal liver structure. Micrograph of the liver section in Tax control group (b), increased white blood and macrophage cells (Inflammation) (black arrows) and central hepatic vein dilatation and hyperemia (red arrow), due to the oxidative stress caused by Tax. Micrograph of the liver section in Thym (18 mg/kg) group (c), normal liver structure. Micrograph of liver section in Thym + Tax (18 mg/kg) group (d), normal liver structure

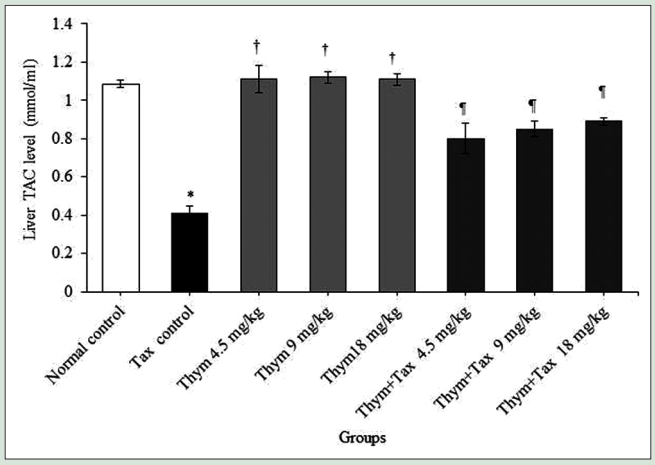

Figure 4: TAC level change in the male rats. *$P < 0.001$ compared to the normal control group. †$P < 0.05$ compared to Tax control group. ¶$P < 0.05$ compared to the Tax control group. TAC: Total antioxidant capacity; Thym: *Thymus vulgaris*; Tax: Tax

Total antioxidant capacity levels

The results of measured TAC levels in the study groups showed a significant decrease in the Tax control group compared to the normal control group ($P < 0.001$). Furthermore, a significant increase in TAC levels was showed in all Thym and Thym + Tax groups compared to the Tax control group ($P < 0.001$) while had no significant effect on the levels of TAC in all Thym groups compared to the normal control group ($P > 0.05$) [Figure 4].

Blood serum nitrite oxide levels

The mean NO levels in the blood serum increased significantly in the Tax control group compared to the normal control group ($P < 0.001$). The mean of NO levels in the blood serum did not change significantly in all Thym groups compared to the normal control group ($P > 0.05$). The mean NO levels in the blood serum decreased significantly in all Thym and Thym + Tax groups compared to the Tax control group ($P < 0.001$) [Figure 5].

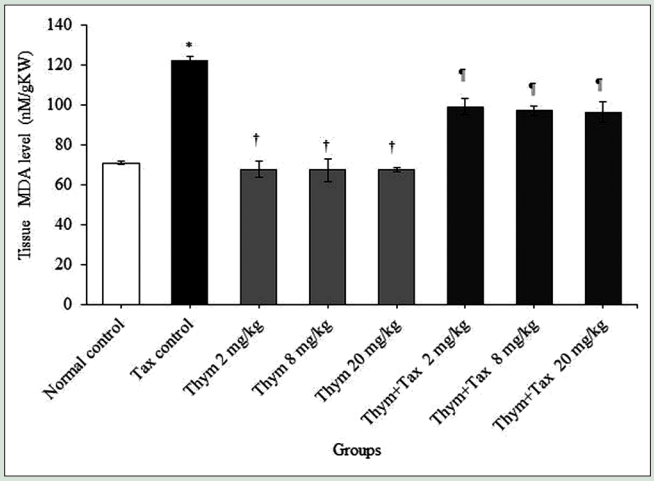

Figure 3: Comparison of testis MDA level between groups. *$P < 0.001$ compared to the normal control group. †$P < 0.001$ compared to the Tax control group. ¶$P < 0.001$ compared to the Tax control group. MDA: Malondialdehyde; Thym: *Thymus vulgaris*; Tax: Tax

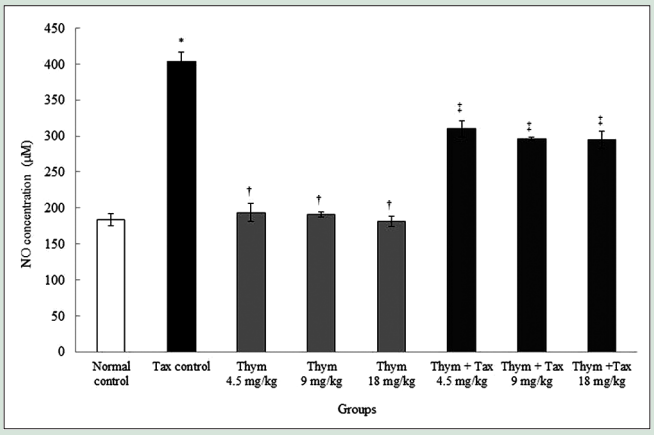

Figure 5: Effects of Thym, Tax and Thym + Tax on the mean NO levels. *Significant increase of NO in Tax control group compared to normal control group ($P < 0.001$). †Significant decrease in all doses of Thym groups compared to Tax control group ($P < 0.001$). ‡Significant decrease in all doses of Thym + Tax groups compared to Tax control group ($P < 0.001$). NO: Nitrite oxide; Thym: *Thymus vulgaris*; Tax: Tax

DISCUSSION

The liver is one of the vital body organs and the first defense barrier that plays a pivotal role in detoxification of toxic agents and chemical drugs. Chemotherapy, the main factor involved in oxidative stress, can disrupt the structure and performance of the liver.[19] Thus, simultaneous use of potential plant antioxidants and chemotherapy medications has drastically increased to protect the cells and tissues against the destructive effects of free radicals.[20]

The findings of the current research suggested that Tax administration had adverse and destructive effects on liver histology and function, oxidant-antioxidant imbalance as well and increase in NO level. On the other hand, Thym as an herbal relief the diverse effects of Tax administration, obviously in some liver parameter. It also recovers the cell damage offering by MDA decreasing and histology evaluation and the rate of oxidation (by calculating the amount of TAC). The current study results also showed that Thym is able to reduce lipid peroxidation (decreased MDA) and increase antioxidant capacity (increased TAC) of liver tissue; thus, it is reducing oxidative stress. Consistent with these findings, a large body of studies has shown anti-oxidant properties of Thym.[7,13,14]

Thym seems to inhibit the lipid peroxidation induced by Tert-Butyl hydroperoxide in the liver.[7] Further, Thym is a lipophilic molecule that is able to inhibit lipid peroxidation via Fenton reaction.[21] Gani showed that alcoholic extract of *N. sativa* attenuated hepatic enzymes and lipid peroxidation, which is in line with the results of the present study.[22]

Thus, it appears that Thym with its anti-oxidant properties could reduce MDA and increase TAC in the treatment groups by inhibiting the production of ROS. The present study also indicated the recovery effect of Thym on some liver parameter as well as decreasing the oxidative stress by showing declining of MDA. The toxicity of Tax administration can lead to blood and biochemical changes, oxidative stress, and lipid peroxidation. Therefore, the mechanism for the toxicity of Tax compounds is oxidative stress.[23] The findings revealed that, compared to the normal control group, the number of hepatocytes in the control group of Tax has significantly decreased whereas the central venous size has significantly increased. In addition, there was a significant increase in the number of hepatocytes and a significant reduction in the size of the central venous in recipient groups Thym and Tax + Thym in all doses as compared to the control Tax administration group. Another important finding was that some changes in the liver were observed in the control group of Tax administration that were in the form of the plethoric state of the sinuses, macrophages accumulation around the central veins and the lymphoid cells penetration in the port space, as well as the central vein diameter enlargement.

It seems that the invasion of free radicals to liver cells causes necrosis in parenchymal cells.[7] These cells can induce inflammatory responses in the liver, which leads to tissue damage by single-nuclei inflammatory cells. The necrotic cells release the pro-inflammatory mediators, and it can exacerbate poison-induced liver injury.[24] Apparently, macrophages are activated in response to tissue injury and release positive mediators, such as the alpha tumor necrosis factor, interleukin-1 and NO.[7] In the present study, macrophages are actually the same as copper cells that are in the liver sinuses. It may seem that the copper cells accumulation and the secretion of toxic mediators in the areas, that have not undergone necrosis yet, are involved in causing liver toxicity and necrosis.[25]

Moreover, free radicals' production and subsequent oxidative stress can be one of the most critical and essential causes of the liver cells death.[9] The results corroborate the ideas of Cresteil *et al.* who suggested that the liver injury and apoptosis induction in hepatocytes can be caused by Tax.[26] Tax administration-induced of free radicals may invade to liver cells and cause necrosis in parenchymal cells. These cells can trigger inflammatory responses in the liver and cause the single-nuclei inflammatory cells to invade the tissue injury. The necrotic cells release the pro-inflammatory mediators, and this can exacerbate toxin-induced liver injury.[27] It may seem that the oxidative stress, which is induced by Tax administration can induce the production of active oxygen species, some notable examples are hydroperoxides, singlet oxygen, hydrogen peroxide and superoxide that lead to the destruction of cell, DNA, proteins, and intracellular lipids and ultimately to liver injury.[28]

Thym appears to carry out a protective effect against fibrogenesis on the liver through polyphenol capacity and by inhibiting the stellate cells activity and destroying the transduction signals' way and expressing the cell cycle protein.[29] Stellate cells play a crucial part in the improvement of liver fibrosis and oxidative stress.[4] It seems that Thym has the capability to inhibit P38MAPK phosphorylation in the activated LPS in microglia. Thym can exert its anti-inflammatory effects on nuclear factor kappa B (NF-Kβ). Thym can inhibit NF-Kβ by reducing H_2O_2 production, inhibiting IKβ kinase and phosphorylation P65 and depleting P65.[30] Kanter *et al.* illustrated that Thym inhibits the induction of ethanol's undesirable effects through the inhibition of lipid's induction, which is in line with the findings of the current study.[31]

The results of this study indicate that there is a significant difference between liver antioxidant capacity and AST, ALT, and ALP levels in the control Tax group and the normal control group respectively. Similarly, there's a negative correlation, in all doses, between the antioxidant capacity of liver tissue in the control Tax group and AST, ALT and ALP levels in the group received Thym and Tax + Thym. The increase in the activity of liver function index enzymes in serum indicates a liver injury in the current study. Moreover, the findings of Nili-Ahmadabadi *et al.* confirmed the results of the current study in that Thym could decrease serum ALT, AST, and ALP levels.[32]

These enzymes can be released into the bloodstream due to the incidence of necrosis or cell membrane damage.[9] It may seem that Tax can induce damage to the cell membrane integrity by the inhibition of complex one to four (I-IV) and the respiratory chain.[33] The results are in agreement with Bai *et al.* findings which revealed that the Tax administration in male rats for 1 week induces the increase of liver enzymes and conversely reduce the TAC.[29] Thym appears to stabilize cell membranes and prevents leakage of enzymes by preventing lipid peroxidation.[16]

Thym can exert its antioxidant and anti-inflammatory effects by inducing antioxidant enzymes, adjusting lipid metabolism, and reducing lipid peroxidation.[7] The results are consistent with those of who suggested that administration of Thym reduces liver enzymes in diabetic rats and prevents injuries to hepatocytes.[34] The results of this study indicated a significant increase in the amount of NO in the serum of the recipient control Tax group compared to the normal control group. Furthermore, there was a significant decrease in recipient Tax + Thym group in serum NO level compared to control Tax group. It seems that oxidative stress in cells increases the synthesis of NO synthase and consequently leads to increase in nitrite production and decrease in cell survival.[35]

Due to the high consumption of oxygen, mitochondria dysfunction may increase the production of free radicals in most tissues of the body, including NO radicals and due to the oxidative and nitrosative stress, it may induce injury to the tissues, especially the liver.[8] Administration of Tax through the induction of oxidative stress can significantly increase the amount of nitrotyrosine and NO biomarkers in the liver.[36] On the other hand, antioxidants can damage and degrade the NO system (protein enzymes, substrates, and cofactors), hence, reduces NO production.[4] The results are in agreement with of Gedikoğlu *et al.* findings which showed that Thym can reduce NO in morphine-induced damage to the liver.[7]

The results are in accord with recent studies indicating that Tax, as one of the chemotherapy drugs, is apparently able to damage and degrade hepatocytes, reduce antioxidant capacity and elevate serum levels of liver enzymes and NO by inducing oxidative stress. On the contrary, resveratrol, a potent antioxidant agent, can reduce the destructive effects of these organophosphates to some extent. Accordingly, using food and fruits that are high in Thym can be a good strategy to reduce free radicals and prevent injuries to the liver of the people who are exposed to chemotherapy drugs, specifically patients.

CONCLUSION

The results of this study showed that Tax administration would outbreak dangerous impress from the point of both histology and function. The study approves that eliminated liver oxidant-antioxidant balance as molecular advocator due to the administration of Tax would supervise cellular chain reaction, observable either with light microscopy. Thym up-regulates dynamically improves the oxidant system as long as lipid peroxidation following Tax administration. Finally, the antioxidant properties of Thym may be a main reason for its positive effect on liver parameters; however, additional studies are required to define its exact mechanism of action.

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Conflicts of interest

There are no conflicts of interest.

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