Impact of Peppermint and Thyme in Ameliorating Cardiac and Hepatic Disorders Induced by Feeding Rats Repeatedly Heated Fried Oil

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ABSTRACT

Deep frying is one of the most popular cooking methods using oil. Many people prefer fried food and make it a lifestyle for them. Numerous studies have demonstrated that consumption of heated oils from fast food can lead to undesirable health consequences. An investigation was carried out to study potential protective of thyme or peppermint alone or their combination against cardiac and hepatic disorders in rats fed a commercial diet fortified with heated frying oil (HFO) (15% w/w) for 45 days. Fifty Male Wistar rats divided to 5 equal groups: G I control, GII: animals fed basal diet fortified with 15% (w/w) HFO (positive control), GIII-V: animals fed as in GII and treated with thyme extract (500mg/kg), peppermint extract (290 mg/ kg), and the combination of both extracts through oral gavage, for 45 days. The results showed that rats in GII exhibited a significant increase in glucose, lactate dehydrogenase (LDH), Creatine Kinase (CK-MB), liver enzymes and lipid profile in comparison to control. Moreover, a significant rise in lipid peroxidation (MDA), nitric oxide (NO) and protein carbonyl contents (PCC), accompanied by a decline in antioxidants activity in cardiac and hepatic homogenates was also observed. These biochemical alterations were ameliorated when thyme, peppermint, and their combination was administered to rats fed diet supplemented with HFO compared to the GII. These data suggest the use of these herbs might protect against cardiac and hepatic injuries induced by feeding HFO.

Key Words: *Oxidized oil, Peppermint, Thymus Vulgaris, Heated fried oil, Hepatic disorders.*

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INTRODUCTION

One of the most popular methods in cooking is deep frying, where its popularity return to short and easy preparation and palatability to consumers [1]. Fried foods have uniquearoma amount that cannot be provided by other cooking methods[2].Since the frying method involves presence oxygen and high temperature, thermal and oxidative effects will lead to the degrading quality of HFO [3]. Oil properties such astype, temperature, and duration have a large effect on thequality of final products [4]. The safety of heated fried oil (HFO), which is ingested with fried food, is a concern. Major properties such as toxic chemicals generated as polycyclic aromatic hydrocarbons, acrylamide and free radicals for that the HFO can be regarded as a xenobiotic [5-8]. Subsequently, consumption of fried foods is highly associated with the risk of coronary heart disease (CHD)[9], coronary artery disease [10], type 2 diabetes[11], heart failure[12] and obesity[13]. Previous investigations reported the presence of natural antioxidants from aromatic and medicinal plants is related to decreasing chronic diseases like damage of DNA [14] carcinogenesis [15], diabetes [16], and cardiovascular disease [17].

Peppermint (*Mentha piperita L.*) and Thyme (*Thymus vulgaris L.*) are a genus of an aromatic perennial and have medicinal substances of Lamiaceae family, peppermint is grown during increase the temperature in many countries [18]. The major chemical compounds of peppermint are menthol, menthone, and menthofuran, it also contains

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menthylacetate, eucalyptol, iso menthone and neomenthol [19]. Peppermint has antibacterial activity [20], antioxidant activity [21, 22], hepatoprotective effect [23], neuroprotective effect [24] hypocholesterolemic effect [25] and anti-diabetic effect [26].

Thyme is most prevalent in the Mediterranean regions [27]. Thyme contains high concentrations of phenols, including thymol, carvacrol, 1,8-cineole, q-cymene, linalool, borneol, a-pinene, and camphor [28]. Thyme is one of the most important species and is used as anti-inflammatory [29], antibacterial [30], antifungal [31], hepatoprotective [32], antioxidant [33, 34] and antitumor [35]. Therefore, this study aimed to investigate the impact of heated fried oil on the liver and heart functions in the rats. Furthermore, the role of natural antioxidant (Peppermint and Thyme) effect alone or in a mixture in ameliorating cardiac and hepatic disorders

MATERIALS AND METHOD

Raw materials

Fresh Palm oil and the leaves of *Mentha piperita* and *Thymus vulgaris* were obtained from the local supermarket in Jeddah, Saudi Arabia

Experimental animals

Fifty adult male Wister rats, weighing 150 to 200 g were used as experimental animals obtained from the Central Animal House of King Fahd Medical Research Center. Jeddah, Saudi Arabia. The rats were kept at normal temperature and stander light cycle for one week before the start of experiments to adapt with adequate food and water. Animal procedures were performed under the Ethics committee of King Fahd Medical Research Center and the recommendations for proper care and use of laboratory animals. (Reference number:581-17)

Preparation of water extracts of Mentha piperita

*Mentha piperita*leaves are washed, weighed (100 g/L) and triturated with water in the blender for 7 minutes. then the juice is filtered and frozen in the amber flask. Each flask was melted daily at ambient temperature two hours before administration [36].

Preparation of water extracts of Thymus vulgaris

30g of dried paper of thymus was infused in 60 ml of distilled water for a day then, the sample was filtered using filter paper after that the aqueous filtered stored at _20 _C for 3 days [37].

Preparation of heated fried oil (HFO) Diets

Palm oil is used as heated oil ten times, the heating process involved use 2.5L of the oil to fry 1K of potatoes and the temperature of the heating oil reach about 180ºC for 10 min. To reheat the oil twice, the hot oil is cool for 5 hours, and then the entire frying process is repeated with a fresh batch of potatoes without adding fresh palm oil to compensate for oil losses. The test diets were formulated by mixing 15% (w:w) of each oil with commercial rat feed according to [38].

The Experimental Design

Fifty animals were used and divided into five groups each group contained 10 rats as follow: Group I (control): rats were fed a basal diet and given only distilled water. Group II: rats were fed a basal diet fortified with 15% (w / w) palm oil heated for 10 times. Group III: rats were fed as in group 2 and received 500mg/kg of *Thymus vulgaris* water extract by oral gavage for 45 days [37]. Group IV: rats were fed as in group 2 and received 290 mg/ kg body weight of *Mentha piperita* water extract by oral gavage for 45 days [36]. Group V: rats were fed as in group 2 and were received a mixture of the two herbs as in group 3 and 4 by oral gavage for 45 days.

During the experimental period, body weight was recorded once a week. At the end of the experimental period (45 days), rats fasted overnight before scarification. Blood samples were withdrawn by a heparinized capillary tube from the retro-orbital plexus of each rat under anesthesia with diethyl ether, then centrifuged at 3000 rpm for 10 min to separate serum, which stored at -20° C until biochemical analysis. Immediately after blood sampling, animals sacrificed and the heart and liver of each animal dissected and homogenized (1g/10ml ice-cold potassium chloride, 150 mM). The homogenate was then used for determination of oxidative stress by estimation of the level of the levels of malondialdehyde (*MDA*) as a lipid peroxidation marker, nitric oxide, and Protein Carbonyl Contents, glutathione reductase, and the activities of superoxide dismutase (SOD), and catalase (CAT) by colorimetric method using commercial KIT. Serum was used for estimated LDH, *Creatine kinase-MB* (CK-MB), blood glucose, and lipid profile: total cholesterol, LDL-C, HDL-C, and triglycerides levels. AST, ALT, and ALP were also estimated to study the liver function, by the colorimetric method using commercial KIT from sigma Aldrich.

Statistical Analysis

The data of each group were analyzed using a one-way analysis of variance (ANOVA) with Microsoft excel program (2010) Mega Stat (10.0) Add-in. Results were expressed as mean ± standard deviation (SD). Values of P more than or equal to 0.05 were considered to be a non-significant difference. While values less than 0.05 were counted as a significant difference.

RESULTS

Effect of thyme and /or peppermint on serum enzyme activities

The effect of administration of aqueous extracts of *Thymus vulgaris* and /or peppermint *Mentha piperita L.* for 6 weeks on serum level of AST, ALT, ALP, LDH,and CK-MB in rats fed HFO were summarized in Table (1).As shown in the table, there were highly significant increases (P=0.000) in the serum level of AST, ALT, ALP, LDH, and CK-MB in rats fed a diet fortified with HFO (GII) as compared with normal control rats (GI). Treatment rats fed HFO with thyme and /or peppermint significantly reduced the activity of all tested enzymes when compared to the untreated HFO group (GII).As compared to the individual treatment, the mixture of the aqueous extracts of thyme and peppermint had a more significant effect in restoring AST, ALT, ALP, LDH, and CK-MB levels.

Table 1: Effect of Thymus vulgaris and /or Mentha piperita L. on serum enzyme activities of rats fed HFO

Groups	AST (U/L)	ALT (U/L)	ALP (U/L)	LDH (U/L)	CK-MB (U/L)
Control	26.3±4.52	31.6±5.08	85.4±7.71	426.03±10.21	130.99±4.29
HFO	72.9±9.92 *** ^^^	93.6±6.96 *** ^^^	142± 9.43 *** ^^^	914.08±9.60 *** ^^^	264.56±5.29 *** ^^^
HFO + thyme	42.4±4.25 *** ### ^^^	49.6±3.20 *** ### ^^^	105.8±9.02 *** ### ^^^	446.01±5.56 *** ### ^^	149.36±8.74 *** ### ^^^
HFO + peppermint	39.3±4.37 *** ### ^	41±4.55 *** ###	101.3±4.37 *** ### ^	443.69±8.79 *** ### ^	147.85±6.29 *** ### ^^^
HFO + thyme + peppermint	33.3±5.66 ** ###	37.9±4.07 ** ###	94.1±9.05 * ###	435.72±5.80 * ###	137.11±2.73 * ###

The values are the mean ± S.D. of parameters measured
P < 0.001 *** ,0.01 **, 0.05* significantly different with control group.
P < 0.001 ### significantly different with HFO group.
P < 0.001 ^^^ ,0.01^^ ,0.05^ significantly different with HFO treated withthyme + peppermintgroup

Effect of thyme and /or peppermint on serum lipid profile and glucose in rats fed with HFO

Table (2) showed the effect of thyme, peppermint or their mixture on serum lipid profile and glucose in rats fed on diet fortified with HFO. In the HFO group, there was a highly significant (p=0.000) elevation in TC, TG, LDL-C accompanied by a highly significant (p=0.000) reduction in HDL-C level as compared with the normal group. Moreover, an increase in glucose levels was significant in HFO to control. On the other hand, rats fed a diet fortified with HFO and treated with either thyme and peppermint or their mixture for 6 weeks and decreasing in TC, TG, LDL-C, glucose with increasing in HDL-C levels when compared to HFO group (Group II) .Moreover, the combined treatment of thyme and peppermint was more effective in preventing the alteration in the above parameters.

Effect of Thyme and /or peppermint on tissue antioxidant activities of rats fed with HFO

The effect of administration of aqueous extracts of thyme and /or peppermint for 6 weeks on hepatic and cardiac antioxidants in rats consumed HFO diets is summarized in Table (3),it is obvious that a highly significant decrease (P=0.000) in SOD, CAT and GR activities in hepatic and cardiac tissues in HFO group (GII) when compared to their corresponding values in the control group. Supplementation with the aqueous extracts of thyme and /or peppermint has significantly (p=0.000) ameliorated the antioxidant status of the HFO group. Furthermore, the best-pronounced results were in the group treated with the mixture of both herbs when the results were closed to the control group.

Table 2: Effect of thyme and /or peppermint on serum lipid profile and glucose levels in rats fed HFO

Groups	Total cholesterol (mmol/L)	Triglyceride (mmol/L)	HDL-C (mmol/L)	LDL-C (mmol/L)	Glucose (mmol/L)
Control	2.26±0.36	1.41±0.40	1.22±0.094	0.37±0.06	4.92±0.44
HFO	7.57±1.30 *** ^^^	4.46±0.47 *** ^^^	0.58±0.08 *** ^^^	2.55±0.38 *** ^^^	9.43±0.57 *** ^^^
HFO +thyme	3.91±0.38 *** ### ^^^	2.28±0.36 *** ###	1.06±0.057 *** ### ^^^	1.26±0.10 *** ### ^^^	7.13±0.43 *** ### ^^^
HFO + peppermint	3.45±0.48 *** ###	2.45±0.37 *** ### ^^	1.10±0.057 *** ### ^^^	1.22±0.08 *** ### ^^^	6.02±0.55 *** ###
HFO +thyme +peppermint	2.97±0.38 * ###	1.93±0.34 ** ###	1.15±0.058 * ###	0.58±0.14 ** ###	5.64±0.75 ** ###

The values are the mean ± S.D. of parameters measured
P < 0.001 *** ,0.01 **, 0.05* significantly different with control group.
P < 0.001 ### significantly different with HFO group.
P < 0.001 ^^^ ,0.01^^ ,0.05^ significantly different with HFO treated withthyme + peppermintgroup.

Table 3:Effect of Thymus vulgaris and /or Mentha piperita L. on antioxidant activities in hepatic and cardiac tissues in rats fed HFO

Groups	CAT (U/mg protein)		SOD (U/mg protein)		GR (U/g protein)	
	Liver	Heart	Liver	Heart	Liver	Heart
Control	73.65±5.01	35.01±1.46	6.94±0.58	3.58±0.27	0.89±0.06	0.42±0.03
HFO	32.88±2.79 *** ^^^	14.24±1,23 *** ^^^	3.04±0.27 *** ^^^	1.73±0.22 *** ^^^	0.22±0.04 *** ^^^	0.17±0.02 *** ^^^
HFO + Thyme	49.04±4.10 *** ### ^^^	22.84±1.39 *** ### ^^^	4.41±0.41 *** ### ^^^	2.81±0.16 *** ### ^^^	0.73±0.05 *** ### ^^	0.34±0.03 *** ### ^^
HFO + Peppermint	57.50±6.50 *** ### ^^^	25.57±1.00 *** ### ^^^	4.10±0.38 *** ### ^^^	3.03±0.13 *** ### ^^	0.66±0.06 *** ### ^^^	0.29±0.03 *** ### ^^^
HFO + Thyme+ Peppermint	68.14±3.45 *** ###	30.41±1.53 *** ###	6.18±0.38 ** ###	3.27±0.17 *** ###	0.81±0.04 ** ###	0.38±0.03 * ###

The values are the mean ± S.D. of parameters measured
P < 0.001 *** ,0.01 **, 0.05* significantly different with control group.
P < 0.001 ### significantly different with HFO group.
P < 0.001 ^^^ ,0.01^^ ,0.05^ significantly different with HFO treated withthyme+ peppermintgroup.

The effect of the aqueous extract of Thyme and /or peppermint on the oxidative stress of rats fed HFO

The effect of administration of water extracts of thyme and /or peppermint for 6 weeks on oxidative stress marker in hepatic and cardiac tissues is presented in Table (4). The current results showed that the levels of oxidative stress marker (MDA and, NO) and the content of PC in hepatic and cardiac tissues were significantly increased (p=0.000) in rats received HFO (G2) compared to control group. While supplementation of thyme and /or peppermint in the HFO group displayed significantly decreased in the above parameters compared to the untreated HFO group Furthermore, the best results were in the group treated with the mixture of both herbs when compared with each herb group.

Table 4:Effect of Thyme and /or peppermint on oxidative stress marker in hepatic and cardiac tissues of rats fed HFO

Groups	MDA (μ mol/g prot)		NO (μ mol/g prot)		PC (nmol/mg prot)	
	Liver	Heart	Liver	Heart	Liver	Heart
Control	18.75±0.98	14.70±1.40	4.16±0.28	2.61±0.34	2.91±0.16	1.81±0.12
HFO	35.91±1.49 *** ^^^	26.54±1.78 *** ^^^	9.27±0.48 *** ^^^	4.72±0.29 *** ^^^	8.36±0.25 *** ^^^	4.82±0.22 *** ^^^
HFO+ thyme	24.75±2.24 *** ### ^^^	22.15±1.20 *** ### ^^^	5.85±1.82 ** ### ^	3.16±0.17 *** ### ^	4.22±0.29 *** ### ^^^	2.85±0.49 *** ### ^^^
HFO +peppermint	27.32±2.47 *** ### ^^^	19.38±1.00 *** ### ^^^	6.32±0.79 *** ### ^^^	2.95±0.33 ** ### ^^	3.85±0.36 *** ### ^^^	2.45±0.35 *** ### ^^
HFO+ thyme+ peppermint	22.22±1.44 *** ###	17.25±1.48 *** ###	4.95±0.31 * ###	2.84±0.28 * ###	3.30±0.40 ** ###	2.10±0.06 * ###

The values are the mean ± S.D. of parameters measured
P < 0.001 *** ,0.01 **, 0.05* significantly different with control group.
P < 0.001 ### significantly different with HFO group.
P < 0.001 ^^^ ,0.01^^ ,0.05^ significantly different with HFO treated withthyme + peppermintgroup.

DISCUSSION

The practice of using repeatedly heated cooking oil is common way to decrease cost, vegetable oil benefits could deteriorate throughout repeated heating which produced lipid oxidation and formation of trans-fat [39, 40], and the consumption of HFO increase the oxidative stress which might increase the risk of atherosclerosis [41] cancers [42], and cardiovascular disease [43].

The liver is the main organ of detoxification and metabolism for most chemicals, while water-soluble material could be easier excreted through kidneys, lipophilic converts into liver tissue before excreting [44]. The liver has big effects on lipid metabolism where it was synthesis many products such as cholesterol, lipogenesis, triglycerides, and lipoproteins [45]. Liver enzyme including AST and ALT have been regarded as markers of liver injury [46]. ALT is mainly in the liver tissues, but AST can also be found in the heart and skeletal muscles. Elevate AST and ALT may indicate negative effects on the liver though hepatitis, a physical trauma, ischemia, or cause injury as a result of drugs or toxins substances [47]. ALP is present in many organs such liver. Both ALP and GGT mainly are elevated in biliary tract diseases [48].

In the present study, rats fed on diet fortified with HFO had a significant increase in AST, ALT, and ALP. Dysfunction arising in the liver was coming from consumption HFO. Elevated serum aminotransferases might be related to destructive effects for toxic substances in HFO. However,several studies have examined the relationship between chronic consumption of HFO diets and the effect on raising serum liver enzymes in the rat [49-51]. Furthermore, in our study, rats fed on diet fortified with HFO had a significant increase in CK-MB and LDH when compared to the normal rats. These increased indicate the damage or destruction of myocardial cells return to the reduction of oxygen supplementation or glucose, cardiac membrane be permeable or rupture entirely, which leadsto the deficiency of many enzymes. Serum CK-MB is an important early causing not onlyby myocardial infarction but also any kind of myocardial injury because founding in myocardial tissue abundantly and the virtual absence of other tissues and also more sensitivity [52]. Elevation in the lactate dehydrogenase (LDH) activity indicates the disturbance in the normal cardiac functions[53]. Similar results were reported by [54, 55]. The study by Rahman *et al* [56] observed that the fried rapeseed oils (both mustard and rai) were more toxic for the rat with raised cardio-hepatic changes.

In the present investigation, treated rats fed a basal diet containing 15% HFO with aqueous extracts of thyme and/or peppermint was significantly decreased the serum AST, ALT, ALP, LDH, and CK-MB. This indicates the ability of these extracts to enhance liver and heart function. The improvements in liver and heart enzymes in the HFO group after treatment could be beneficial in preventing cardiac and hepatic disorders. Many studies showed the positive effect of peppermint on liver function parameter [57-61].

Regard to the hepatoprotective effect of thyme [32, 62-64] reported that *Thymus vulgaris* used as a hepatic treatment by causes a significant positive change in oxidative stress and inflammatory markers, restoring normal liver functions and preventing histopathological changes. However,(Mohamed Fizur *et al*; Nagoor Meeran *et al*) [65, 66] observed that the feeding of rats with thymol, was able to lower the elevated activity of serum CK-MB, suggested thymol might be keeping cardiac mitochondrial either structure or function.

In the present study, rats in the groupreceived HFO had a significant increase in TC, TG, and LDL-C in parallel to a highly significant decrease in HDL-C as compared to the control group. Many studies reported the effects of HFO consumption on the lipid profiles of rats [67, 68].

The increase in TC and TG levels in the current study coincided with the findings of [69, 70]. This increase in the level of cholesterol in the blood (Hypercholesterolemia) has been implicated in cardiovascular diseases. Hence, HFO diets may increase the risk of cardiovascular diseases. The increase in serum LDL-C and the decrease in serum LDL-C in HFO diets is in agreement with the work of [71]. However, examination relationship between HDL-C and cardiovascular risk was pervious studied where most of them illustrated a strong, inverse, independent relationship between HDL-C and CVD [72-74] Regard effect for feeding HFO on glucose levels, the current results showed significantly increasing in glucose level (HFO groups) comparing to control groups. Results are in agreement with [75-78].

(Chiang *et al*) [79] concluded that rodents fed a diet containing 20% HFO had glucose intolerance and insulin deficiency, due to oxidative stress-associated β-cell dysfunction.

Enhanced HMG-COA reductase activity in the liver may be liable for increased concentration of plasma cholesterol [80, 81]. The increase in HDL-C might be a result of the low admission of linoleic acid content of HFO or might be an assurance system against the oxidative stress brought about by the eating regimen containing HFO and a mechanism to avoid oxidative changes in other lipoprotein such as LDL [82] In the present investigation, treated rats fed diet fortified with HFO with aqueous extracts of thyme and/or peppermint was reduced serum TC, TG, and LDL-C, glucose and increased HDL-C compared to their untreated HFO rats indicating that the addition of thyme and peppermint could repair lipid metabolism dysfunction induced by HFO.

The hypolipidemic and hypoglycemic effects of peppermint and thyme were studied by many researchers [83-86]. These effects maybe related to the presence of substances such as menthol, thymol and flavonoid have important radical scavenging activity [87]. Moreover, flavonoids that present in mentha may act in several ways on blood components like lipids [88].

Toghyani et al [89] attributed the reduction of triglycerides and cholesterol to the lowering effect of thymol or carvacrol on HMG- Co-A reductase, the rate-limiting enzyme of cholesterol synthesis.

The present study showed an increase in levels of MDA, NO and the content of PC accompanied with a significant decrease in CAT, SOD, and GR activities in hepatic and cardiac tissues in the HFO group compared to the control group. The current results agree with several studies conducted on rats fed with [90, 91]. Recently, Ayari *et al* [92] showed an elevation in the level of MDA and reduced in the activities of CAT and GR in rats fed thermo-oxidized virgin olive oil compared to the control group.

Lipid peroxidation ranged fromintermediates and end productsincluding lipid hydroperoxides, aldehydes, and malondialdehyde (MDA) [93]. MDA is the most popular indicator of oxidative damage to cells and tissues. The increase in MDA levels in rats HFO may be elicited by free radicals of lipid peroxidation. The most general and accepted way to evaluate protein damage is by measuring protein carbonyls. The presence of increased protein carbonyl groups is an indicator of protein oxidation and thus, oxidative damage [94]. Protein carbonyls are unable to catabolize to rectify amino acids and therefore, block proteolysis and oxidized protein accretion [95] which reduces amino acid recycling and cell integrity. It could be suggested that protein carbonyl concentration should also be measured in addition to MDA because protein damage is most affected by ROS in comparison to lipid and DNA damage mechanisms [96]. Endogenous antioxidants including superoxide dismutase (SOD), catalase (CAT), and glutathione reductase (GR) protect the body from damage caused by ROS and free radicals. The significant decrease in the antioxidant activity in the current study agrees with [97, 98].

SOD is a free radical scavenging enzyme that protects cells from oxidative stress as a defense mechanism of the cell against the endogenous and exogenous release of superoxide [98]. Also, it is effectedbythe CATin a precise manner to scavenge ROS. Catalase is an antioxidant enzyme that converts the H_2O_2 into water and oxygen; thus, preventing the lipid peroxidation of the cell membrane [99]. However, glutathione reductase is the enzyme which, convert of oxidized glutathione back to its reduced form.

In the present investigation, treated rats feda dietcontaining HFO with aqueous extracts of thyme and/or peppermint was significantly decreased the level of MDA, NO and PC accompanied with a significantincrease in CAT, SOD,and GR in liver and heart tissues.

Oxidative stress-induced by HFO resulted in a modification of antioxidant enzymes activities in the liver and heart but treated by thyme and peppermint rise level of antioxidant this can repair the damage that may occur in tissues by HFO. Thyme has a high level of flavonoid, thymol and carvacrol act a scavenge for free radicals.

Many studies have investigated the effect of thyme and peppermint in liver and heart tissue. El-Newary *et al* [63] observed that the administration of T. Vulgaris in rats fed alcohol ameliorate the increase in the level of MDA and significantly increased the antioxidants enzyme activities (GR, CAT, and SOD) in the liver.

Many experimental and clinical studies showed the beneficial effect of peppermint in improving the antioxidant parameter [62, 100]. Peppermint most of its pharmacological actions were related to antioxidant activity and theability to scavenge free radicals and/or inhibit lipid peroxidation [101-103].

CONCLUSION

According to the results obtained it could be concluded that the two herbs showing stronger amelioration and may block many complications of cardiovascular and hepatic disease by controlling hyperglycemia, hyperlipidemia, oxidative stress and thus protects liver and heart from damage.

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