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Cranberry Extract as a Functional Food in Treatment of Oxidative Stress in Iron-Induced Hepatic Toxicity in Rats

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Abstract

The present study was to evaluate the protective role of cranberry extract against iron-induced hepatic toxicity in rats. Administration of iron sulfate (30 mg/kg body weight) orally for 21 days, led to significantly ($p<0.01$) increased in the levels of blood hemoglobin, glucose, lipid profile, plasma and hepatic lipid peroxidation, iron and transferrin. Also, oral administration of iron sulfate showed a significant decrease ($p<0.01$) in the levels of plasma and liver enzymatic and non-enzymatic antioxidants. Administration of cranberry extract at different doses (75 mg/kg and 150 mg/kg body weight) significantly ($p<0.01$) restore the levels of plasma and hepatic markers, lipid profile, lipid peroxidation levels as well as increased the levels of plasma and hepatic enzymatic antioxidants and non-enzymatic antioxidants with normalize plasma iron and transferrin concentration in blood. Cranberry extract at a dose of 150 mg/kg body weight exhibits significant protection on hepatic more pronounced than both cranberry 75 mg/kg b.w. and vitamin C. In conclusion, the results clearly suggest that the cranberry extract may be effective in enhances the protection of liver toxicity by its free radical scavenging effect and antioxidant activity.

Keywords: Cranberry extract; Iron overload; Antioxidant; Liver; Oxidative stress biomarkers

Introduction

Iron is a nutrient that is related to health and immunity [1]. It is the most common element on earth, unfortunately iron is chemically unstable and easily oxidized into an insoluble ferric form , ferric iron is unavailable in most biological systems [2].As a transition metal, iron has five oxidation states (Fe^{2+}-Fe^{6+}) in addition to the ground state, and the most common states are $Fe^{2+}$and Fe^{3+}[3]. The unpaired electrons from iron make one-electron redox reactions possible. Fenton discovered that ferrous iron and hydrogen peroxide catalyze the oxidation of tartaric acid [4-6]. The work of Haber and Weiss subsequently showed that the hydroxyl free radical was produced by ferrous iron and hydrogen peroxide in a chain reaction, as shown below [5-7].The OH radical can non-specifically oxidize lipid molecules in the cell membrane and lipoprotein lipids (e.g., unsaturated fatty acids in phospholipids and cholesterol) to form LOOH in the Fenton reaction [4]. Free radicals result in the consumption of antioxidant defenses which may lead to disruption of cellular functions and oxidative damage to membranes and enhance susceptibility to lipid peroxidation. Increased generation of reactive oxygen species (ROS) and lipid peroxidation has been found to be involved in the pathogenesis of many diseases of known and unknown etiology and in the toxic actions of many compounds [5]. Flavonoids are phenolic compounds abundantly distributed in plants. It has been reported that most of them are effective antioxidants [6]. Many plant extracts and plant products have been shown to have significant antioxidant activity [7], which may be an important property of medicinal plants associated with the treatment of several ill-fated diseases including diabetes. Cranberry extracts rich in these compounds reportedly inhibit oxidative processes including oxidation of low-density lipoproteins [8, 9], oxidative damage to at neurons during simulated ischemia [10], and oxidative and inflammatory damage to the vascular endothelium [11]. Not surprisingly, plants such as cranberry extract contain high levels of unsaturated fatty acids and poly-phenols [8], which are excellent scavengers of reactive and represent a promising iron chelating effects. *in vivo* tests have been conducted with foods to determine for example, its hepatoprotective [11], hypolipidemic, hypoglycemic and antioxidant activity [12]. As a continuation of interested research program in pharmaceutical importance of natural products [13-16] especially cranberry extract [17,18], we report herein, a facile route to evaluate the chelating, antioxidant and hepatoprotective effects of cranberry extract against oxidative stress induced by iron sulfate in rats.

Materials and Methods

Dose of cranberry

Cranberry extract was purchased from Virgin Extracts™, chinese cranberry was given to adult rats with 1/150 LD_{50} (75 mg/kg.b.w.) and1/75 LD_{50} (150 mg/kg.b.w.) daily for 3 weeks [17,18] by oral gastric gavage tube.

Ferrous sulfate 99% was purchased from Sigma Aldrich, USA.

Experimental animals

This experiment was conducted in accordance with guidelines established by the animal care and use Faculty of pharmacy, October 6th University, Cairo, Egypt. 50 adult rats weighting around 180 ± 10 g were purchased from Faculty of veterinary medicine, Cairo University. They were individually housed in cages in an air-conditioned room

with a temperature of 22 ± 2°C, a relative humidity of 60%, and an 8:00 to 20:00 light cycle. During the acclimatization period, each animal was raised on a regular diet ad libitum. The regular diet consists of wheat flour 22.5%, corn starch 27.2%, soybean powder 20%, essential fatty acids 0.6%, sucrose 10%, cellulose 2.6, corn oil 5%, vitamins 2% (A 0.6 mg/kg, D 1000 IU/kg, E 35 mg/kg, niacin 20 mg/kg, pantothenic acid 8 mg/kg, riboflavin 0.8 mg/1000 kcal, thiamin 4 mg/kg, B6 50 µg/kg and B12 7 mg/kg of diet) and minerals 10% (calcium 5 g/kg, Phosphorus 4 g/kg, fluoride 1 mg/kg, iodine 0.15 mg/kg, chloride 5 mg/kg, iron 35 mg/kg, copper 5 mg/kg, magnesium 800 mg/kg, potassium 35 mg/kg, manganese 50 mg/kg and sulfur3 mg/kg of diet) [19].

Experimental design

The animals were divided into 5 groups consisting of 10 animals (180 g ± 10 g), two controls groups and three treatment groups:

Group (1): Control negative (0.9% saline, 3 ml/kg.b.w., orally).

Group (2): Positive control (ferrous sulfate 30 mg/kg b.w. suspended in 1 ml 0.9% saline was given orally daily for 21days) [20].

Group (3): Ferrous sulfate 30 mg/kg b.w.+Cranberry extract (75 mg/kg b.w.) daily for 21 days, orally daily dose [18].

Group (4): Ferrous sulfate 30 mg/kg b.w.+Cranberry extract (150 mg/kg b.w.) daily for 21 days, orally daily dose [18].

Group (5): Ferrous sulfate 30 mg/kg b.w.+Vitamin C (1 g/kg b.w.) daily for 21 days, orally daily dose [21].

Blood and tissue samples

At the end of the experiment, rats of each group were sacrificed by cervical decapitation. Blood samples were collected in dry, clean, and screw capped heparin tubes and divided in to two parts, one part for hemoglobin determination, Also, the second part was for plasma which separated by centrifugation at 2500 r.p.m for 15 minutes and kept in a deep freeze at -20°C until used for subsequent biochemical analysis.

The abdomen was opened and the liver specimen was quickly removed and cleaned by rinsing with ice-cold isotonic saline to remove any blood cells, clots, then blotted between 2 filter papers and quickly stored in a deep freezer at (-20°C) for subsequent biochemical estimation of plasma and liver reduced glutathione GSH [22], superoxide dismutase (SOD) [23], catalase (CAT) [24] and TBARS [25] as well as blood hemoglobin [26], plasma glucose [27], iron [28], transferrin [29], alanine aminotransferase (ALT) [30], aspartate aminotransferase (AST) [30], alkaline phosphatase (ALP) [31], triglyceride [32], total cholesterol [33], HDL-C [34] and LDL-cholesterol [35]. Plasma LDL-cholesterol level was calculated from Falholt and Falholt [36] formula (LDL-cholesterol=total cholesterol-triglycerides/5-HDL-cholesterol).

Statistical analysis

The obtained data were analyzed and graphically represented using the statistical package for social science (SPSS, 13.0 software, 2009), for obtaining mean and standard deviation of mean. The data were analyzed using one-way ANOVA to determine the statistical significance of differences among groups. Duncan's test was used for making a multiple comparisons among the groups for testing the inter-grouping homogeneity [37].

Results

Oral administration of ferrous sulfate (30 mg/kg body weight) resulted in a significant increase in plasma glucose and blood hemoglobin compared to the normal control group ($p<0.01$). Supplementation of cranberry extract at 75 mg/kg and 150 mg/kg.b.w. normalize plasma glucose and blood hemoglobin compared to the group that received ferrous sulfate ($p<0.01$) (Table 1).

Oral administration of Ferrous sulfate (30 mg/kg body weight) resulted in a significant increase in plasma iron, transferrin and transferrin saturation (TS%)compared to the normal control group ($p<0.01$). Supplementation of cranberry extract at 75 mg/kg and 150 mg/kg.b.w. resulted in a significant decrease in plasma iron, transferrin and transferrin saturation (TS%)compared to the group that received ferrous sulfate ($p<0.01$)(Table 2).

No.	Groups	Glucose (mg/dl)	Hb% (g/dl)
(I)	Normal (0.9% saline)	84.46 ± 5.11	12.70 ± 0.62
(II)	Control: Ferrous sulfate (30 mg/Kg.b.w.)	137.18 ± 7.84^{*a}	16.25 ± 0.50^{*a}
(III)	Cranberry extract (75 mg/kg.b.w.)	124.64 ± 8.25^{*ab}	13.40 ± 0.43^{*ab}
(IV)	Cranberry extract (150 mg/kg b.w.)	115.37 ± 10.06^{*abc}	12.86 ± 0.70^{*abc}
(V)	Vitamin C (1 g/kg b.w)	110.66 ± 8.50^{*abc}	12.75 ±0.68^{*abc}

Table 1: Plasma level of plasma glucose and blood hemoglobin in normal and experimental groups of rats. Values are given as mean ± SD for groups of eight animals each. *Significantly different from normal group at $p<0.01$. a: significant from normal control; b: significant from ferrous sulfate (30 mg/kg b.w.) supplement group; c: significant from cranberry extract (75 mg/kg b.w.); d: significant from cranberry extract (150 mg/kg b.w.).

Oral administration of ferrous sulfate (30 mg/kg.b.w.) resulted in a significant increase in plasma ALT, AST, and ALP compared to the normal control group ($p<0.01$). Supplementation of cranberry extract at 75 mg/kg and 150 mg/kg.b.w. resulted in a significant decrease in plasma ALT, AST and ALP compared to the group that received ferrous sulfate ($p<0.01$) (Table 3).

No.	Groups	Iron (µg/dl)	Transferrin (mg/dl)	Transferrin saturation (TS%)
(I)	Normal (0.9% saline)	157.08 ± 9.80	183.74 ± 10.52	60.90 ± 4.38
(II)	Control: Ferrous sulfate (30 mg/kg b.w.)	311.50 ± 8.35^{*a}	246.19 ± 18.73^{*a}	90.13 ± 5.08^{*a}
(III)	Cranberry extract (75 mg/kg b.w.)	208.22 ± 11.2^{*ab}	205.20 ± 12.66^{*ab}	72.29 ±3.40^{*ab}
(IV)	Cranberry extract (150 mg/kg b.w.)	168.00 ± 6.18^{*abc}	193.84 ± 8.47^{*bc}	61.74 ± 4.52^{*bc}
(V)	Vitamin C (1 g/kg b.w)	173.50 ± 7.69^{*abc}	188.33 ± 9.58^{*abcd}	65.63 ± 3.95^{*b}

Table 2: Plasma level of plasma glucose, iron, transferrin and transferrin saturation (TS%)in normal and experimental groups of rats. Values are given as mean ± SD for groups of eight animals each. *Significantly different from normal group at p<0.01. a: significant from normal control; b: significant from ferrous sulfate (30 mg/kg b.w.)supplement group; c: significant from cranberry extract (75 mg/kg b.w.); d: significant from cranberry extract (150 mg/kg b.w.). ST%=(Iron/Transferrin) *71.24.

Oral administration of ferrous sulfate (30 mg/Kg.b.w.) resulted in a significant increase in plasma total cholesterol (TC), triglycerides (TG) and LDL-C as well as a significant decrease in plasma HDL-C compared to the normal control group (p<0.01). Supplementation of cranberry extract at 75 mg/kg and 150 mg/kg.b.w. resulted in a significant decrease in plasma total cholesterol (TC), triglycerides (TG) and LDL-C as well as a significant increase in plasma HDL-C compared to the group that received ferrous sulfate (p<0.01) (Table 4).

Oral administration of ferrous sulfate (30 mg/kg.b.w) resulted in a significant decrease in blood and liver reduced glutathione (GSH) and activities of superoxide dismutase (SOD) and catalase (CAT) as well as a significant increase in plasma and liver TBARs compared to the normal control group (p<0.01). Supplementation of cranberry extract at 75 mg/kg and 150 mg/kg.b.w. resulted in a significant increase in blood and liver GSH, SOD and CAT as well as a significant decrease in plasma and liver TBARs compared to the group that received ferrous sulfate(p<0.01)(Tables 5 and 6).

No.	Groups	ALT (IU/l)	AST (IU/l)	ALP (IU/l)
(I)	Normal (0.9% saline)	18.76 ± 2.37	32.08 ± 2.00	68.27 ± 5.49
(II)	Control: Ferrous sulfate (30 mg/kg b.w.)	42.38 ± 3.90^{*a}	58.90 ± 5.82^{*a}	105.40 ± 8.73^{*a}
(III)	Cranberry extract (75 mg/kg b.w.)	30.21 ± 2.28^{*ab}	44.73 ± 5.04^{*ab}	83.29 ± 6.30^{*ab}
(IV)	Cranberry extract (150 mg/kg b.w.)	23.86 ± 3.06^{*abc}	36.08 ± 4.23^{*cb}	71.25 ± 5.00^{*bc}
(V)	Vitamin C (1 g/kg b.w)	27.50 ± 3.77^{*ab}	40.66 ± 4.39^{*b}	79.64 ± 6.11^{*abd}

Table 3: Activity of alanine transaminase (ALT), aspartate transaminase (AST) and alkaline phosphatase (ALP) in plasma of normal and experimental groups of rats. Values are given as mean ± SD for groups of eight animals each. *Significantly different from normal group at p<0.01. a: significant from normal control; b: significant from ferrous sulfate (30mg/kg b.w.) supplement group; c: significant from cranberry extract (75 mg/kg b.w.); d: significant from cranberry extract (150 mg/kg b.w.).

No.	Groups	TC (mg/dl)	TG (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)
(I)	Normal (0.9% saline)	95.50 ± 6.48	77.20 ± 5.45	32.66 ± 3.28	47.78 ± 4.09
(II)	Control: Ferrous sulfate (30 mg/kg b.w.)	164.66 ± 9.80^{*a}	142.33 ±13.26^{*a}	20.95 ± 2.07^{*a}	115.25 ± 10.79^{*a}
(III)	Cranberry extract (75 mg/kg b.w.)	135.82 ± 11.37^{*ab}	119.70 ± 11.15^{*ab}	28.36 ± 3.14^{*ab}	83.52 ± 6.42^{*ab}
(IV)	Cranberry extract (150 mg/kg b.w.)	107.15 ± 8.64^{*abc}	85.41 ± 6.58^{*bc}	36.24 ± 4.08^{*bc}	53.83 ± 3.09^{*bc}
(V)	Vitamin C (1 g/kg b.w.)	117.54 ± 7.50^{*abcd}	98.05 ± 6.44^{*abc}	31.18 ± 2.60^{*b}	66.75 ± 5.22^{*abcd}

Table 4: Level of plasma total cholesterol (TC), triglycerides (TG), HDL-C and LDL-C of normal and experimental groups of rats. Values are given as mean ± SD for groups of eight animals each. *Significantly different from normal group at p<0.01. a: significant from normal control; b: significant from ferrous sulfate (30mg/Kg.b.w.)supplement group; c: significant from cranberry extract (75 mg/kg b.w.); d: significant from cranberry extract (150 mg/kg b.w.). LDL-C (mg/dl)=TC-HDL-[TG/5].

No.	Groups	GSH (mg%)	SOD (U/ml)	CAT (U/ml)	TBARs (mmol/dl)
(I)	Normal (0.9% saline)	23.50 ± 2.47	39.08 ± 3.00	25.97 ± 4.20	0.42 ± 0.05
(II)	Control: Ferrous sulfate (30 mg/kg b.w.)	13.82 ± 2.09^{*a}	27.16 ±4.10^{*a}	9.18 ± 1.84^{*a}	0.67 ± 0.04^{*a}
(III)	Cranberry extract (75 mg/kg b.w.)	19.00 ± 3.25^{*ab}	34.50 ± 4.28^{*a}	15.66 ± 3.05^{*ab}	0.55 ± 0.05^{*ab}
(IV)	Cranberry extract (150 mg/kg b.w.)	24.06 ± 3.17^{*bc}	41.29 ± 4.08^{*b}	23.98 ± 2.44^{*bc}	0.43 ± 0.06^{*bc}
(V)	Vitamin C (1 g/kg b.w.)	21.44 ± 2.76^{*b}	33.45 ± 2.68^{*abd}	20.86 ± 3.10^{*abc}	0.47 ± 0.04^{*ab}

Table 5: Level of blood reduced glutathione (GSH) and activities of superoxide dismutase (SOD), catalase (CAT) and Thiobarbaturic acid reactive substances (TBARs) in normal and experimental groups of rats. Values are given as mean ± SD for groups of eight animals each. * Significantly different from normal group at p<0.01. a: significant from normal control; b: significant from ferrous sulfate (30 mg/kg b.w.)supplement group; c: significant from cranberry extract (75 mg/kg b.w.); d: significant from cranberry extract (150 mg/kg b.w.).

No.	Groups	GSH (µg/mg protein)	SOD	CAT	TBARs (mmol/g tissue)
(I)	Normal (0.9% saline)	5.2 ± 0.57	8.38 ± 1.22	74.16 ± 6.20	11.37 ± 1.27
(II)	Control: Ferrous sulfate (30 mg/kg b.w.)	2.35 ± 0.33^{*a}	4.70 ± 0.84^{*a}	53.00 ± 4.09^{*a}	26.04 ± 3.75^{*a}
(III)	Cranberry extract (75 mg/kg b.w.)	3.75 ± 0.41^{*ab}	6.32 ± 0.65^{*ab}	66.48 ± 4.28^{*ab}	17.83 ± 2.09^{ab}
(IV)	Cranberry extract (150 mg/kg b.w.)	4.94 ± 0.38^{*bc}	8.15 ± 0.43^{*bc}	72.06 ± 6.15^{*bc}	12.74 ± 0.86^{*bc}
(V)	Vitamin C (1 g/kg b.w.)	4.80 ± 0.50^{*bc}	7.05 ± 0.92^{*abcd}	68.11 ± 3.61^{*b}	15.27 ± 1.30^{*ab}

Table 6: Level of liver reduced glutathione (GSH) and activities of superoxide dismutase (SOD), catalase (CAT) and Thiobarbaturic acid reactive substance (TBARs) in normal and experimental groups of rats. Values are given as mean ± SD for groups of eight animals each. *Significantly different from normal group at p<0.01.SOD; one unit of enzyme activity was taken as the enzyme reaction, which gave 50% inhibition of pyrogallol autoxidation in one minute/mg protein; CAT; µmol of H_2O_2consumed/min/mg protein;a: significant from normal control; b: significant from ferrous sulfate (30 mg/kg b.w.) supplement group; c: significant from cranberry extract (75 mg/kg b.w.); d: significant from cranberry extract (150 mg/kg b.w.).

Discussion

Iron deficiencies or iron overload disturb the biochemical-physiological balance and are common and have clinical relevance.

To avoid toxic potential while still providing essential biological needs, the levels of iron supplied must be rigorously controlled. The control of iron absorption is a key step in the process, because the metal absorbed is retained and its excretion is limited [38]. However, iron accumulation after an overdose or a prolonged chronic therapeutic dosage suggests that a first order passive process could explain iron absorption3 in addition to the one physiologically controlled.

Antioxidants are the first source of protection of the body against free radicals and other oxidants, being the compounds that the attack and the formation of radical species within cells. The group of antioxidants inside the organism is known as the total antioxidant state (TAS) [39].

Results of the present study showed that oral administration of ferrous sulfate (30 mg/kg bodyweight) resulted in a significant increase in plasma glucose and blood hemoglobin compared to the normal control group. Supplementation of cranberry extract at 75 mg/kg and 150 mg/kg b.w. normalize plasma glucose and blood hemoglobin levels compared to the group that received ferrous sulfate. These results were in agreement with previous studies concluded that iron administration as $FeSO_4$ provided an increase in RBCs parameters in rats [40-42].

These results were in agreement with Sarker et al., [43]; reported that mice injected with Fe^{+3} exhibited an increased in liver iron deposition. Administration of polyphenols significantly reduced serum and tissue iron concentration; these may be attributed to iron chelator effect of polyphenols. Several studies had demonstrated that curcumin can bind iron and it had properties of an iron chelator [44,45]. Cranberry containing anthocyanins can also prevent the oxidation of ascorbic acid caused by metal ions through chelating the metal ions, and forming ascorbic (copigment)-metal anthocyanin complex [46] and scavenge O_2 [47].

In the present study, higher activities of plasma aspartate aminotransferase and alanine aminotransferase (an indicator of hepatocytes mitochondrial damage) have been found in response to iron overload-induced oxidative stress. Such increased activities might be attributed to the leakage of these enzymes from the injured liver cells into the blood stream because of the altered liver membrane permeability [48]. Increase in serum alkaline phosphatase activities is the indicative of cellular damage due to loss functional integrity of cell membranes.

The accumulation of iron in blood was effectively reduced by hesperidin, which revealed that cranberry's polyphenols chelate the iron. Moreover, the hydroxyl groups of polyphenols or its active metabolites might bind with iron and enhanced the excretion of iron, which in consequence decrease accumulation of iron and reduce the toxic effects of iron.

Given that increased LDL cholesterol (LDL-C) and decreased HDL cholesterol (HDL-C).Both Brunet et al. [49] and Dabbagh et al. [50] found an increase in total cholesterol and triglycerides.

The Fe^{+3} induced rise of cholesterol in serum and tissues may be due to changes in the gene expression of hepatic enzymes mainly HMG-COA reductase. Heavy metal induced change in the gene expression of HMG-COA reductase has already been reported [51]. The increased PLs content in Fe^{+3} intoxicated rats may be due to elevation in the levels of FFAs and cholesterol. The antioxidant property could also contribute to the protection of membrane lipids from free radical there by cranberry's polyphenols attenuated the abnormal dispersion of membrane lipids in circulation as well as reduced the excessive generation of more toxic peroxides, which cause drastic changes in cells and tissues. Reduced risk of cardiovascular disease is often attributed to the intake phytochemicals, which lower excessive cholesterol and/or TGs concentrations [52].

Lipid peroxidation is the process of oxidative degradation of poly unsaturated fatty acid and the products of lipid peroxidation inactivate cell constituents by oxidation or cause oxidative stress by undergoing radical chain reaction ultimately leading to the cell damage [53]. Iron is the most common cofactor within the oxygen handling biological machinery and, specifically, lipid peroxidation of biological membranes is the main pathogenic mechanism of iron overload induced tissue damage [54].

Since cranberry has shown antioxidant and free radical scavenging activity [55], the present study primarily ameliorating the effect of cranberry' polyphenols on iron accumulation and oxidative damage in the liver of iron overloaded rat is studied. Oral administration of cranberry extract significantly inverse the iron induced peroxidative damage in liver which is evidenced from the lowered levels of thiobarbituric acid reactive substances and lipid hydroperoxides. This may be due to the antioxidative effect of polyphenols [56].

An antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons from a substance to an oxidizing agent. Oxidation reaction can produce free radicals, which start chain reactions that damage cells.

Antioxidants terminate these chain reactions by removing free radical intermediates, and inhibit other oxidation reactions by being oxidized themselves. As a result are often reducing agents such as thiols, ascorbic acid or polyphenols [57]. The enzymatic antioxidants superoxide dismutase, catalase and glutathione peroxidase and glutathione-S transferase play a vital role during the process of scavenging reactive oxygen species or preventing their formation [58].

Superoxide dismutase, catalase and glutathione peroxidase constitute the major enzymatic antioxidant defenses which convert active oxygen molecules in to non-toxic compounds [59]. Superoxide dismutase is a ubiquitous enzyme with an essential function in protecting aerobic cells against oxidative stress. It is primarily mitochondrial enzyme usually found in the plasma membrane [60].

Vitamin C is a naturally occurring free radical scavenger which decreases free radical ability and lipid peroxidation sequence [61]. It regenerates membrane bound alpha-tocopherol radical and removes the radical from the lipid to the aqueous phase. It also protect tissues from lipid peroxidation both *in vivo* and *in vitro* [62]. Finally, the antioxidant and renal protective effects of cranberry extract might be associated with the structure-antioxidant relationship of its active constituents such as vitamin C, vitamin E and polyphenols (anthocyanins). Chelating effect of cranberry extract against liver toxicity induced by iron sulfate has not been reported earlier to my knowledge, and this study is perhaps the first observation of its kind.

Conclusion

The present study showed that cranberry extract has a powerful hepatoprotective activity against iron sulfate induced liver toxicity. These effects could be due to membrane protective action of cranberry by scavenging the free radicals and its antioxidant action. This could serve as a stepping stone towards the discovery of newer safe and effective free radical scavenging agents.

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