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Antihepatotoxic Effect of Some Natural Antioxidants Against Liver Damage Induced By CCl4 in Rats

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ABSTRACT

In recent years, the etiology of many diseases was attributed to increased oxidative stress and the role of diet or dietary constituents as natural antioxidants was magnified. The present study aims to investigate the antihepatotoxic effect of two antioxidant rich edible plants namely; Cichorium intybus (chicory) and Rhus coriaria (sumac) against carbon tetrachloride (CCl4) liver toxicity in rats as a model of increased oxidative stress. A model of chronic hepatic injury in rats was induced by carbon tetrachloride (CCl4) and then, the impact of chicory and sumac to antagonize this toxicity was evaluated. Four groups, each of eight rats were included. All animals except those in group one were administered orally with CCl4 (2 ml /Kg b.w.) in corn oil 1:1 V/V twice a week for four weeks. Group one was given only corn oil and served as a negative control group. Groups 2, 3 and 4 were pretreated with CCl4. Then the feeding experiment was started. Group one and group two were fed on standard diet so that group one was a negative control and group two was a positive control. Group three was fed on a standard diet + 150 g chicory per Kg diet while group four was given standard diet + 150 g sumac per Kg diet. After an experimental period of 8 weeks, blood was withdrawn after overnight fasting and biochemical parameters were analyzed. Activity of serum ALT and AST, serum total protein, serum albumin and serum glucose were estimated. Activity of antioxidant enzymes in liver tissue including superoxide dismutase, glutathione peroxidase and catalase were analyzed. Histopathological examination for liver tissue was done. Results obtained from this study revealed that there was an elevation in activities of s. AST, s. ALT, liver catalase and liver glutathione peroxidase as well as the concentration of s. glucose while there was a decline in the levels of s. total protein, s. albumin and the activity of liver superoxide dismutase in the positive control group. Also, the histopathological examination of liver tissue showed abnormal alterations. All these alternations in the previous parameters were more or less normalized in the groups that were fed on chicory and sumac. Thus it can be concluded that, addition of chicory and sumac to the diet can counteract the hepatotoxicity of CCl4. Consequently, chicory and sumac, those nutrients with high medicinal value, can be used for liver disorders as adjuvant therapy and for those who are exposed to increased oxidative stress that may affect their hepatic function.

Key words: CCl4 hepatotoxicity, antioxidant, chicory, sumac, rats.

Introduction

The liver has a vital role in the main functions of the body (Khan and Sultana, 2009) including detoxification, protein synthesis, and production of biomolecules necessary for digestion. Liver injury induced by various hepatotoxins has been recognized as a major toxicological health problem for years (Thirumalai et al., 2011), since liver is considered as the first target for detoxification and biotransformation of any toxin.

Chronic carbon tetrachloride (CCl4) intoxication is a well-known model for producing oxidative stress and chemical hepatic injury. Its toxic nature is due to its biotransformation in the liver that produces very dangerous hepatotoxic metabolites, such as lipoperoxide and free peroxide radicals that are highly reactive and play an important role in the pathogenesis of various degenerative human diseases such as atherosclerosis, liver disorders, lung and kidney damage, aging and diabetes mellitus (Sahreen et al., 2011 & Ilaiyaraja and Farhath Khanum, 2010). The destructive effects of free radicals are prevented by several natural antioxidant defense mechanisms such as antioxidant enzymes (Superoxide dismutase, catalase and glutathione peroxidase) and biomolecules (glutathione, vitamins E and C). An imbalance between reactive free radical formation and scavenging by antioxidants leads to increased oxidative stress and consequently tissue damage (Khan and Sultana, 2009). It has been assumed that a diet rich in antioxidant strengthens the antioxidant defense system of...
the human body (Stangeland et al., 2009). Chicory and sumac are antioxidant rich edible plants normally consumed in different countries. Chicory leaves have been used in green salad and sumac fruits have been used as a spice. Also, they are of great health value and have been used in folk medicine long times ago (Al-Jassabi & Azirun, 2010).

*Cichorium intybus*, known as “chicory” has been known in Africa and south Asia for several hundred years (Heibatollah et al., 2008). It is grown as a leaf vegetable or salad green in Europe and as a fructose crop in many parts of the world (Ilaiyaraja & Farhath Khanum, 2010). The plant is being used traditionally to cure various ailments in Ayurvedic and Unani systems and found to have enormous applications in food industry as well (Ilaiyaraja & Farhath Khanum, 2010). The leaves are used for easing skin inflammations and swellings, infusions for anemia and digestive disorders and inhibiting the growth of several tumor cell lines (Heibatollah et al., 2008). The whole plant extracts was reported to have anti-diabetic (Pushparaj et al., 2007), antioxidant (Gazzani et al., 2000), antibacterial (Petrovic et al., 2004), antihepatotoxic (Zafar and Ali, 1998), cardioprotective properties (Nayeemunnisa & Kumuda, 2003) and preventing immunotoxicity induced by ethanol (Kim et al., 2002). Inulin, fructooligosaccharides, polyphenols such as chlorogenic acid, caffeic acid derivatives are the main active compounds present in chicory (Kocsis, et al., 2003). However, the scientific studies on the hepatoprotective effects of the leaf of *C. intybus* are very rare although used as folk remedy for treatment in some regions of the world.

Sumac is the common name for a genus (*Rhus*) that contains over 250 individual species of flowering plants in the family Anacardiaceae (Rayne & Mazza, 2007). Its leaves have been used in dying and tanning fine leather for their high tannin content (Chakraborty, et al., 2009). Sumac is also used as a herbal remedy in traditional medicine owing to its antifibrogenic, antifungal, anti-inflammatory, antimalarial, antimicrobial, antimitagenic, antioxidant, antithrombin, antitumorigenic, antiviral, cytotoxic hypoglycaemic, leukopenic (Rayne and Mazza, 2007) and atheroprotective effects (Zargham & Zargham, 2008). Previous phytochemical studies of this plant reported that it contained flavonoids as quercetin and kaempferol glycosides (Zalacain et al., 2003), tannins, anthocyanins as cyanidin, peonidin, pelargonidin and petunidin (Mavlyanov et al., 1997), phenolic acids as gallic, protocatechuic, p-OH-benzoic and vanillic acids (Mavlyanov et al., 1995) and organic acids and found that sumac can be used as a natural antioxidant (Al-Jassabi & Azirun, 2010).

Most of the previous studies done in this respect mentioned the protective effect of the natural antioxidants against liver injury, but rare or even none highlighted the antitoxic impact of natural antioxidants. The present study aims to investigate the antihepatotoxic effect of the leaves of the two antioxidant rich plants namely; *Cichorium intybus* (chicory) and *Rhus coriaria* (sumac) against CCl4 liver toxicity in rats.

**Materials and Methods**

**Materials:**

Carbon tetrachloride (CCl4) that was used to induce hepatocellular toxicity in this study was obtained from Oxford Laboratory Reagents, India. The *Cichorium intybus* (chicory) and *Rhus coriaria* (sumac) were obtained from the Cairo herbs market, Egypt. Most of the ingredients used for preparation of the diet were obtained from the local market. Ingredients used for formulation of vitamin and salt mixtures were obtained from Fluka (Germany) and BDH (England) Chemical Companies. Skim milk powder was obtained from Irish Dairy Borad, Gratten House, Dublin, Ireland. Kits for determination of different biochemical parameters were obtained from Biodiagnostic Company, Egypt.

Animals used in the biological experiment were obtained from the Central Animal House, National Research Centre, Egypt.

**Methods:**

The leaves of chicory and sumac were dried in an air ventilated oven at 60 C°. The obtained dried plants were then milled in a mechanical grinder (Braun, Germany) into fine powder and used in the feeding experiment.

The standard control diet was prepared according to Reeves et al., (1993) as shown in table (1). The dried powder of each of the two items was added as 150 g for each Kg diet on the expense of starch.
Table 1: Composition of diet of control rats (g/100g diet)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim milk*</td>
<td>42.9</td>
</tr>
<tr>
<td>Sucrose</td>
<td>5</td>
</tr>
<tr>
<td>Cellulose</td>
<td>4</td>
</tr>
<tr>
<td>Corn oil</td>
<td>8</td>
</tr>
<tr>
<td>Salt mixture*</td>
<td>3.5</td>
</tr>
<tr>
<td>Vitamin mixture*</td>
<td>1</td>
</tr>
<tr>
<td>Choline chloride</td>
<td>0.06</td>
</tr>
<tr>
<td>Corn starch</td>
<td>35.5</td>
</tr>
</tbody>
</table>

* Protein content of skim milk was estimated as 31%.

Control diet was prepared according to Reeves et al. (1993).

Salt and vitamin mixtures were prepared according to Reeves et al. (1993).

Thirty two white male albino rats (Sprague Dawley strain) with a body weight ranging from 100 to 130 g were used. Each animal was housed individually in a separate polypropylene cage and maintained in controlled temperature 25 °C. Food and water were allowed ad-libtum to each rat. Animals were divided into 4 groups, each comprising 8 rats. Chronic hepatocellular toxicity was induced in all groups (except for group 1) by oral administration of CCl4 in corn oil 1:1 V/V (2 ml per Kg body weight) twice a week for four weeks as modified from that dose given by Chatterjee et al., (2011). Group 1 received only corn oil and served as the negative control group. Groups 2, 3 and 4 were orally administered with the CCl4 dose twice a week for four weeks. Then, the feeding experiment started as follows:

- **Group 1:** was given the standard diet and served as a negative control.
- **Group 2:** was given the standard diet and served as a positive control.
- **Group 3:** was given the standard diet + 150 g chicory per Kg diet.
- **Group 4:** was given the standard diet + 150 g sumac per Kg diet.

The feeding experiment lasted for 8 weeks. At the end of the experimental period, blood was taken from orbital vein (after overnight fasting) and delivered into tubes, then centrifuged and the resultant serum was kept in freezer at –20 °C until analysis. Liver of each rat was separated and divided into two portions; one portion was immersed in 10% formalin solution for further histopathological examination while the other portion was kept in freezer for the determination of antioxidant enzymes in liver tissue.

Activity of each of ALT and AST in serum was estimated according to the procedures described by Reitman and Frankel (1957). Serum total protein was determined according to Cannon et al., (1974). Serum glucose was estimated as described by Trinder (1969). Serum albumin was determined according to Doumas et al., (1971). Activity of antioxidant enzymes in the liver tissue including; superoxide dismutase (SOD) was determined according to the method described by Nishikimi et al., (1972), glutathione peroxidase was estimated according to the method of Paglia and Valentine (1967) and catalase was estimated as described by Aebi (1984). The concentration of all of the previously mentioned biochemical parameters were measured by a colorimetric technique using a spectrophotometer (Shimadzu UV-2401 PC, Australia).

A portion of liver tissue in each group of rats was selected and fixed in 10% formalin diluted with distilled water and processed for paraffin embedding. Sections were stained with hematoxylin and eosin and examined under microscope.

**Statistical analysis:**

Results were analyzed statistically using the computerized program SPSS version "17". The independent student "T" test was done. Data were represented as mean ± SE. Significance was considered at a level of 0.05.

**Results:**

Table (2) illustrated all the analyzed biochemical parameters for all studied groups. Significant differences were observed between the negative control and the positive control for all parameters.

As shown in fig. (1), activities of serum AST and ALT were significantly elevated in positive control compared to negative control group (92.16 ± 4.686 U/L & 46.66 ± 2.728 U/L for AST and 74.83 ± 3.664 & 24.58 ± 3.034 U/L for ALT, respectively), indicating liver damage. However, this increase was lower in rats receiving chicory or sumac with the diet. The values obtained for rats receiving either the chicory or the sumac were significantly lower than that of the positive control, but still higher than that of the negative control. The values of AST for chicory and sumac were 66.5 ± 1.58 & 71.16 ± 3.218 U/L, respectively and for ALT were 27.33 ±1.2 & 30.16 ± 2.271 U/L, respectively.
Table 2: Concentration of serum AST, ALT, glucose, total proteins, albumin, and activities of the liver tissue antioxidant enzymes; SOD, CAT and GPx for all groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Serum</th>
<th>Liver Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AST U/L</td>
<td>ALT U/L</td>
</tr>
<tr>
<td>Negative control</td>
<td>46.66 ± 2.728</td>
<td>24.58 ± 3.034</td>
</tr>
<tr>
<td>Positive control</td>
<td>92.16 ± 4.686</td>
<td>74.83 ± 3.664</td>
</tr>
<tr>
<td>Chicory + SE</td>
<td>66.5 ± 1.58</td>
<td>27.33 ± 1.2</td>
</tr>
<tr>
<td>Sumac + SE</td>
<td>71.16 ± 3.218</td>
<td>30.16 ± 2.271</td>
</tr>
</tbody>
</table>

*P1: compared to the negative control. P2: compared to the positive control.*

Fig. 1: Activities of serum ALT and AST (U/L) in control and other treated groups.

Fig. 2: Concentration of serum glucose (mg/dl) in control and treated groups.

The concentration of serum glucose, as shown in fig. (2), was elevated significantly in the positive control compared to the negative control with values of 117.3 ± 2.210 & 76.42 ± 1.312 mg/dl, respectively. This elevation was reduced in the chicory and sumac treated groups but still significantly higher than the negative control in case of chicory (104.6 ± 5.1 mg/dl) and became more or less similar to the negative control in case of the group that received sumac (80.24 ± 3.057 mg/dl).

Values recorded for total protein was illustrated in fig. (3), which showed significant reduction in total protein for the positive control compared to the negative control (8.966 ± 0.438 & 11.05 ± 0.235 g/dl,
respectively). The group receiving chicory showed a slight insignificant increase compared to the positive control (9.25 ± 0.34 & 8.966 ± 0.438 g/dl, respectively) but no change in case of sumac was observed when compared to the positive control (8.714 ± 0.226 & 8.966 ± 0.438 mg/dl, respectively).

![Fig. 3: Concentration of serum total protein (g/dl) in control and other treated groups.](image)

Figure (4), illustrated concentration of serum albumin for all groups. There was a reduction in albumin for the positive control group compared to that of the negative control group with values of 3.073 ± 0.077 & 4.164 ± 0.172 g/dl, respectively. There was a slight improvement in the level of albumin in case of groups receiving chicory and sumac compared to the positive control. This increase was significant in the group of chicory compared to the positive control (3.79 ± 0.16 & 3.073 ± 0.077, g/dl, respectively) but insignificant in the group of sumac compared to the positive control (3.308 ± 0.152 & 3.073 ± 0.077, g/dl, respectively).

![Fig. 4: Concentration of serum albumin (g/dl) in control and other treated groups.](image)

![Fig. 5: Activity of superoxide dismutase (SOD) (U/gT) in liver tissue in control and other groups](image)
Activities of liver antioxidant enzymes; superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) are illustrated in figures 5, 6 and 7, respectively. There was a significant reduction in the activity of liver SOD in the positive control group compared to that of the negative control group (117.8 ±7.433 & 234.2 ±16.34, U/g tissue, respectively). This reduction was normalized significantly in the groups that received chicory and sumac compared to the positive control (213.2 ±6.69, 193.5 ±14.35 & 117.8 ±7.433 U/g tissue, respectively) and became near the values reported for the negative control. Activities of both liver CAT and GPx were increased significantly in positive control compared to negative control with values of 1.483 ± 0.031 & 1.039 ± 0.018 U/g tissue, respectively for CAT and 52.53 ±2.11 & 38.36 ±1.456 U/g tissue, respectively for GPx. This increase was lowered in groups that received chicory and sumac so that there was a significant decrease for the group of chicory compared to the positive control in case of CAT (1.064 ±0.026 & 1.483 ±0.031 U/g tissue, respectively). While, there was a significant reduction in the activity of GPx in groups which received chicory or sumac compared to the positive control (37.06 ±1.563, 43.35 ±1.669 & 52.53 ±2.11 U/g tissue, respectively) and became more or less similar to the negative control insignificantly in case of chicory but still higher than the negative control significantly in case of sumac.

Histopathological study of liver from the negative control group animals showed a normal hepatic architecture with distinct hepatic cells and sinusoidal spaces (fig. 8A). However, positive control or CCl4-intoxicated group of animals exhibited severe histopathological changes (fig. 8 B-E), such as marked dilatation and congestion of central vein (fig. 8B), diffuse vacuolar degeneration of hepatocytes (fig. 8C), sporadic cell necrosis with eosinophilic cytoplasm and pyknotic nuclei (fig. 8D), necrosis of hepatocytes with atrophy of hepatic cord (fig. 8E), portal infiltration with mononuclear cells (fig. 8F). Histopathological examination of liver in the CCl4 treated group that received either chicory or sumac illustrated in (fig. 9 A-F). Liver tissue examination in the group that received chicory (fig. 9 A-C) showed normal size of central vein and preserved hepatic cells, few cells showed necrosis (fig. 9A), formation of newly formed bile ductuelles and oval cell hyperplasia (fig. 9B), that were insinuated between hepatic cords (fig. 9C). In the CCl4 treated group that received sumac (fig. 9 D-F), examination showed mild vaculation of hepatocellular cytoplasm as well as slight activation of kupffer cells (fig. 9D). Portal area revealed congestion of portal b. v. with perivascular aggregation of mononuclear cells (fig. 9E), hyperplasia of biliary epithelium (fig. 9F).
Fig. 8: Light photomicrographs of livers in rats (A-F). In control group normal hepatocytes (8A). In diseased group (8B-8F) liver showed marked dilatation and congestion of central vein (8B), diffuse vacuolar degeneration of hepatocytes, (fig. 8C), sporadic cell necrosis with eosinophilic cytoplasm and pyknotic nuclei (8D), necrosis of hepatocytes with atrophy of hepatic cord (8E), portal infiltration with mononuclear cells (8F) (H & E, 400X).

Fig. 9: Light photomicrographs of livers in rats (A-F). In chicory group liver tissue the C. V. normal in size, most of the hepatocytes appeared normal in size and shape except for few cells showed necrosis (9A), area show congestion of portal b. v. , formation of newly formed bile ductuales and oval cell hyperplasia (9B), that were insinuated between hepatic cords (9C). In sumac group liver showed mild vacudation of hepatocellular cytoplasm as well as slight activation of kupffer cells (9D). Portal area revealed congestion of portal b. v. with perivascular aggregation of mononuclear cells (9E), hyperplasia of biliary epitheliur (9F) (H & E, 400X).

Discussion:

The role of oxidative stress as etiological factor for many diseases such as aging, cancer, coronary heart disease, atherosclerosis, liver disorders, lung and kidney damage and diabetes mellitus has been highlighted (Dew et al., 2005 and Ilaiyaraja & Farhath Khanum, 2010). The human body has an antioxidant defense system and it has been assumed that a diet rich in antioxidant strengthens this system (Stangeland et al., 2009).

The liver is the main organ concerned with detoxification and biotransformation of any toxin. Meanwhile, during the metabolic processes, excessive free radicals are generated and may also cause liver damage. Thus liver is exposed to injury more than any other organ in the body. Liver diseases are a serious health problem
showed that there was a significant decrease in the activity of the antioxidant enzyme SOD in the liver tissue of CCl4 treated animals which could be due to the feedback inhibition or oxidative inactivation of enzyme protein. Peroxidative degradation of membrane lipids of endoplasmic reticulum rich in polyunsaturated fatty acids leads to the formation of lipid peroxides that cause damage to the membrane and alter cellular function. Lipid peroxidation has been proposed to disrupt cellular membrane, resulting in loss of membrane integrity, and may lead to leakage of ALT and AST and increasing their activities in the plasma (Recknagel et al., 1989). The plasma transaminases (ALT and AST) are known to be increased significantly in rats after exposure to toxic doses of CCl4 (Agarwal and Mehendale 1983). The increased activities of ALT and AST observed in CCl4-treated rats in this study corresponded to the extensive liver damage induced by the toxin and this result is in consistence with the above explanation. The tendency of these enzymes to return towards a near normal level in groups receiving either chicory or sumac is a clear manifestation of antihepatotoxic effect of these items which depends on their strong antioxidant activity that exert membrane stabilizing effect on hepatic cells. Similar findings were found by Heibatollah et al., (2008) who reported that leaf extract of chicory exerted hepatoprotective effect in rats intoxicated with CCl4 documented by lowering the increased activity of serum ALT and AST back to near the normal levels. The main active compounds of chicory are: inulin, fructooligosaccharides, caffeic acid derivatives, five other hydroxycinnamic acids and eight flavonoids (e.g.; quercetin, kaempferol, luteolin and apigenin glycosides) (Kocsis et al., 2003 and Mehmood et al., 2012). The strong antioxidant activity of the aforementioned polyphenols is responsible directly for antihepatotoxic activity of chicory. Also, sumac was reported to have antioxidant activity due to its content of phytochemicals (flavones, tannins, anthocyanins, phenolic acids; mainly gallic acid and organic acids) that explains its antihyperglycemic activity (Al-Jassabi and Azirun, 2010).

Hypoalbuminemia and decline in total protein content were noticed as a result of intoxication of hepatocytes with CCl4 in the positive control group reflecting the decline in the liver function due to the hepatocellular damage. Aniya et al., (2005) reported similar results. Addition of either chicory or sumac to the diet resulted in improvement of these two parameters.

As a result of liver cell injury the blood glucose is elevated in the positive control reflecting the toxic effect of CCl4 on hepatocytes that lead to impairment of liver metabolism and that result is in consistent with other investigators (Pingale, 2009). Addition of sumac to the diet returned the blood glucose levels back to near the normal levels that became insignificantly different from the normal control. Meanwhile, addition of chicory decreased the blood glucose level significantly compared to the positive control but still significantly higher than the normal control. Previous studies on chicory extracts and formulations containing its roots or leaves revealed that, they produce antihyperglycemia (Petlevski et al., 2003). This hypoglycemic effect of the two added food items was attributed to their strong antioxidant activity.

To prevent the damage caused by oxygen-free radicals, tissues have developed an antioxidant defense system that includes nonezymatic antioxidants (e.g., glutathione, vitamins C and E) and enzymatic activities such as that of superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GSH-Px). SOD catalyzes dismutation of the superoxide anion (O2-) into H2O2 and GSH-Px and CAT both detoxify H2O2 and convert lipid hydroperoxides to nontoxic alcohols (Szymonic-Lesiuk et al., 2003). The results from this study showed that there was a significant decrease in the activity of the antioxidant enzyme SOD in the liver tissue of CCl4 treated animals which could be due to the feedback inhibition or oxidative inactivation of enzyme protein due to excess ROS generation (Prabha & Annapoorni, 2009). Decreased SOD activity was reported by Marzouk et al., (2011) and is in agreement with the data observed in this study.

On the other hand, there was a significant increase in the activity of the CAT and GPx in the liver tissue of CCl4 treated animals which could be a defense mechanism of the tissue to counteract the free radicals resulting from increasing oxidative stress. This may resulted in increasing the scavenging mechanisms of the enzymatic antioxidant system. The activities of these antioxidant enzymes were more or less corrected in the groups that were fed on diet supplemented with either chicory or sumac. This may be attributed to the convenience due to availability of the antioxidants present in either chicory or sumac. Epidemiological studies have suggested associations between the consumption of polyphenol-rich foods and prevention of diseases (Diplock et al., 1998). It was reported by many investigators that under pathological conditions, the efficiency of the antioxidant defense mechanism is altered and over production of free radicals causes imbalance among free radicals and antioxidants, consequently when the former takes over the latter, it leads to tissue damage (Halliwell, 1994). Depending on these findings, the role of chicory and sumac as antioxidants to counteract the deleterious effect of CCl4 on the liver tissue could be explained. Similar findings was reported by Abbass et al., (2012) who stated that one of the main constituents of sumac is gallic acid, which possesses potent antioxidant properties. More
over, Heibatollah et al., (2008) reported that C. Intybus exerted hepatoprotective action on the liver tissue of CCl4 treated animals due to its membrane stabilizing effect on hepatic cells by the antioxidant effect of this plant extract.

Histopathological changes that were observed in the liver tissue of CCl4 treated rats were ameliorated in the groups of rats pretreated with CCl4 and fed on diet supplemented with either chicory or sumac reflecting that regeneration of hepatocytes occurred upon treatment with the two plants. These findings supported the biochemical findings in this study.

From the present study, it can be concluded that addition of chicory or sumac to the diet of rats that were treated with CCl4 more or less counteract the hepatotoxic action of CCl4 to various extent. This may indicate that consumption of these nutrients concomitant with the treatment of hepatic patients may be helpful for the recovery than the medical treatment alone. These two dietary items are also beneficial for those who are exposed to increased oxidative stress that may negatively affect their hepatic function.

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Reference


