LIVER DISEASE STUDIES

Cnidoscolus aconitifolius Leaf Extract Protects against Hepatic Damage Induced by Chronic Ethanol Administration in Wistar Rats

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Abstract — Aims: This study focused on the possible protective effect of Cnidoscolus aconitifolius leaf extract (CA) against hepatic damage induced by chronic ethanol administration in rats. Methods: Male Wistar rats were distributed into seven groups of six rats each. The first group was the control, second group received 20% ethanol-only (7.9 g/kg), third and fourth groups were pre-treated with CA (100 and 200 mg/kg, respectively) before treatment with ethanol. The fifth and sixth groups received CA and kolaviron (KV; 200 mg/kg), respectively, while the seventh group received KV and ethanol. KV served as the reference antioxidant. Results: Ethanol-treated rats had significantly (P<0.05) elevated serum and liver post-mitochondrial malondialdehyde, an index of lipid peroxidation. Ethanol toxicity lowered the antioxidant defense indices, such as reduced glutathione (GSH), superoxide dismutase (SOD) and catalase (CAT). Specifically, the activities of hepatic SOD and CAT decreased by 48 and 51%, respectively, while the level of GSH decreased by 56%. In addition, serum total cholesterol, triglycerides and low-density lipoproteins-cholesterol levels were significantly (P<0.05) elevated in ethanol-treated rats. Also, significant (P<0.05) elevation in serum alanine and aspartate aminotransferases, and γ-glutamyl transferase activities were observed in ethanol-treated rats. Supplementation with CA significantly (P<0.05) decreased the activities of liver marker enzymes, stabilized the lipid profiles and restored the antioxidants status of ethanol-treated rats. The activities of CA were comparable with KV in the ethanol-treated rats. This observation was supported by histopathological examination of liver slides. Conclusion: These findings suggest the hepatoprotective and antioxidant effects of CA leaf extract, which offered protection against ethanol-induced toxicity.

INTRODUCTION

Alcohol is one of the oldest drugs that humans have used since the beginning of civilization. High alcohol consumption results in critical problems in the body including alcohol liver diseases (ALDs) (Pari and Karthikesan, 2007). Many pathways are thought to be involved in ALD, including oxidative stress and mitochondrial damage (Stewart et al., 2001). Reactive oxygen species (ROS) are continuously produced in biological system by the action of mitochondrial electron transport system and nicotinamide adenine dinucleotide phosphate oxidase (Cadenas et al., 1997), even during alcohol metabolism. This holds true for the production of superoxide anion radicals, hydrogen peroxide and hydroxyl radicals (Koch et al., 1991; Reinke et al., 1997). These ROS are cellular renegades, and can wreak havoc in biological system by tissues damage, altering biochemical compounds, corroding cell membranes and killing out rightly (Wiseman and Halliwell, 1996). Therefore, an important intervention to counteract the oxidative challenges against liver during chronic alcohol consumption is to reinforce endogenous antioxidant defense mechanisms (Koch et al., 2000). Recently, herbs have attracted attention as health-beneficial foods (physiologically functional foods) and as source materials for drug development. Herbal medicines derived from plant extracts are being utilized increasingly to treat a wide variety of clinical diseases, although relatively little is known regarding their modes of action. Studies have shown that commonly consumed medicinal plants are good sources of polyphenols, saponins, flavonoids and phenyl propanoids, which are active in vivo antioxidants and may boost the endogenous antioxidant defense system (Koch et al., 2000).

Cnidoscolus aconitifolius is a drought deciduous shrub that is mainly cultivated for food because of its important medicinal value. A wide variety of the folkloric use of this herb in ethno medicine includes treatment for alcoholism, insomnia, gout, scorpion stings and as cure for brain and vision improvement (Atuahene et al., 1999). Basic research involving animal models have shown that this herb attenuates renal dysfunction caused by ethanol toxicity, and also exhibits insulinogenic property in inbred type-2 diabetic mice, and it elicits hepatoprotective activity in rats intoxicated with mega dose of paracetamol (Oladeinde et al., 2007; Oyagbemi and Odetola, 2010; Adaramoye and Aluko, 2011). In view of the reputed efficacies of this vegetable plant, this present work studied its possible protective effects against hepatic damage induced by chronic ethanol administration in Wistar albino rats.

MATERIALS AND METHODS

Chemicals

Trichloroacetic acid and thiobarbituric acid (TBA) were purchased from BDH Chemical Ltd, Poole, UK. Absolute ethanol and hydrogen peroxide were procured from Sigma Chemical Co., Saint Louis, MO, USA. Other reagents were of analytical grade and purest quality available.

Animals

Inbred 6 weeks old male Wistar albino rats weighing between 170 and 180 g were purchased from the animal house of the Department of Veterinary Physiology, Biochemistry and Pharmacology, University of Ibadan, Nigeria. The animals were kept in well-ventilated cages at room temperature (28–30°C) and under controlled light cycles (12 h light/12 h dark). They were maintained on...
normal laboratory chow (Ladokun Feeds, Ibadan, Nigeria) and water ad libitum. This study was approved by University of Ibadan Animal Ethical Committee (UI-008035). Rats handling and treatments conform to the guidelines of the National Institute of Health (NIH publication 85-23, 1985) for laboratory animal care and use.

Preparation of plant extract

Fresh leaves from C. aconitifolius were collected from the premises of University of Ibadan, Nigeria. The botanical identification was carried out at the herbarium in the Department of Botany, University of Ibadan, Nigeria, where a voucher specimen already exists. About 3 kg of the air-dried leaf was extracted in a soxhlet extractor at 30°C using methanol for 5 h. The extract was concentrated under reduced pressure in vacuum at 35°C for 30 min using a rotary evaporator. The resulting residue called C. aconitifolius leaf extract (CA) was transferred to a hot air oven where it was dried to a constant weight at 40°C. The yield of the preparation was 19.5% (w/w). Prior to the experiments, CA was dissolved in corn oil overnight and was administered to the animals according to their weights.

Study design

Forty-two male albino rats (Wistar strain) were randomly distributed into seven groups of six animals each. Animals were given a period of 2 weeks for acclimatization before the experiment. The first group served as the control and was given corn oil (Vehicle for drugs). The second group received 20% ethanol-only (7.9 g/kg) for 8 weeks. The third and fourth groups were pre-treated for 2 weeks with CA at doses of 100 and 200 mg/kg, respectively, before treatment with 20% ethanol (7.9 g/kg) for the next 8 weeks. The fifth and sixth groups were treated with CA and kolaviron (KV), respectively, at a dose of 200 mg/kg throughout the duration of the study. The seventh group was pre-treated for 2 weeks with KV at a dose of 200 mg/kg before treatment with 20% ethanol (7.9 g/kg) for the next 8 weeks. Previous studies revealed that KV was very effective at 200 mg/kg body weight and thus informed the choice of the dosage for this study (Adaramoye et al., 2005). KV was prepared with corn oil, and absolute ethanol (95%) was diluted with distilled water to 20% and given at a dose of 7.9 g/kg according to Rajakrishnan et al. (1997) and Arulmozhi et al. (2010). All drugs were administered daily to the animals by oral gavage.

Preparation of tissue

Rats were sacrificed 24 h after the last dose of drugs and an overnight fast by cervical decapitation under light ether anaesthesia. Liver samples were quickly removed and washed in ice-cold 1.15% KCl solution, dried and weighed. A section of the liver sample was fixed in 10% formalin. Other parts were homogenized in four volumes of 50 mM phosphate buffer, pH 7.4 and centrifuged at 10,000 g for 15 min to obtain post-mitochondrial supernatant fraction (PMF). The samples were stored at −80°C until used. All procedures were carried out at temperature of 0–4°C. The antioxidant status of the animals was investigated in the PMF.

Preparation of serum

Blood was collected from the inferior vena cava of heart of the animals into plain centrifuge tubes and was allowed to stand for 1 h. Serum was prepared by centrifugation at 3000 g for 15 min in a Beckman Bench Centrifuge. The clear supernatant was used for the estimation of serum enzymes and lipid profile of the animals.

Biochemical assays

Serum and liver protein levels were determined according to the method of Lowry et al. (1951) using bovine serum albumin as standard. Serum alanine and aspartate aminotransferases (ALT and AST) activities were assayed by the combined methods of Mohun and Cook (1957) and Reitman and Frankel (1957). PMF γ-glutamyl transferase activity was assayed using Bayer diagnostic kit according to the method of Fossati et al. (1986). The estimation of serum alkaline phosphatase (ALP) activity was based on the method of King and Armstrong (1988). ALP activity was measured spectrophotometrically by monitoring the concentration of phenol formed when ALP reacts with disodium phenyl phosphate at 680 nm. Serum total bilirubin level was assayed by the method of Rutkowski and Debaru (1966), the method involved the reaction between bilirubin and diazotized sulphanilic acid in alkaline medium to form a blue colored complex, which was read spectrophotometrically at 546 nm. Both serum and PMF lipid peroxidation levels were assayed by the reaction between 2-TBA and malondialdehyde (MDA), an end product of lipid peroxides as described by Walls et al. (1976). PMF reduced glutathione (GSH) level was assayed by measuring the rate of formation of chromphoric product in a reaction between 5,5-dinitrois-2-nitrobenzoic acid and free sulphhydril groups at 412 nm as described by Moron et al. (1979). PMF superoxide dismutase (SOD) activity was measured by the nitro blue tetrazolium reduction method of McCord and Fridovich (1969). PMF catalase (CAT) activity was assayed spectrophotometrically by measuring the rate of decomposition of hydrogen peroxide at 240 nm as described by Aebi (1974). Serum triglyceride (TG) and cholesterol levels were assayed using commercial diagnostic kits (Randox). For the determination of high-density lipoprotein (HDL) level, very low-density lipoprotein and low-density lipoprotein (LDL) lipoproteins were precipitated by addition of phosphotungstic acid and magnesium chloride. After centrifugation, the supernatant containing the HDL fraction was assayed for cholesterol using Randox diagnostic kit. LDL-cholesterol (LDL-C) was calculated using the formula of Friedewald et al. (1972).

Histopathology of liver slices

Liver fragments fixed in 10% formalin were dehydrated in ethanol (95% absolute) and then cleared in xylene before embedded in paraffin. Micro sections (4 µm) were prepared and stained with haematoxylin and eosin (H&E) dye, and were examined under a light microscope.

Statistical analysis

All values were expressed as the mean ± S.D. of six animals per group. Data were analyzed using one-way ANOVA followed by the post hoc Duncan multiple range test for
analysis of biochemical data using SPSS (10.0). Values were considered statistically significant at \( P < 0.05 \).

RESULTS

Phytochemical analysis of methanolic extract of C. aconitifolius

The phytochemical screening of CA revealed the presence of some bioactive compounds in the plant. Seven bioactive constituents were tested, out of which four tested positive in CA. Analysis of tannins, alkaloids, flavonoids and saponins were positive, while phlobatannins, anthraquinones and cardiac glycosides were completely absent in the extract (Table 1).

Effects of CA on ethanol-induced changes in lipid profiles of rats

The administration of 20% ethanol (7.9 g/kg body weight for 8 consecutive weeks) caused a significant increase \( (P < 0.05) \) in the serum total cholesterol (TC) and TGs of the animals compared with the control group (Fig. 1). Precisely, (TC) and TGs were increased by 107 and 136%, respectively. Furthermore, serum LDL-C level of ethanol-treated rats increased by 83% relative to controls (Table 2). In contrast, administration of ethanol significantly \( (P < 0.05) \) decreased the serum HDL-cholesterol (HDL-C) level of the animals (Table 2). Simultaneous administration of CA (100 and 200 mg/kg) or KV and ethanol significantly reduced \( (P < 0.05) \) the hypercholesterolemia and hypertriglyceridemia in these animals (Fig. 1). However, CA at 200 mg/kg alone significantly \( (P < 0.05) \) reversed the adverse effect of ethanol on serum LDL- and HDL-C levels (Table 2). There were no significant differences \( (P > 0.05) \) in serum protein levels of ethanol-treated rats and others (Table 2).

Effects of CA on ethanol-induced changes in serum and PMF antioxidant status of rats

Table 2 shows that administration of ethanol to rats for 8 consecutive weeks caused a significant \( (P < 0.05) \) decrease in the activities of PMF SOD and CAT, and the level of reduced GSH when compared with the control. Specifically, the activities of SOD and CAT decreased by 48 and 51%, respectively, while the level of GSH decreased by 56% in ethanol-treated rats. However, treatment with either KV or CA at 200 mg/kg caused a significant \( (P < 0.05) \) increase in the GSH, SOD and CAT levels of the ethanol-treated rats. In addition, Fig. 2 revealed a discernable elevation in the serum and PMF lipid peroxidation reflected by the increase in MDA contents in the ethanol-treated rats when compared with the control. In the ethanol-treated rats, MDA increased by 98 and 87% in the serum and PMF, respectively. However, treatment with either KV or CA at 200 mg/kg significantly \( (P < 0.05) \) ameliorated the increased serum and PMF lipid peroxidation.

Effects of CA on ethanol-induced changes in the liver function of rats

Figures 3–5 show that the administration of 20% ethanol at a dose of 7.9 g/kg to rats for 8 weeks caused a significant \( (P < 0.05) \) elevation of markers of liver function such as serum ALP, ALT and AST and gamma glutamyl transferase (GGT) when compared with the control. Treatment of ethanol-intoxicated rats with either CA or KV at a dose of 200 mg/kg, significantly \( (P < 0.05) \) augmented the ethanol-induced elevation in these biochemical indices. Furthermore, ethanol-induced increase in serum total bilirubin levels were significantly \( (P < 0.05) \) reduced in animals co-treated with KV or CA (100 and 200 mg/kg; Fig. 6).

Effects of CA on ethanol-induced histopathological changes in rats

Figure 7 shows representative photomicrographs of liver slides from rats treated with ethanol alone, ethanol with CA or KV and those treated with either CA or KV alone. The slides of control animals showed normal architecture without any visible lesions. The impaired biochemical function induced by chronic ethanol administration was also confirmed by microscopic examination of the liver from ethanol-treated rats. Liver injury caused by chronic ethanol administration includes marked hepatic necrosis, severe portal and central venous congestion, with multifocal portal cellular infiltration. Furthermore, in slides of rats treated simultaneously with ethanol and KV or CA at 200 mg/kg, there were no visible lesions but just mild cellular infiltration could be seen. Similarly, slides from rats treated with CA or KV alone shared similar histopathological appearance with the control.

DISCUSSION

It is obvious that chronic ethanol administration produced liver toxicity in rats, which was monitored by both biochemical and histopathological parameters. Numerous studies indicate that free radicals such as hydroxyl-ethyl radical, superoxide and hydroxy radicals are responsible for ethanol-induced oxidative stress (Hoak and Pastirino, 2002). All these radicals formed from ethanol-mediated process have a great potential to react rapidly with lipids, which in turn leads to lipid peroxidation. Various pathways implicated in ethanol-induced oxidative stress include; changes in NAD+/NADH ratio, acetaldehyde protein adducts formation, induction of CYP2E1, formation of 1-hydroxy ethyl free radicals, ethanol-mediated mitochondrial damage, endotoxin-derived activation of Kupffer cells with subsequent production of tumor necrosis factor-alpha (TNF-\( \alpha \)) and decrease in the cellular antioxidant defense (Sergent et al., 2001).

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Table 1. Phytochemical constituents of C. aconitifolius leaf methanolic extract

<table>
<thead>
<tr>
<th>Bioactive compounds</th>
<th>Methanolic extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>+</td>
</tr>
<tr>
<td>Tannins</td>
<td>++</td>
</tr>
<tr>
<td>Phlobatannin</td>
<td>+</td>
</tr>
<tr>
<td>Saponins</td>
<td>++</td>
</tr>
<tr>
<td>Anthraquinones</td>
<td>–</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+++</td>
</tr>
<tr>
<td>Cardiac glycosides</td>
<td>–</td>
</tr>
</tbody>
</table>

–, Absence. +, Presence.
The effect of *C. aconitifolius* on the levels on serum TC and TG in rats treated with ethanol. Asterisk denotes significantly different from control (*P* < 0.05). Double asterisk denotes significantly different from Et (*P* < 0.05). Et, ethanol; CA1, *C. aconitifolius* at 100 mg/kg; CA2, *C. aconitifolius* at 200 mg/kg; KV, kolaviron.

**Table 2. The effect of *C. aconitifolius* leaf extract on the levels of serum protein, HDL-C, LDL-C, hepatic reduced GSH and the activities of hepatic SOD and CAT of rats treated with ethanol**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Serum (mg/dl)</th>
<th>PMF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protein</td>
<td>HDL-C</td>
</tr>
<tr>
<td>Control</td>
<td>3.06 ± 0.54</td>
<td>19.8 ± 4.30</td>
</tr>
<tr>
<td>Et</td>
<td>2.83 ± 0.60</td>
<td>10.1 ± 3.36*</td>
</tr>
<tr>
<td>Et + CA1</td>
<td>3.11 ± 0.71</td>
<td>12.0 ± 3.15*</td>
</tr>
<tr>
<td>Et + CA2</td>
<td>2.93 ± 0.65</td>
<td>16.9 ± 5.01**</td>
</tr>
<tr>
<td>CA</td>
<td>3.13 ± 0.49</td>
<td>18.1 ± 4.57**</td>
</tr>
<tr>
<td>KV</td>
<td>2.80 ± 0.55</td>
<td>18.6 ± 4.07**</td>
</tr>
<tr>
<td>Et + KV</td>
<td>2.91 ± 0.63</td>
<td>16.6 ± 3.25**</td>
</tr>
</tbody>
</table>

Et, ethanol; CA1, *C. aconitifolius* at 100 mg/kg; CA2, *C. aconitifolius* at 200 mg/kg; KV, kolaviron; SOD, superoxide dismutase; CAT, catalase; GSH, reduced glutathione; PMF, post-mitochondrial fraction.

*Significantly different from control (*P* < 0.05).

**Significantly different from Et (*P* < 0.05).

The effect of *C. aconitifolius* on the levels of serum and liver PMF lipid peroxidation in rats treated with ethanol. Asterisk denotes significantly different from control (*P* < 0.05), double asterisk denotes significantly different from Et (*P* < 0.05). Et, ethanol; CA1, *C. aconitifolius* at 100 mg/kg; CA2, *C. aconitifolius* at 200 mg/kg; KV, kolaviron, MDA, malondialdehyde.
Fig. 3. The effect of *C. aconitifolius* on the activities of serum ALT and AST in rats treated with ethanol. Asterisk denotes significant different from control ($P < 0.05$), double asterisk denotes significantly different from Et ($P < 0.05$). Et, ethanol; CA1, *C. aconitifolius* at 100 mg/kg; CA2, *C. aconitifolius* at 200 mg/kg; KV, kolaviron.

Fig. 4. The effect of *C. aconitifolius* on the activities of serum ALP in rats treated with ethanol. Asterisk denotes significant different from control ($P < 0.05$), double asterisk denotes significantly different from Et ($P < 0.05$). Et, ethanol; CA1, *C. aconitifolius* at 100 mg/kg; CA2, *C. aconitifolius* at 200 mg/kg; KV, kolaviron.

Fig. 5. The effect of *C. aconitifolius* on the activities of serum GGT in rats treated with ethanol. Asterisk denotes significant different from control ($P < 0.05$), double asterisk denotes significantly different from Et ($P < 0.05$). Et, ethanol; CA1, *C. aconitifolius* at 100 mg/kg; CA2, *C. aconitifolius* at 200 mg/kg; KV, kolaviron.
AST and ALT are the reliable makers for liver function. It is established that AST can be found in the liver, cardiac muscle, skeletal muscle, kidney, brain, pancreas, lungs, leukocytes and erythrocytes, whereas ALT is predominantly present in the liver (Rej, 1997). The increased levels of serum enzyme such as AST and ALT indicate an increased permeability and damage and/or necrosis of hepatocytes (Goldberg and Watts, 1965). The membrane bound enzymes like ALP and GGT are released into bloodstream depending on the pathological phenomenon (Sillanaukee, 1996). In our study, we found that chronic ethanol consumption caused a significant increase in the activities of AST, ALT, ALP and GGT, which could be as a result of severe damage to the hepatocytes of ethanol-treated animals, thereby causing these enzymes to leak into the plasma. The decreased activities of these enzymes in ethanol-treated rats given CA or KV indicate the possible hepatoprotective effect of CA or KV. This observation is supported by the recent report of Oyagbemi and Odetola (2010), which showed that CA has protective effect against paracetamol-induced hepatic damage in rats. Therefore, our results showed that supplementation of CA or KV attenuated chronic ethanol-induced liver injury evidenced by significant reduction in the activities of serum ALT, AST, ALP and GGT.

GSH acts as a free radical scavenger and regenerator of alpha-tocopherol and plays a significant role in sustaining protein sulfhydryl groups (Glantzounis et al., 2005). Decreased hepatic GSH contents result in increased susceptibility to hepatic injury via induction of lipid peroxidation and TNF-α (Colell et al., 2001). GSH is the main antioxidant...
found in liver cells and plays a protective role in the metabolism of a large number of toxic agents, including ethanol. Many studies assessing the status of hepatic GSH in response to ethanol exposure have shown that both acute and chronic exposure to ethanol cause time-dependent and dose-dependent decreases in hepatic GSH contents (Song et al., 2006). Enhanced ethanol toxicity has been associated with decreased hepatic GSH, which may reflect the depletion of GSH by the overproduction of ROS and subsequent oxidative stress caused by ethanol (Khanal et al., 2009). The result from our study is in line with previous studies that ethanol toxicity caused depletion of hepatic GSH. Our results showed that CA or KV supplementation significantly inhibited the ethanol-induced depletion of hepatic GSH. However, CA or KV treatment alone did not affect hepatic GSH levels. These findings further suggest that the hepatoprotective effect of CA or KV against ethanol is related to the increase in cellular GSH content. In addition, our results showed that CA or KV significantly prevented ethanol-induced elevation of inflammatory infiltrates in histopathological analysis. These anti-inflammatory effects of CA or KV may play an important role in protecting the animals against ethanol-induced hepatotoxicity.

Lipid peroxidation is accepted as one of the principal causes of ethanol-induced liver injury mediated by the production of free radical derivatives. Chronic and acute ethanol administration has been studied in both animal models and human clinical trials to assess relationship between oxidative stress and hepatic lipid peroxidation (Zhou et al., 2002). In agreement with these findings, our results show increased levels of MDA in the serum and liver of alcoholic rats when compared with controls. On the other hand, treatment with CA or KV caused a significant decline in the levels of lipid peroxidation products. This protective effect is probably based on the antioxidant activity of CA or KV, which reduced the oxidative damage by blocking the production of free radicals, and thus inhibited lipid peroxidation. In this study, we also observed a significant decrease in the activities of free radical scavenging enzymes; SOD and CAT, which are the first line of defense against oxidative injury. This is not strange, since ethanol oxidation by CYP2E1 produces 1-hydroxy ethyl radicals, which have been shown to inactivate several proteins including antioxidant enzyme system (Epstein, 1996). The inhibition of antioxidant system may cause the accumulation of H₂O₂ or products of its decomposition (Halliwell, 1994). SOD catalyzes the conversion of superoxide anion into H₂O₂. The primary role of CAT is to scavenge H₂O₂ that has been generated by free radical or by SOD. Importantly, administration of CA or KV restored the activities of enzymatic antioxidants (SOD and CAT) in liver of ethanol-treated rats. CA has been reported to act as an effective antioxidant of great importance against diseases and degenerative processes caused by oxidative stress. The antioxidant property of CA has been linked to the presence of polyphenols, especially flavonoids (Kuti and Konuru, 2004). From these findings, it can be inferred that CA positively modulates the antioxidant status and regenerates the liver to near normal in ethanol-treated rats.

Lipids are a heterogenous group containing active metabolic substances that play an important role in the pathogenesis of alcoholic liver disease. Ethanol is a powerful indicator of hyperlipidemia in both animals and humans (Avogaro and Cazzolato, 1975). The most common lipid abnormalities during chronic alcohol consumption are hypercholesterolemia and hypertriglyceridemia (Baraona et al., 1983), which was confirmed in the present study. Also, in ethanol-treated rats, LDL-C was remarkably increased in the serum, while HDL-C was found to be reduced. The increased cholesterol level during alcohol ingestion is attributed to the increased alpha-hydroxyl methyl glutaryl CoA reductase activity, which is the rate limiting step in cholesterol biosynthesis (Ashakumari and Vijayamal, 1993). Fatty liver results mainly from the accumulation of TG (Cunname, 1987). Increased TG levels after ethanol ingestion may be due to the increased availability of free fatty acid, glycerophosphates, decreased TG lipase activity and decreased fatty oxidation. In the present study, hypertriglyceridemia was confirmed in the serum of ethanol-treated rats. From the above-mentioned observations, we found that supplementation of CA or KV restored the lipid levels of ethanol-treated rats to near normal, which may help reduce the incidence of fatty liver associated with ethanol administration.

In conclusion, supplementation of CA exerts a significant protective effect against hepatic damage induced by chronic ethanol administration in the rats. The protective effect of the extract may be attributed to the active components such as saponins and flavonoids, which elicit antioxidant and detoxifying effects. Therefore, a dietary intake of C. aconitifolius leaf may supply necessary components that offer protection against ethanol-induced toxicity. Further studies are warranted to isolate the active component in this leaf that is responsible for the observed effect.

REFERENCES


