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Hepatoprotective Activity of Methanol Extracts from Artemisia Sieberi Besser (*A. Herba-alba*) Against Ethanol Induced Hepatic Damage Rats

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Abstract: Hepatoprotective effect of methanolic extracts from Artemisia sieberi Besser aerial parts was investigated against ethanol induced-acute hepatotoxicity in experimental rats. They were divided into four groups with 20 rats in each one. Group I: non-hepatotoxic rats received only the vehicle (0.5 $mLkg^{-1}$ body weight) and served as a control group. Group II: rats were orally administered with 2 mL ethanol every alternate day for 30 days to generate hepatotoxity. Groups III: hepatotoxic rats treated with 25 $mgkg^{-1}$ silymarin drug. Group IV: hepatotoxic rats treated with 100 $mgkg^{-1}$ methanol extracts of Artemisia sieberi Besser. All treatments were orally administrated by gavage for 30 consecutive days. At the end of the experiment, the rats of all groups were sacrificed and the excised liver was weighed. Liver enzyme markers (SGOT, SGPT, ALP), total protein, albumin, bilirubin (direct and total) and lipid profile were measured from blood serum samples. As well, the analysis of the CBC was performed on whole blood samples. Results revealed significant increase of the liver enzyme markers, total and direct bilirubin and lipid profile in the hepatotoxic group. Conversely, significant reduction in the liver weight, levels of total protein, albumin and parameters of the CBC panel was also noticed as compared with the control group. However, treatment with methanol extracts significantly enhanced the liver weight and brought back the altered levels of hematological and biochemical markers to the nearby normal levels, compared to those detected in the control and silymarin treated groups. It is concluded from the results of the present study that the methanol extracts of Artemisia sieberi Besser aerial parts possesses hepatoprotective activity against ethanol induced hepatotoxicity in rats.

Key words: Hepatoprotective effect, hepatotoxicity, Artemisia sieberi Besser (*A. Herba-alba*), liver enzymes, hematological parameters, methanol

INTRODUCTION

Liver being a major site of metabolism plays a pivotal role in detoxification of various toxins ingested and or produced during absorption of the food material (Rane *et al*., 2016; Osadebe *et al*., 2012 and Chattopadhyay and Bhattacharya, 2006). The liver is a vital organ with multidimensional functions which supports almost every other organ in the body. The liver is also the main organ for elimination of drugs (Rane *et al*., 2016; Osadebe *et al*., 2012). Liver disorders are the most common health hazard found in developing countries due to dietary habits, alcohol, poor hygiene, unsupervised drug use and smoking. Liver diseases can be none-inflammatory, inflammatory and degenerative. High levels of plasma total Cholesterol (LDL-C) and Triacylglycerol's (TGs) are associated with a high risk of atherosclerosis and cardiovascular disease owing to the insufficiency (Ekaidem *et al*., 2007; Peron, 2016). Hepatotoxicity caused by many toxins Carbon tetrachloride (CCl_4), thioacetamide and acute or chronic alcohol exhaustion various infections like hepatitis A-C and drugs in which are the most common wrongdoer. Free radical production in the alcohol use results in an expansion of hepatitis leading to cirrhosis (Mohan, 2002). The liver can sometimes be damaged by some chemicals called hepatotoxins such as chloroform (Chattopadhyay and Bhattacharya, 2006). There are more than 900 drugs that can lead to hepatotoxicity and is one of the important reasons for some of the drugs withdrawn from the market. Liver toxicity not only occurs from direct toxicity of the primary compound but also from reactive metabolite or immunologically-mediated response. This can affect hepatocytes, biliary epithelial cells and liver vasculature (Singh *et al*., 2011; Swaroop and Gowda, 2012). The hepatotoxic response generated by chemicals depends upon the concentration of the toxicant, distinctive expression of enzymes and the concentration gradient of substance in blood covering the acinus (Dominiczak, 2005). Various plants and polyherbal formulation have hepatoprotective activity. Approximately 160 phytoconstituents and

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other phytochemicals have been claimed to possess hepatoprotective activity (Singh *et al*., 2011). A large number of herbal medicines have the potential to cause liver injury. Bodybuilding products typically cause cholestatic hepatic injury and affected patients are usually young males. Performance enhancing agents are the most commonly implicated agents in the drug-induced liver injury network study. Such supplements typically contain steroids, whose hepatotoxicity potential has been well established (Ekaidem *et al*., 2007; Peron, 2016). There is an acute necessity of reliable hepatoprotective drugs in modern medical practice. The extract of *Trigonella-foenum-graecum* exhibits hepatoprotective potential against rat model induced liver cirrhosis by thioacetamide (Kumar *et al*., 2013). Ozougwa and Eyo (2014), Kadir *et al*. (2013) reported that *Allium cepa* has hepatoprotective effects against paracetamol-induced liver damage in rats. Aqueous bulb extract of *A. cepa* has hepatoprotective effects against hepatotoxicity in adult male albino Wistar rats (Sengupta *et al*., 2011). Ige *et al*. (2011) and Morshedi *et al*. (2011) reported the hepatoprotective potential of *A. cepa* against cadmium-induced hepatotoxicity in rats. Lee *et al*. (2003) and Sadeghifard and Zareian (2009) also reported the hepatoprotective potential of *A. cepa* extract on acetaminophen-induced liver damage in mice. Different extracts from *C. longa* have hepatoprotective activity against CCl_4 and TAA induced toxicity (Shailajan *et al*., 2014; Wang *et al*., 2010; Contreras-Zentella and Hernandez-Munoz, 2016; Ingawale *et al*., 2014). Artemisia has anti-inflammatory (Morshedi *et al*., 2011; Sadeghifard and Zareian, 2009; Tigno and Gumila, 2000), anti-tumor (Kim *et al*., 2003; Emami *et al*., 2010), anti-stomach ulcer (Emami *et al*., 2010; Foglio *et al*., 2002) and antioxidant (Cordova *et al*., 2002; Kim *et al*., 2003) effects. The plant contains various flavonoids including quercetin and retinoid (Bahrami-Karkevandi *et al*., 2011; Asgary *et al*., 2005; Farzaneh *et al*., 2006) and most of its varieties have chlorogenic, sesquiterpene and monoterpenes (Dinani *et al*., 2007; Kim *et al*., 1997) which have strong antioxidant properties. To date, no studies have been done on the impact of Artemisia sieberi Besser on hepatotoxicity.

The present study was conducted to investigate the effects of Artemisia plant extracts on ethanol induced hepatotoxicity. *Artemisia sieberi* is a well-known medicinal plant that has been used in the Middle East traditional medicine for treating various diseases including diabetes mellitus (Tanira *et al*., 1996), microbial infection, poison (Nagappa *et al*., 2003), high blood pressure and gastrointestinal ailments (Suleiman *et al*., 1988; Gharaibeh *et al*. (1988) Konuklugil *et al*., 1997). Thus, the aim of the present study is to evaluate the hepatoprotective activity of methanol extracts of Artemisia sieberi Besser aerial parts against ethanol induced-hepatic damage in male rats.

MATERIALS AND METHODS

Plant material and preparation of the extract

Plant material: Plant material and preparation of the extract plant material: fresh aerial parts of the young and matured Artemisia sieberi Besser plants were collected in June 2017 from Northern Badieh region, Jordan. The plant specimen was authenticated by Professor Jamil Lahham, taxonomist at the herbarium of the Department of Biological Sciences, Faculty of Sciences, Yarmouk University, Irbid, Jordan. The voucher specimen (NO.ART-6-017) was deposited in the Department of Medical Laboratory Sciences, Faculty of Sciences, Al al Bayt University, Al-Mafraq, Jordan. After authentication, the aerial parts of the plant were washed, shade dried and milled into coarse powder by a mechanical grinder. Then, 300 g of the powder was soaked for 5-7 days with 1000 mL of 80% methanol at 25°C. After filtration and extraction by Soxhlet apparatus, the filtered extract was evaporated with a rotary evaporator to remove the methanol solvent under reduced pressure at 50°C. The dry crude extract of the plant samples was stored in the refrigerator in a dark glass bottle until use. A stock solution 0.1 gmL^{-1} from the crude extract was prepared by dissolving 0.1 g of dry crude extract in 1 mL (Dimethyl Sulfoxide (DMSO)) and then diluted in 9 mL normal saline. This stock solution was freshly prepared and directly used in the experiment.

Animals: Eighty male Wister rats weighing 150-180 g were obtained from the animal house of the Jordan University of Science and Technology, Irbid, Jordan. The rats were harbored in stainless steel cages under standard laboratory condition of 12 h light/dark cycle throughout the experimental period. They had access to food and water ad libitum. The animals were daily checked and monitored carefully for any changes.

Experimental design: The animals were kept inside cages in the animal house at the Faculty of Sciences, Al al-Bayt University. Eighty rats were randomly divided into 4 groups with 20 rats in each one. Group I consisted of non-hepatotoxic rats that received only the vehicle (0.5 $mLkg^{-1}$ body weight) and served as a control group. Group II: the rats were orally administered 2 mL of 95% ethanol every alternate day for 30 days to generate the hepatotoxicity. Groups III: hepatotoxic rats administered 25 $mgkg^{-1}$ silymarin drug. Group IV: hepatotoxic rats treated with 100 $mgkg^{-1}$ methanol extracts of Artemisia sieberi Besser. All treatments were orally administrated by gavage using a feeding needle for 30 consecutive days. Rats were maintained in these treatment regimens with free access to food and water ad libitum during the whole experimental period. The conducted experiments complied with the guidelines of the animal ethics committee which has been established at the Department

of Medical Laboratory Sciences, in accordance with the international accepted principles for laboratory animal use and care.

Sample collection: Blood samples were collected directly from each animal group by cardiac puncture after scarification by cervical dislocation under light ether anesthesia. Part of the collected blood sample was deposited in EDTA-blood collecting tubes to be used for measuring some hematological parameters as described below. The remaining blood sample was deposited into red-capped blood collecting tubes and allowed to clot for 30 min before centrifuging using a bench top centrifuge. The serum was collected and stored at -20°C until the day of biochemical analysis. The liver from each animal group was also excised and weighed.

Biochemical analysis: Liver enzyme markers (Glutamate Oxaloacetate Transaminase (SGOT), Glutamate Pyruvate Transaminase (SGPT), Alkaline Phosphatase (ALP)), total protein, albumin, bilirubin (direct and total) and lipid profile were measured from blood serum samples using commercial analytical kits (sigma, Lab-kit, Spain) and spectrophotometer method (AU 2700 Olympus, OSR6121, Japan).

Hematological analysis: The CBC was performed on an automated hematology analyzer using well mixed whole blood to which EDTA was added to prevent clotting. ESR was measured by wintergreen method.

Statistical analysis: The results were expressed as mean±SD. Differences between groups were analyzed with student's t-test. Differences between groups were considered at a 95% confidence limit and a probability level of 0.05. The results were considered as significant, if $p<0.05$.

RESULTS AND DISCUSSION

In the present study, the used dose (100 $mgkg^{-1}$) of Artemisia sieberi Besser methanol extracts is considered safe. Since, no mortality and toxic signs were observed on animals for 24 h after the administration of the plant extract tested dose. The hepatoprotective activity of Artemisia sieberi Besser methanol extracts against ethanol induced hepatotoxicity in male rats was evaluated by measuring various biochemical and hematological parameters (Table 1-4). The administration of ethanol to rats as hepatotoxic model, caused liver damage as indicated by the significant increase in serum liver enzymes SGOT, SGPT, ALP, total bilirubin and decrease in liver weight, total proteins and albumin ($p<0.05$). When compared to control group (Table 1 and 2). The treatment with the plant methanol extracts has brought back the liver weight to the near normal, lowered the levels of the liver enzymes and improved total proteins and albumin levels. While oral administration of 25 $mgkg^{-1}$ silymarin as standard drug induced a significant reduction in serum SGOT, SGPT, ALP (Table 1) and total bilirubin ($p<0.05$) compared to results of hepatotoxic group (Table 2). Also, it is significantly reduced the liver weight when compared with those of the untreated control group (Table 1). In addition, methanol extracts treated group showed significant reduction in cholesterol, triglyceride and LDL levels. Conversely, the HDL level was increased compared to results of both hepatotoxic and silymarin treated groups (Table 3). The effect of Artemisia sieberi Besser methanol extracts on some hematological parameters (CBC test) are also investigated. The results revealed that the RBC and WBC count, PCV, HB, ESR and the percentage of WBC differential count were significantly decreased ($p<0.05$) in the hepatotoxic group (Table 4). In contrast, treatment hepatotoxic rats with the plant methanol extracts and the silymarin drug enhanced the value of these hematological parameters to a relatively close manner, compared to those noticed in the untreated control group. Based on literature review that revealed no research work has been previously conducted on the Artemisia plant variety and the extract. Hence, the present study was carried out to evaluate the hepatoprotective activity of methanol extracts from Artemisia sieberi Besser aerial parts against ethanol induced-hepatic damage in male rats. Liver damage induced by ethanol is a common used model for the screening of hepatoprotective drugs and is associated with increment of lipid peroxidation (Cordova *et al*., 2002). The rise in serum levels of SGOT, SGPT and cholesterol has been attributed to the damaged structural integrity of the liver. They are cytoplasmic in location and released into blood circulation after hepatocytes damage. When rats were treated with ethanol, it induces hepatotoxicity by metabolic activation (Bahrami Karkevandi *et al*., 2011). Other studies suggested that the loss of membrane structure and integrity from the lipid peroxidation was accompanied with the elevated levels of marker enzymes like-SGOT, SGPT, ALP, total protein and bilirubin. Peroxidation during the metabolism of the hepatotoxic agent may result in the occurrence of hepatitis leading to cirrhosis. The results of the present study showed that the serum levels of SGOT, SGPT, ALP (Table 1), total cholesterol, triglycerides, LDL cholesterol were significantly higher ($p<0.05$) decrease in HDL cholesterol was detected in the same group (Table 3). This could be attributed to the formation of highly reactive free radicals that directly attacks the polyunsaturated fatty acids of the endoplasmic reticulum and thus, causes over production by cholesterol (Nagappa *et al*., 2003). The index of protective effects of the plant extract is confirmed by its ability in reducing the cellular

Table 1: Effects of the methanolic extracts from Artemisia sieberi Besser on the liver enzymes and liver weight (g) in the hepatotoxic rats

Groups	Treatments	N	SGOT (U/L)	SGPT (U/L)	ALP (U/L)	Liver weight (g)
I	Control vehicle (0.5 mLkg^{-1} body weight)	20	34±1.22	20.13±1.25	38±4.53	11.6±0.76
II	Hepatotoxic rats administered 2 mL of ethanol orally every alternate day for 30 days	20	124±15.6*	142.74±9.67	144±13.47**	9.19±0.47**
III	Treated hepatotoxic group treated with 100 mgkg^{-1} of the methanolic extracts from Artemisia sieberi Besser for 30 days	20	66±4.88**	78±6.22**	101±18.73**	10.1±0.34**
IV	Treated hepatotoxic group administered 25 mgkg^{-1} of silymarin for 30 days	20	62±6.43**	86±12.49**	98±10.54**	9.8±0.67**

Values (U/L) for liver enzymes and (g) for liver weight are the mean values±standard devotion of 20 rats, *statistically significant when compared to control group (I) at p<0.05: **statistically significant when compared to untreated group (II) at p<0.05

Table 2: Effects of the methanolic extracts from Artemisia sieberi Besser on some biochemical parameters (total protein, albumin, total bilirubin and conjugated bilirubin) in the hepatotoxic rats

Groups	Treatments	N	Total protein (GL^{-1})	Albumin (gdL^{-1})	Bilirubin total (mgmL^{-1})	Conjugated bilirubin (mgmL^{-1})
I	Control vehicle (0.5 mLkg^{-1} body weight)	20	6.46±0.32	4.43±0.85	118±11.57	11.6±0.76
II	Hepatotoxic rats administered 2 mL of ethanol orally every alternate day for 30 days	20	3.38±0.32*	2.18±0.57*	144±13.47**	9.19±0.47**
III	Treated hepatotoxic group treated with 100 mgkg^{-1} of the methanolic extracts from Artemisia sieberi Besser for 30 days	20	5.28±1.13*	3.17±0.22**	101±18.73**	10.1±0.34**
IV	Treated hepatotoxic group administered 25 mgkg^{-1} of silymarin for 30 days	20	5.16±1.36****	3.8±0.49**	98±10.54**	9.8±0.67**

Values (gdL^{-1}) for total protein, albumin and (mgmL^{-1}) bilirubin total and conjugated bilirubin (mgmL^{-1}) are the mean values±standard devation of 20 rats, *statistically significant when compared to control group (I) at p<0.05: **statistically significant when compared to untreated group (II) at p<0.05

Table 3: Effects of the methanolic extracts from Artemisia sieberi Besser on the lipid profile in the hepatotoxic rats

Groups	Treatments	N	Cholesterol (gdL^{-1})	Triglycerides (gdL^{-1})	HDL1 (mgdL^{-1})	LDL (mgdL^{-1})
I	Control vehicle (0.5 mLkg^{-1} body weight)	20	144.67±9.3	78.4±10.44	34.63±5.8	27.2±4.62
II	Hepatotoxic rats administered 2 mL of ethanol orally every alternate day for 30 days	20	186.87±16.6*	148.38±17.8*	24.45±3.73*	55.8±10.53*
III	Treated hepatotoxic group treated with 100 mgkg^{-1} of the methanolic extracts from Artemisia sieberi Besser for 30 days	20	158.44±14.8*	24.70±4.63*	26.66±2.84*	38.43±5.6**
IV	Treated hepatotoxic group administered 25 mgkg^{-1} of silymarin for 30 days	20	148.45±12.8*****	98.6.73±12.62**	28.74±5.38*	36.74±8.46**

Values (gdL^{-1}) for total cholesterol, triglycerides and (mgdL^{-1}) for HDL and LDL are the mean values±standard deviation of 20 rats, *statistically significant when compared to control group (I) at p<0.05: **statistically significant when compared to untreated group (II) at p<0.05

Table 4: Effects of the methanol extracts from Artemisia sieberi Besser on some hematological parameters in the hepatotoxic rats

Parameters	Control vehicle (0.5 mLkg^{-1} body weight)	Hepatotoxic rats administered 2 mL of ethanol orally every alternate day for 30 days	Treated hepatotoxic group treated with 100 mgkg^{-1} of the methanolic extracts from Artemisia sieberi Besser for 30 days	Treated hepatotoxic group administered 25 mgkg^{-1} of silymarin for 30 days
RBC (×10^{6} µ)	8.3±0.7	6.9±0.5	7.8±0.6	7.6±0.4
Hb (gdL^{-1})	14.6±0.52	9.4±0.77	12.0±1.64	13.1±1.59
WBC (×10^{3} µ)	21.8±3.4	13.7±1.45	16.7±1.38	18.4±1.61
Neutrophils (%)	40±4.5*	34 ±8.3**	41±5.2	43±6.7
Basophiles (%)	2±0.6	1±0.2	2±0.3	2±0.7
Eosinophils (%)	3±0.9	3±0.6	3±0.2	3±0.8
Lymphocytes (%)	62±4.7	67±5.7	61±4.4	60±6.1
Monocytes (%)	6±0.7	7±0.4	7±0.2	5±0.8
PCV (%)	44.4±1.16	29.7±1.34	37.6±1.73	40.5±1.29
ESR (mmh)	17±2.6	23±5.8	16±4.7	15±4.4

The mean values ± standard deviation of 20 rats, *statistically significant when compared to control group (I) at p<0.05: **statistically significant when compared to untreated group (II) at p<0.05

injurious or preserving the normal hepatic physiological mechanism. Which have been disturbed by the ethanol (Suleiman *et al*., 1988) and induced significant inhibition of the parameters of lipid profile and increases the HDL cholesterol as good cholesterol related to the antioxidant activity and/or the inhibition of the generation of free radicals. This is important in the protection against ethanol hepatotoxicity. The reduction of the levels of the lipid profile parameters as cholesterol, triglycerides, LDL cholesterol and the significant increasing in HDL cholesterol in the plant extract treated hepatotoxic rats is an indication of the stabilization of hepatocyte plasma membrane as well as repairing of the hepatic tissue damage, that induced by ethanol. The hepatotoxicity and nephrotoxicity of ethanol in experimental animals are well characterized in the literature, however little information

is known about the effects of ethanol on blood poisoning. Results of the present study revealed that the hematological parameters: RBC and WBC count, PCV, Hb, ESR and the percentage of WBC count were significantly reduced in the hepatotoxic rats (Table 4). While the treatment with methanol extracts of Artemisia sieberi Besser caused a significant increase in these hematological parameters, returning back the altered levels nearby to the normal. The liver has a vital role in the hematopoiesis and the synthesis of blood coagulation proteins. The liver disease is associated with hematological abnormalities and causes alterations in red blood cell lipid function. That rise due to the effects of liver disease, immune mechanisms and hypersplenism. Liver association is often observed in several hematological disorders, leading to abnormal liver function tests, abnormalities in liver imaging studies or clinical symptoms presenting with hepatic manifestations (Gharaibeh *et al*., 1988). In hemolytic anemia, jaundice and hepatosplenomegaly are often seen mimicking liver diseases. As well, in hematologic malignancies, malignant cells infiltrate the liver and may cause abnormal liver function test results accompanied by hepatosplenomegaly or the formation of multiple nodules in the liver. These cases may further evolve into fulminate hepatic failure. When the RBC membrane is severely damaged, immediate lyses occurs within the circulation (intravascular hemolysis). While in cases of less severe damage, the cells may be destroyed within the monocyte-macrophage system in the spleen, liver, bone marrow and lymph nodes (extravascular hemolysis) (Tanira *et al*., 1996; Shailajan *et al*., 2014). Ethanol administration causes immunosuppressive effects as indicated by phagocytic capacity, chemotactic migration and cell adhesiveness of rat peritoneal macrophages. In hemolysis, serum Lactate Dehydrogenase (LDH) levels (specifically the LDH1 and 2 isoforms) increase because of lysed erythrocytes (Tanira *et al*., 1996). Serum Aspartate Transaminase (AST) levels are also mildly elevated in hemolysis with the LDH/AST ratio mostly over 30 (Wang *et al*., 2010). Total bilirubin levels may uncommonly exceed 5 $mgdL^{-1}$, if the hepatic function is normal, except in the case of acute hemolysis that caused by sickle cell crisis. Liver dysfunction can also be caused by blood transfusion for anemia in Sickle Cell Disease (SCD) and thalassemia (Contreras-Zentella and HernandezMunoz, 2016; Ingawale *et al*., 2014). It was found that the RBC and WBC count, PCV, ESR and the neutrophil percentage was decreased (Table 4). Moreover, neutrophils from hepatotoxic rats have also shown to present functional abnormalities such as less phagocytizing capacity and chemotactic responses (Sengupta *et al*., 2011). This might be extended to other inflammatory cells like those involved in allergic processes. The present study indicated that treatment with methanolic extracts of Artemisia sieberi Bessert might ameliorate some disturbed hematological parameters of hepatotoxic rats. It has been suggested that anemia occurrence is due to the increased non-enzymatic glycosylation of RBC membrane proteins which correlates with hyperglycemia and hepatotoxity (Phaniendra *et al*., 2015). Oxidation of these glycosylated membrane proteins and hyperglycemia in hepatotoxic rats cause an increase in the production of lipid peroxides and leading to hemolysis of RBC. In this experiment, we did not measure the RBC membrane lipid peroxide levels in hepatotoxic rats. However, Baravalia *et al*. (2011) demonstrated that serum lipid peroxide level increased in diabetic and hepatotoxicity. Treatment with the methanol extracts may decrease the elevated lipid peroxide level to a normal level. Thus, increased RBC count of methanol extract treated rats could be due to the lowered lipid peroxide level in RBC membrane leading to a decreased susceptibility of RBC to hemolysis (Bin-Jumah, 2019). Neutrophils ingest and kill bacteria and have been called the body's first line of defense against bacterial infections. It has been suggested that the body's defense mechanism against infections was disturbed as a result of altered neutrophil function in hepatotoxic rats (Mehta and McIntyre, 1998; Anonymous, 2019). Results of the present study demonstrated that treatment with methanol extracts of Artemisia sieberi Besser increased the lowered neutrophil percentage of WBC, compared to the control level. This indicated that methanol extracts of Artemisia might enhance the defense mechanism of the body against infections and toxins in experimental rats. As well, treatment with the extracts may delete the immunosuppressive effect of ethanol, by improving the functional capacities of rat peritoneal macrophages (Ingawale *et al*., 2014). The results of the present study, under experimental conditions, suggest that treatment with the methanol extracts of Artemisia sieberi Besser aerial parts may be the critical remedy for the adverse effect of ethanol on liver and immune functions. Hence, it is concluded that the methanol extracts revealed the hepatoprotective capability against ethanol induced-hepatic damage in experimental rats. However, a further investigation is required for isolating active ingredients of the extracts and revealing the mode of its action.

CONCLUSION

The present study revealed the hepatoprotective activity of Artemisia sieberi Besser methanol extracts aerial parts against ethanol induced-hepatic damage in experimental rats.

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