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Research Article

EVALUATION OF HEPATOPROTECTIVE ACTIVITY AND OXIDATIVE STRESS PARAMETERS OF ALCOHOLIC EXTRACT OF *ARTABOTRYS HEXAPETALUS* (L.F) BHANDARI

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ABSTRACT

In spite of the tremendous advances made, no significant and safe hepatoprotective agents are available in modern therapeutics. Therefore, due importance has been given globally to develop plant-based hepatoprotective drugs, effective against a variety of liver disorders. The aim of the current study is to screen the alcoholic extract of *Artabotrys hexapetalus* (L.f) Bhandari (AEAH) for hepatoprotective activity in rats which were intoxicated by paracetamol. This article describes phytochemical (qualitative), hepatoprotective activity and oxidative stress parameters of the above selected plant drugs by studying the serum enzyme levels like SGOT, SGPT, ALP, ACP, Total Bilirubin, Direct Bilirubin, SOD, GSH, Vitamin C and Catalase levels of the animals treated with hepato toxicant paracetamol. The alcoholic extract of AEAH reversed the hepatotoxicity induced by paracetamol in the rats, indicating their hepato-protective action. The study was also supported by the histopathological studies which reversed structural damage occurred due to paracetamol. This study was further supported by the DNA fragmentation studies which showed the absense of fragmentation of DNA in AEAH treated groups, indicating the hepatoprotective activity of *Artabotrys hexapetalus* (L.f) Bhandari. Hence it can be concluded that the plant extract possesses a promising hepatoprotective and antioxidant effect.

INTRODUCTION

The liver is the key organ of metabolism, secretion and excretion. Because of its strategic location in the body it is constantly exposed to environmental pollutants, xenobiotics and chemo therapeutic agents[1].

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Liver injury may be acute and chronic where the acute liver injury can be caused by several factors like drugs, alcohol consumption, poor hygiene and industrial chemicals. The most common causes of chronic liver failure may be due to Hepatitis B, Hepatitis C, Cirrhosis, long-term alcohol consumption, malnutrition, and hemochromatosis. Among these causes, the most commonly observed are drug induced, alcohol consumption and poor hygiene where drugs account for approximately 20-40% of all instances of hepatic failure and 75% of the idiosyncratic drug reactions lead to liver transplantation or death[2]. There are two main categories of substances that produce hepatotoxicity, one group consists of agents that are intrinsically toxic i.e., their hepatotoxicity is a fundamental property to which most exposed individuals are

susceptible. These are called True, Intrinsic or Predictable hepatotoxins. The other group consists of agents that produce hepatic injury only in unusually susceptible humans i.e., their toxic effects results from the special vulnerability of the affected individual. This form of hepatotoxicity is called Non-predictable or Idiosyncratic hepatotoxicity[3].

The interest in hepatoprotective activity kindled after the publication of the report on isolation of silymarin, a flavonolignan, from *Silybum marianum* and its efficacy as a hepatoprotective agent. The discovery drew the attention of the research workers throughout the world towards medicinal plants to search for hepatoprotective agent among them[4].

*Artabotys hexapetalus*is (L.f.) Bhandari generally described as a folk drug which has wide range of medicinal uses belonging to family Annonaceae is widely distributed in the southern part of China, and is used in traditional Chinese medicine for the treatment of malaria.

Phyto-chemical analysis (**Table no 1**) revealed the presence of alkaloids, carbohydrates, flavonoids, glycosides, phytosterols/terpenes, proteins and saponins and lipids were qualitatively analyzed[5]. *Artabotys hexapetalus*is (L.f.) Bhandari has been employed in traditional herbal medicine to treat a variety of health conditions. Some studies showed that extracts and its constituents posses Antibacterial and antifungal activity studies[6] Anti-fertility activity [7,8]. Anthelmentic and Cytotoxic activities[9]. The present study investigated the hepatoprotective potential and the oxidative stress parameters of *Artabotys hexapetalus*is (L.f.) Bhandari alcoholic extract treatment against paracetamol induced liver toxicity in rats. More over DNA fragmentation assay was also carried out as a supportive study.

MATERIALS AND METHODS:

Drugs and chemicals

Silymarin is obtained from SIGMA chemicals, Mumbai. Carbon tetrachloride, Paracetamol and all other chemicals used in the study were obtained from S.D fine chem. ltd, Mumbai**.** All chemicals used in the study were of analytical grade.

Plant collection, authentification and preparation of extracts

Artabotrys Hexapetalus (L.f) Bhandari leaves and fruits were collected from A.P forest academy**,** Bahadurpally, Hyderabad, Telangana, during the month of December in the year 2011. The plant was authenticated by a taxonomist from Osmania University bearing the **voucher number: 0006**. The collected plant material was washed and shade dried for two weeks and powdered mechanically. The dried powder was sieved through mesh no.44. The alcoholic extracts were prepared by continuous Soxhlet extraction method and the obtained liquid extract was filtered and evaporated under reduced pressure by using rotary evaporator (Buchi-R-210) until a soft mass is obtained. This extract as a suspension was used for further investigation.

Animals

Male and female Wistar albino rats weighing about (150-200 g) were used. The animals were housed in polypropylene cages and maintained at 27^{o} | 2^{o}C and 12 hour light dark cycle. They were acclimatized to the laboratory conditions for 5 days prior to use in animal house. The study was approved by the Institutional Animal Ethics Committee and the reference number is **MRCP/PCOL/2012/004**. The animals were fed with standard laboratory feed and drinking water ad libitum.

Study Protocol:

Suspensions of *Artabotrys hexapetalus* (L.f) Bhandari extracts were prepared in 1% tween. 36 male albino rats in the weight range of 150-200gms were selected and they are divided into six groups as mentioned below, consisting of six animals each. And the treatments were given as per the following table (**Table 2**). The blood sample was collected under light ether anesthesia. The collected blood samples were centrifuged at 3000 rpm at 4 |C for 10 minutes to separate the serum. The serum was used for the assay of marker enzymes and the liver was subjected to histopathology.

Biochemical parameters and oxidative stress parameters

The biomarker enzymes like, Aspartate aminotransferase (AST/SGOT), Alanine aminotransferase (ALT/SGPT), Alkaline phosphatase (ALP), Acid phosphatase (ACP), Bilirubin and oxidative stress parameters like Superoxide dismutase (SOD), Glutathione (GSH), Malonedialdehyde (MDA), Vitamin C and Catalase are estimated from the collected blood samples by the following methods. SGOT/ AST, SGPT/ALT was estimated by Henderson method [10] and Tietz method[11]. Alkaline Phosphatase (Alp) was estimated by king and kings method ; Acid Phosphatase was estimated by colorimetric method [12, 13]. Bilirubin by Modified Jendrassik & Grof's Method [14].

Superoxide Dismutase (SOD): [15,16]

The concentrations of superoxide dismutase were determined by Colorimetric method using Superoxide dismutase activity assay kit which uses WST-1 [4-[3-(4-iodophenyl)-2-(4-nitrophenyl)-2H-5-tetrazolio]-1,3-benzene disulfonate sodium salt] . It produces a water-soluble formazan dye on reduction with superoxide anion. The rate of the reduction with a superoxide anion is linearly related to the xanthine oxidase (XO) activity, and is inhibited by SOD. Thus, the reduction activity of SOD can be determined by a colorimetric method**.**

Glutathione (GSH)[17,18] **:** The sulfhydryl group of GSH cause a constant reduction of 5,5-dithiobis(2-nitrobenzoic acid) (DTNB) and forms a yellow coloured TNB (5-Thio-2-Nitrobenzoic acid) along with the GSSG which is recycled by glutathione reductase and NADPH.

Malondialdehyde (MDA) [19] **:** When MDA reacts with Thiobarbituric Acid (TBA) it generates a MDA-

TBA adduct which can be detected by colorimetric method at Optical density of 532 nm. MDA levels as low as 1 nmol/well can be detected by this method

Catalase [20, 21]

The method involves This involves two reactions. Firstly the hydrogen peroxide (H_2O_2) is decomposed into water and oxygen in presence of catalase. The catalase concentration is directly proportionally to the rate of disintegration of hydrogen. Sample with catalase is incubated in a known amount of hydrogen peroxide and the reaction is allowed for exactly one minute. Then sodium azide is added to quench the remaining catalase. Secondly the residual hydrogen peroxide in the reaction mixture expedites the coupling reaction of 3,5-dichloro-2-hydroxy-benzenesulfonic acid (DHBS) and 4-aminoantipyrene (AAP) in combination with Peroxidase catalyst. The quinoneimine dye coupling product is measured at 520nm, which correlates to the amount of hydrogen peroxide remaining in the reaction mixture.

Vitamin C[22] **:** Proprietary catalysts present in the kit oxidize ascorbic acid and generate a product which interacts with the ascorbic acid probe to generate colour and fluorescence. Ascorbic acid is easily determined by either colorimetric (spectrophotometry at λ = 570 nm) or fluorometric (Ex/Em = 535/587 nm) methods. The assay can detect 0.01-10 nmol of ascorbic acid per assay in various samples.

Statistical Analysis: Data obtained are presented in mean ± standard error of mean (SEM). The data were analysed using the one-way analysis of variance (ANOVA), and the differences between the groups were determined using the Dunnett post hoc test as provided by the Graph pad PRISM V5.02 software. The limit of significance was set at $p < 0.05$ level.

RESULTS AND DISCUSSION:

Levels of hepatoprotective parameters in animals treated with different doses of alcoholic extracts **(AEAH1, AEAH2, AEAH3)** of *Artabotrys hexapetalus* (L.f) Bhandari were presented in **Table 3 and 4**. Results represented in table showed that in animals treated with toxicant Paracetamol (PCM), the level of serum enzymes like SGOT, SGPT, ALP, ACP, Total bilirubin (TB) and Direct bilirubin increased. when the animals were treated with different doses of Alcoholic extracts **(AEAH1, AEAH2, AEAH3)** of *Artabotrys hexapetalus* (L.f) Bhandari, the serum enzyme levels were brought down significantly and the activity has shown dose dependency. The serum enzyme levels reduced drastically and were comparable to the enzyme levels in the control animals which indicated that the alcoholic extracts **(AEAH1, AEAH2, AEAH3)** have the hepatoprotective action.

Oxidative stress parameters levels which indicate the oxidative reactions causing hepatotoxicity of animals treated with different doses of alcoholic extracts **(AEAH1, AEAH2, AEAH3)** of AH are presented in **Table no 5**. The results showed that in animals treated with toxicant Paracetamol, the level of oxidative stress parameters like SOD, GSH, Vitamin C and Catalase decreased and the levels of MDA increased, which indicated that the oxidative stress had increased drastically. when the animals were treated with different doses of alcoholic extracts **AEAH1, AEAH2, AEAH3)** of AH, the levels of oxidative stress parameters like SOD,GSH, Vitamin C and catalase were significantly increased and the levels of MDA were significantly decreased. The activity has also shown dose dependency, and were comparable to the control animals which indicated that the alcoholic extracts **(AEAH1, AEAH2, AEAH3) of AH** have the hepato-protective action.

DISCUSSION:

Liver function tests are most commonly performed by blood tests to assess the function of the liver or injury caused to the liver. The most widely used liver enzymes that are sensitive to abnormalities in liver are the two aminotransferases SGOT and SGPT form a major constituent of the liver cells and phosphatases like ACP and ALP . They are present in lesser concentration in the muscle cells. When the liver cells get damaged or injured, these enzymes dribble into the blood stream, raising their blood levels. Hence raised blood levels of these aminotransferases and acid phosphatases signify liver disease or injury. This condition was evident in the present study when the animals were treated with toxicant Paracetamol. When the animals were treated with alcoholic extracts **(AEAH1, AEAH2, AEAH3)** at different doses, the levels of these significantly decreased indicating that the damage caused to liver is reversed. The levels of these enzymes were brought down and were comparable to that of control animals **(NC)** when they are treated with higher dose of alcoholic extract **(AEAH3).** Direct and Total bilirubin are some of the liver enzymes which will increase in the blood when there is damage to liver. The current study was also in accordance with it. When the animals were treated with Paracetamol, the levels of these enzymes increased. When the animals were treated with different doses of Alcoholic extracts **(AEAH1, AEAH2, AEAH3)** of AH, the levels of these proteins had come down to normal and were comparable with the controls. This indicated that the hepatotoxicity caused by Paracetamol could be reversed by the Alcoholic extracts of AH. NAPQI a reactive metabolite, lead to the imitation of protein binding of the residues in the cytoplasm finally leading to necrosis of the liver tissue. In normal conditions, this NAPQI reacts immediately with GSH forming a conjugate and is excreted from the body. In the current study, following toxic doses of Paracetamol, the levels of GSH were decreased. At this decreased levels of GSH the detoxification enzyme GSH peroxidase cannot be effective for complete depletion of GSH [23].

This was in accordance with present study where it was found very low levels of GSH in rats treated with toxic dose of Paracetamol and the reverse was seen in rats treated with extracts of AH revealing the restoration of GSH levels and serving the detoxification process. The effect of the extract of AH was equivalent to the standard drug silymarin treatment and was even better than standard at 250 mg /kg dose. It has also been reported that during the formation of the reactive metabolite NAPQI by the action of the enzyme CYP450, there is release of superoxide anion and upon dismutation releasing superoxides and hydrogen peroxides by fenton type reactions[24]. In the present study, it was found that the levels of SOD were reduced significantly in rats treated with Paracetamol leading to the fact that the enzymes have been depleted in the toxic doses, progressing the fenton type reactions. It has also been reported by James et al., that iron catatlysed Haber-weiss reaction is also involved in the production of oxidative stress. The administration of AH extracts **(AEAH1, AEAH2, AEAH3)** in the rats had increased the levels of SOD giving a protective effect to the observed oxidative stress which in accordance with the previous study done where administration of encapsulated SOD had decreased the toxicity in acetaminophen rats[25]. Catalase is frequently used by all the cells in decomposition of H_2O_2 to oxygen which are less reactive and water molecules. Increase in the process of formation of H_2O_2 and depletion of Catalase indicates the tissue damage due to the provision of large amount of H_2O_2 available at the tissues for its toxic effects[26]. Catalase is said to be located in the peroxisomes of plant cells and are normally involved in the usage of oxygen and generate CO_2 and breakdown of Nitrogen. In the current study the Catalase levels were decreased in rats treated with acetaminophen and by treating the animal with extracts of AH **(AEAH1, AEAH2, AEAH3)** at different doses increased the levels of Catalase. With a dose **(AEAH3)** of 500 mg/kg the Catalase levels were almost returned to similar levels of controlled animals. Malondialdehyde (MDA) is a mutagenic compound and is frequently used as a biomarker for oxidative stress. MDA is one the products of lipid peroxidation and increase in the levels of MDA indicate the degree of lipid peroxidation[27] occurring in the tissues which is in accordance with the present study in rats treated with Paracetamol. Rats treated with high dose of 500 mg/kg of AH **(AEAH3)** showed a decreased MDA levels. But when treated with lower doses **(AEAH1, AEAH2)** did not show any significant effect in decreasing the levels of MDA. It could be understood that the higher doses of the extracts of AH have a significant effect on bringing down the levels of MDA, indicating the reduction in lipid peroxidation. Free radicals like superoxide radical H_2O_2, and the single oxygen initiate the lipid peroxidation, leading to damage of cell membranes. Vitamin C or ascorbic acid neutralizes these radicals by reacting with them and prevent the damage due to oxidation. In current study, when the animals were treated with Paracetamol, the levels of Vitamin C has decreased drastically which indicated that the free radicals were increased to very high levels and causes the lipid peroxidation. When these animals were treated with extracts of AH **(AEAH1, AEAH2, AEAH3)** the levels of Vitamin C increased quite significantly and are comparable to that of standard drug treatment. DNA fragmentation observed in the present study is a result of oxidative stress that was demonstrated through elevation in MDA, reduction in antioxidant enzymes and Glutathione content in rat liver [28]. This is due to leakage of the contents of mitochondria by the endonucleases, which are responsible for breakdown of the DNA strands and this is considered as an indirect marker of mitochondrial injury[29]. There is increase in the outward show of endonucleases present in the mitochondria, which are responsible for the breakdown of DNA. The oxidative and Nitrosative stress are the major triggers for the damage and release of such lytic enzymes from the mitochondria[30]. The endonucleases transit forms the mitochondria towards the nucleus and proceeds for the collapse of DNA by fragmenting. This mechanism is preceeded by the increase in the levels of calcium in the cytosol by the induction of membrane permeability transmission[31].

The presence of the nuclear DNA fragments were observed in the tissues of rats treated with Paracetamol group providing an evidence of mitochondrial damage and loss of tissue function which was also supported by the increased levels of serum enzymes like SGOT, SGPT, ACP etc. DNA in rats treated with Alcoholic extract of *Artabotrys hexapetalus* (L.f) Bhandari was intact that is contributing to the protection of mitochondrial oxidative stress. Hence the plant *Artabotrys hexapetalus* (L.f) Bhandari is protecting the DNA from the fragmentation due to toxicity. As per **Fig 2**, the cross section of liver of animals treated with Paracetamol showed severe structural damage with necrotic areas. The animals treated with standard silymarin (**Fig 3**) showed no such changes which indicated its hepato protective action. When animal treated with alcoholic extracts **AEAH1 (Fig 4)** mild inflammation without fibrotic septae were observed indicating less degree of hepatoprotective action. When the dose was increased to250mg/kg body weight**,** less disarrangement and degeneration of hepatocytes were observed in **Fig 5** which indicates marked regeneration activity and hepatoprotective action. When the dose was further increased to 500 mg/kg **(AEAH3),** showed no visible changes in the liver (**Fig 6**). This indicates the dose dependent hepato protective of the Alcoholic extracts of AH **(AEAH1, AEAH2, AEAH3).**

Histopathological changes of liver biopsy

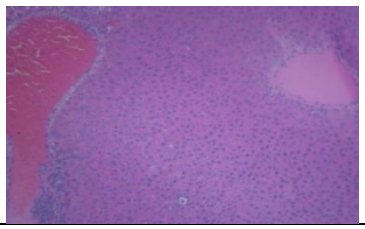


Fig 1. NC

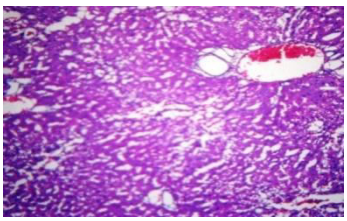


Fig 2. PCM (2g/Kg)

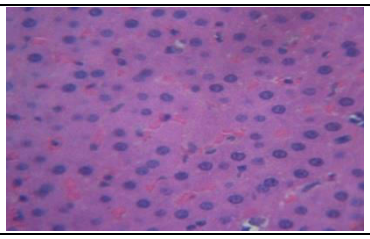


Fig 3. SS (100mg/Kg)

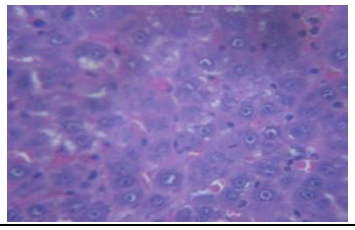


Fig 4. AEAH1 (100 mg/Kg)

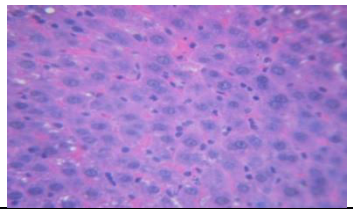


Fig 5. AEAH2 (250 mg/Kg)

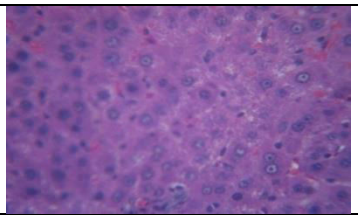
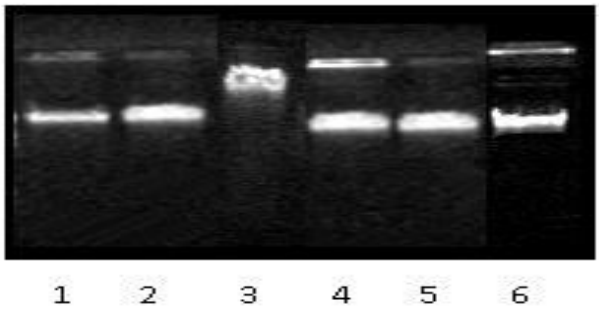


Fig 6. AEAH3 (500 mg/Kg)

Fig. 7. DNA Fragmentation Assay of liver of rats treated with Artabotrys hexapetalus (L.f) Bhandari



(1) **NC2** **(2) SS2** **(3)PCM** **(4) AEAH1 (100mg/kg)** **(5)AHAH2 (250 mg/kg)** **(6)AHAH3 (500 mg/kg)**

The extent of DNA fragmentation was more and the DNA was broken down in the Paracetamol treated group indicating the liver toxicity. In silymarin treated group the DNA was found to be intact and Alcoholic extract of AH treated group **(AEAH1)** showed slight DNA fragmentation indicating minimum hepatoprotection compared to that of the control and standard group. Increased dose of Alcoholic extract of AH treated group **(AEAH2)** showed absence of DNA fragmentation indicating hepatoprotection. Alcoholic extract of AH treated group **(AEAH3)** showed intact DNA indicating the hepatoprotection against Paracetamol induced hepatotoxicity.

Table 1: Preliminary Phyto-chemical studies

S. no	**Tests**	**alc. extract**
1	Phenol test	+ve
2	Shinoda test	+ve
3	Lead acetate test	-ve
4	Foam test	+ve
5	Borntragers test	+ve
6	Killar kilani test	+ve
7	Dragendorff's test	+ve
8	Mayer's test	+ve
9	Wagner's test	+ve
10	Hager's test	+ve
11	Ferric chloride test	+ve
12	Bromine test	+ve
13	Liebermann's test	+ve
14	Salkowiski reaction	+ve
15	Leibermann-Buchard test	-ve

Table 2: Study Protocol

Group	**Treatment**	**Dose (Once daily)**
Group I (NC2)	Controls (1 % Tween 80)	1 ml
Group II (PCM)	Toxicant (Paracetamol)	2g/kg
Group III (SS*)	Standard (Silymarim)	100 mg/kg
Group IV (AEAH1*)	Alcoholic Extract	100 mg/ kg
Group V (AEAH2 *)	Alcoholic Extract	250 mg/ kg
Group VI(AEAH3 *)	Alcoholic Extract	500 mg/ kg

* Received paracetamol 2g/kg body weight once daily from 4th to 10th day

Table 3: Serum biochemical parameters of different doses of alcoholic extract (AEAH1, AEAH2 and AEAH3) of AH against PCM induced hepatic damage

GROUPS	SGOT(U/L)	SGPT(U/L)	ALP(U/L)	ACP(U/mL)
NC2	29.13±1.02	36.05±1.43	108.2 ± 3.27^{b}	17.25 ± 1.11^{b}
PCM	$42.55\pm0.66^{**}$	$44.63\pm1.49^{**}$	$126.6\pm1.76^{**}$	$23.51\pm1.44^{*}$
SS2	251.3 ± 12.33^{a}	273.8 ± 12.73^{a}	225.0 ± 2.68^{a}	29.33 ± 1.15^{b}
AEAH1	$64.90\pm1.07^{**c}$	$82.28\pm3.19^{**b}$	$131.3\pm2.32^{**}$	$18.43\pm0.30^{**c}$
AEAH2	$52.70\pm1.31^{**}$	$62.68\pm0.09^{**}$	$124.3\pm1.30^{**}$	$14.52\pm0.97^{**a}$
AEAH3	$29.83\pm1.14^{***}$	$39.83\pm3.64^{***}$	$108.3\pm6.01^{***}$	$12.17\pm0.48^{***a}$

Values expressed Mean ± SEM; *** p<0.001, **p<0.01 * p<0.05 when compared to standard group; [a] p<0.001, [b] p<0.01, [c] p<0.05 when compared to Paracetamol group

Table 4: Serum biochemical parameters of different doses of alcoholic extract (AEAH1, AEAH2, AEAH3) of AH against PCM induced damage

GROUPS	**TB(mg/dL)**	**DB(mg/dL)**
NC2	$0.188\pm0.003^{***\,a}$	$0.1053\pm0.002^{***\,a}$
PCM	0.062 ± 0.001^{a}	0.0808 ± 0.0002^{a}
SS2	$1.423\pm0.001^{***}$	$1.215\pm0.006^{***}$
AEAH1	$0.992\pm0.004^{***\,a}$	$0.0955\pm0.0001^{*\,a}$
AEAH2	$0.622\pm0.001^{***\,a}$	$0.0645\pm0.001^{**\,a}$
AEAH3	$0.433\pm0.39^{***\,a}$	$0.645\pm0\text{-}0190^{**\,a}$

Values expressed Mean ± SEM; *** p<0.001, **p<0.01 * p<0.05 when compared to standard group; [a] p<0.001, [b] p<0.01, [c] p<0.05 when compared to Paracetamol group

Table 5: Oxidative stress parameters in rats treated with different doses of Alcoholic extract of AH (AEAH1, AEAH2, AEAH3)

GROUPS	SOD (U/mL)	GSH (U/mL)	MDA (M mol / L)	VIT.C (mg/dL)	CATALASE (Units/mL)
NC2	178.2±0.46$^{***\,a}$	1.733±0.045^{a}	15.95±1.60$^{***\,a}$	96.15±0.36^{a}	48.82±2.5$^{**\,a}$
PCM	40.61±0.15^{a}	0.575±0.058^{a}	29±1.17^{a}	20.72±1.17^{a}	20.32±1.82^{c}
SS2	148.1±4.57***	1.580±0.068***	19.8±1.37***	99.55±0.99***	33.64±0.36**
AEAH1	98.55±0.18$^{***\,a}$	1.585±0.065^{a}	27.7±2.50^{**a}	77.93±2.61$^{**\,a}$	32.98±1.96^{c}
AEAH2	107.9±2.64$^{***\,a}$	2.018±0.027$^{***\,a}$	24.5±1.67^{***c}	81.64±1.26$^{**\,a}$	34.84±1.02^{a}
AEAH3	136.7±2.95^{a}	1.637±0.081^{a}	19.12±0.51^{a}	92.04±3.07$^{**\,a}$	42.03±0.50^{***a}

Values expressed Mean ± SEM; *** p<0.001, **p<0.01 * p<0.05 when compared to standard group; ^{a} p<0.001, ^{b} p<0.01, ^{c} p<0.05 when compared to Paracetamol group

CONCLUSION

In conclusion, the results demonstrated that the progression of Paracetamol induced liver toxicity could be reduced or prevented using the ethanol extract of *Artabotrys hexapetalus* (L.f) Bhandari. The natural plant extract exerted its hepatoprotective effect by preventing the harmful cascade of events induced by Paracetamol toxicity which was evidenced by the decrease in the biochemical parameters in rats treated with alcoholic extract of AH.

The SGOT, SGPT, ALP, ACP, TB and DB levels were decreased significantly in all the alcoholic extract groups. The oxidative stress parameters were also modified in rats treated with different doses of alcoholic extract and showed dose dependency indicating the free radical scavenging activity and reduction in the lipid peroxidation mechanisms. Histopathological findings showed minimum hepatic damage in groups treated with low doses and normal lobular architecture of the liver by administering the high dose of plant extract of AH.

Conflicts of interest

The authors declare no conflict of interest.

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