RESEARCH ARTICLE

Hepatoprotective Activity and Molecular Docking Studies of *Actinidia deliciosa* Fruit Peel Extract Phytocompounds

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ABSTRACT

In the case of liver illnesses, herbal treatment offers a non-invasive, all-natural alternative to conventional medicine. Methanolic extract of the peel of *Actinidia deliciosa* was screened for its hepatoprotective in rodent models with antioxidant activity *in-vitro* H_2O_2 radical with hydroxyl radical scavenging assay was also used to assess the extract's antioxidant potential. The gold standard was ascorbic acid. Various phytochemical constituents were identified, such as flavonoids, terpenoids, phenols, tannins, and alkaloids. *In-vivo*, hepatoprotective activity was performed by using paracetamol (3 g/kg)and ethanol (12 mL/kg) induced hepatotoxicity models. Total protein and albumin levels were raised, while SGPT, SGOT, cholesterol, and bilirubin were dramatically lowered. The extract effectively mopped up the harmful free radicals. However, a histological examination was also conducted in our investigation to determine the specifics of the damage caused by the hepatotoxic chemical and the plant's potential to repair the hepatic structure. Several investigations have also shown that hepatoprotection is directly linked to antioxidant capacity. Molecular docking experiments investigated interactions with the active site of CYP450 2E1. By decreasing its expression, CYP2E1 prevents APAP bioactivation, decreasing NAPQI and protecting glutathione (GSH) levels. From the results, it is clear that to methanolic extract of *A. deliciosa* possesses hepatoprotective and antioxidant activities.

Keywords: *Actinidia deliciosa,* Hepatoprotective, Antioxidant activity, CYP450 2E1, Molecular docking.

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INTRODUCTION

Drugs and non-drug substances can also induce liver damage, known as hepatotoxicity. About 20 to 40% of all cases of fulminant hepatic failure are attributable to drug-induced liver injury (DILI), making it a prominent cause of ALF in the US and Europe. As many instances are missing or underreported, we still do not know the true incidence of drug-induced liver impairment, which has been reported to be as low as 1 in 10,000 to 100,000. Drug-induced liver injury can be caused by various medications, including sedatives, tranquilizers, antidepressants, antipsychotics, and anti-infectives (such as anti-tubercular medicines). Drug-induced liver impairment is most commonly associated with paracetamol and ethanol. In the research, silymarin is the gold standard medication. The body and the environment are sources of free radicals, highly reactive and unstable chemicals. Infections, disorders, and even one's way of life can all contribute to their development. Antioxidants are compounds that halt the deterioration of cells caused by free radicals.[1,2]

Treatments based on herbs have been used for liver problems in India for quite some time, and their popularity has been spread internationally by major pharmaceutical companies. Almost 160 phytoconstituents isolated from 101 plants are said to have liver-protective properties. Hepatoprotective action has been found in the following plants: *Flacourtia indica, Annona squamosa, Silybum marianum, Coccinia grandis, Cassia roxburghii,* and *Ficus carica*. An atomic-level model of the interaction between a small molecule and a protein can be created using the molecular docking approach, which helps characterize the actions of molecules at the requisite site of target proteins and clarify essential biological processes. This study's objectives are to (1) evaluate the hepatoprotective effect of a methanolic extract of *Actinidia deliciosa* fruit peel and (2) determine the affinity of the extract's active ingredients for a protein produced in the disease.[3,4]

MATERIALS AND METHODS

Plant Collection and Drying

A. deliciosa fruit was procured from a neighborhood store. The authenticity of this content was confirmed. The freshly picked *A. deliciosa* fruits needed to remove any remaining dirt before

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the peels could be removed, dried for about ten days, and then ground into a coarse powder in a blender.[5]

Extraction of *A. deliciosa* (Cold extraction)

In an orbital shaker (REMI), 30 grams of powdered dried fruit peel was immersed in 300 mL of solvent and shaken for 50 hours at room temperature. Under low pressure and 50°C, extracts were concentrated and evaporated until dry.[6]

Preliminary Phytochemical Analysis

Preliminary phytochemical experiments were performed on the extract, following the procedure outlined in the Khandelwal book, in order to determine the numerous phytoconstituents found in the fruit peel.[7]

GC-MS Analysis of Compounds of Methanolic peel Extracts of *A. deliciosa*

The BR-5MS is a triple-quadrupole gas chromatography-mass spectrometry (GC-MS) that uses a fused-silica capillary column. The GC is a Bruker Scion 436-GC (5% diphenyl/95% dimethyl polysiloxane).[8]

Acute Toxicity Studies of MEAD

To determine whether or whether the methanolic extract of *A. deliciosa* peel is harmful, acute toxicity tests were conducted. Acute oral toxicity is assessed using a dose-response curve.[9]

Antioxidant Activity

In-vitro

Methanolic extract of *A. deliciosa* peel was tested for its antioxidant properties in laboratory dishes.

Hydroxyl radical scavenging activity

Extractives' ability to scavenge hydroxyl radicals was measured using the Halliwell technique. The spectrophotometer reading was taken at 532 nm. Scavenging ability was determined by measuring the percentage of hydroxyl radical oxidation of 2-deoxy-d-ribose.

$$\%\, Hydroxylradicalscavengingactivity = \frac{[A0 - (A1 - A2)]}{A0} \times 100$$

Where A0: absorbance of control exclusive of a sample.
A1: absorbance after adding sample and 2-deoxy-D-ribose.
A2: absorbance of the sample without 2deoxy-D-ribose.

Inhibitory concentration 50% (IC_{50}) was determined by plotting the percentage of inhibition against the concentration. Three independent runs were conducted at each concentration.[10]

H_2O_2 radical scavenging activity

Although it is a weak oxidant, hydrogen peroxide can directly inactivate a small number of enzymes, typically by oxidation of critical thiol groups. H_2O_2 solution (0.6 mL) was mixed with test chemicals (10–50 µg/mL). The absorbance of H_2O_2 was measured after ten minutes at 230 nm and compared to that of ascorbic acid (the standard).[11]

$$\%H_2O_2 = \frac{\text{A1control} - \text{A2sample}}{\text{A1control}} X100$$

In-vivo Methods

Paracetamol-induced hepatotoxicity model

Wistar albino rats of either sex weighing between 200 and 250 g were chosen and distributed into five groups of 6. Animals in groups III, IV, and V were given methanolic peel extract of *A. deliciosa* (200 and 400 mg/kg) and silymarin (reference drug) (100 mg/kg) for 7 days; on the 8th day, hepatotoxicity was induced by giving paracetamol (3 g/kg bd.wt.) orally to all groups, including diseased group (Group II) and the normal vehicle group (Group I). Retro-orbital plexus was used to draw blood 24 hours after the last paracetamol dose. Biochemical parameters were analyzed after the serum was parted by centrifugation at 3000 rpm and 4°C for 20 minutes.[12]

Histopathological studies

A 10% neutral formalin solution was used to preserve liver slices. Eosin and hematoxylin were used to stain the tissue slices. Photomicrographs were taken while examining the slides with a light microscope. Inflammation, fibrosis, necrosis in the centrilobular spaces, and lymphocyte infiltration were all seen.[13]

Ethanol-induced hepatotoxicity model

To begin, we chose 200 to 250 g Wistar albino rats in good health and randomly assigned them to one of five groups (with six rats in each). About 50% ethanol (12 mL/kg, *p.o.*) for 1 to 8 days after 2 hours pre-treatment each day in group II, except

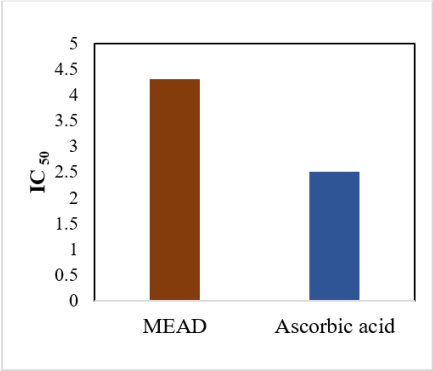

Figure 1: Hydroxyl radical scavenging assay of MEAD

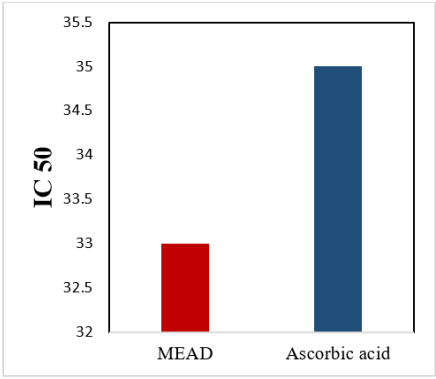

Figure 2: Hydrogen peroxide radical scavenging assay of MEAD

rats in the normal control group, i.e., group I, for 8 consecutive days, and methanolic peel extract of *A. deliciosa* (200 and 400 mg/kg) for groups III, IV, and silymarin (reference drug) (100 mg/kg) for group V. Plasma was drawn from retro-orbital plexus 6 hours after the previous dose and allowed to clot. In order to analyze several biochemical characteristics, serum was centrifuged at 3000 rpm at 40°C for 20 minutes.[14]

Molecular docking studies

The primary goal is to achieve a configuration of ligand-receptor complex that minimizes binding free energy. For molecular docking to be used in practice, there has to be a repository for PDB-formatted target structures and a process for preparing ligands for docking. Several programs (Discovery Studio, etc.) are available for this purpose, and they all provide PDB output after the ligand has been created.[15,16]

Docking simulations on cytochrome P_{450} 2E1 enzyme

Alcohol, drugs, toxins, lipids, and carcinogens all benefit from cytochrome P450 2E1's (CYP2E1) presence in the body. CYP2E1 remarkably affects toxicity. Over half of the cytochrome P450 messenger RNA and 7% of the cytochrome P450 protein in the liver are encoded by CYP2E1.

A significant drop in NAPQI and a lessening of GSH depletion follow the suppression of CYP2E1 expression, preventing APAP bioactivation. Because of this, the hepatoprotective effect towards APAP-induced liver injury is largely due to the inhibitory impact of CYP2E1. The inhibition of CYP2E1 maintains normal GSH levels and lowers ROS formation in the liver, leading to hepatoprotective activity. Quercetin protects liver cells from oxidative damage by inhibiting CYP2E1 and simultaneously inducing heme oxygenase-1 (HO-1). Also, CO from HO-1 uptake inactivated CYP2E1 and contributed to the defense effect of human liver cells.[17,18]

Statistical Analysis

The standards are shown as Mean ± SEM, with n = 6. The control, disease control, and standard groups were used to compare all of the groups. With Dunnett's test, significant numbers were written as $p < 0.01$ and $p < 0.05$.

RESULTS AND DISCUSSION

The hepatoprotective and antioxidant properties of a methanolic extract of *A. deliciosa* peel were investigated using animal models. The following are all of the study's findings.

Preparation of Methanolic Extract of the peel of *A. deliciosa*

Peel of *A. deliciosa* was subjected to a cold extraction procedure to get a methanolic extract. Following this formula, we were able to determine the %yield of the extract.

$$\%\ Yield of extract = \frac{Amount of extract obtained}{amount of powder used} X100$$

$$= 40.798/90 \times 100$$
$$= 45.33\ \%\ w/w$$

Phytochemical Analysis

A preliminary phytochemical study found flavonoids, triterpenoids, phenolic substances, tannins, and alkaloids in the peel of *A. deliciosa*.

GC-MS of MEAD

In GC-MS analysis, a subsequent bioactive compound was identified in the extract. Quinic acid, flavylium chloride, farnesol isomer a, shikimic, palmitic, stearolic, erucic, myristic, caproic, caprylic, and succinic acid, santovar A, DEHA, S-(2-Aminoethyl)-L-cysteine, longiborneol.

Acute Toxicity Studies of MEAD

Up to 2000 mg/kg body weight per day, the animal showed no symptoms of toxicity or fatality. Throughout the research, scientists looked for various morphological and behavioral traits. Consumption of things like food and water was also tracked. Even after 14 days of monitoring, all the animals were found healthy and unharmed.

Dose Selection

The toxicity, as mentioned above, studies indicate that a dosage of 2000 mg/kg, bd. wt. is safe. Both 200 and 400 mg/kg body weight per day were used in the pharmacological tests.

***In-vitro* Antioxidant Activity**

Hydroxyl radical scavenging activity

Researchers have found evidence that the hydroxyl radical, a highly reactive free radical generated in biological systems, is a highly destructive species capable of destroying nearly every molecule in a living cell. These radicals can interact with DNA by forming bonds with its nucleosides, leading to strand breaks. In addition, as these species can quickly remove a hydrogen atom from an unsaturated fatty acid, they are often regarded as catalysts in the lipid peroxidation process.

MEAD was more effective than the reference medication ascorbic acid at scavenging hydroxyl radicals (IC_{50} = 39 and 32 µg/mL). According to the findings, MEAD exhibited strong antioxidant activity (Figure 1). In addition to being a good scavenger of ROS, MEAD extracts have been shown to be effective at neutralizing hydroxyl radicals. There may be enough phenolic, flavonoid, and glycoside components in MEGH to account for its hydroxyl radical scavenging activity.

Hydrogen peroxide radical scavenging assay

According to the findings, MEAD exhibited less antioxidant activity (Figure 2)

***In-vivo* Methods for Evaluation of Hepatoprotective Activity**

Paracetamol-induced hepatotoxicity action

It was used to cause hepatotoxicity in rats, and results showed that levels of SGPT, SGOT, bilirubin, and cholesterol were elevated, while levels of albumin and total protein were decreased. MEAD at 200 and 400 mg/kg significantly prevented elevation of these parameters compared to hepatotoxic rats (Table 1).

Table 1: Hepatoprotective activity of MEAD on paracetamol-induced hepatotoxicity model.

Treatment	*SGOT (U/L)*	*SGPT (U/L)*	*Cholesterol (mg/dL)*	*TP (g/dL)*	*Albumin (g/dL)*	*Bilirubin (mg/dL)*
Control	35.33 ± 1.8	40.5 ± 2.8 3	34.33 ± 2.15	7.48 ± 0. 7	4.33 ± 0.16	0.2 0.03
Paracetamol (3 g/kg)	168.83 ± 3.9^{*aA}	178.33 ± 2.72*	89 ± 3.17*	3.21 ± 0. 29*	2.06 ± 0.13*	1.16 ± 0.18*
MEAD (200 mg/kg)	117.16 ± 4.07^{*aA}	129 ± 3.64 *aA	70.5 ± 2.54^{*a}A	4.53 ± 0. 48*bA	3.33 ± 0.18*aA	0.61 ± 0.04*aA
MEAD (400 mg/kg)	88.16 ± 3.17^{*aA}	94.6 ± 3.19*aA	57.83 ± 2.55* ans	5.63 ± 0. 46*aA	5.58 ± 0.07*aA	0.56 ± 0.03**ans
Silymarin (100 mg/kg)	63.16 ± 0.64 *a	58.5 ± 0.80*a	48.16 ± 0.28* a	9.31 ± 0. 14^{*a}	7.28 ± 0.07*a	0.25 ± 0.02Nsb

With n = 6, the values are shown as Mean ± SEM. The statistical analysis was performed using ANOVA and Dunnett's test. The outcomes were contrasted with those of the control group (*p >0.0001, **p >0.001), the paracetamol control (^{a}p <0.0005, ^{b}p < 0.0001), and the standard (^{A}p <0.0001)in order to determine significance.

Table 2: Hepatoprotective activity of MEAD on liver weight and body weight

Group	*Liver weight (g)*	*Initial bd.wt., (g)*	*Final bd.wt., (g)*
Control	5.08 ± 0.1	216.6 ± 8.36	224.1 ± 6.4
Paracetamol (3 g/kg)	8.96 ± 0.29	250 ± 9.16	232.5 ± 10.1
MEAD (200 mg/kg)	7.05 ± 0.2	233.3 ± 12.4	220 ± 9.7
MEAD (400 mg/kg)	6.43 ± 0.24	218.3 ± 7.8	213.3 ± 7.0
Silymarin (100 mg/kg)	5.18 ± 0.22	205.8 ± 4.1	212.5 ± 4.8

Biochemical markers such as serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), cholesterol, and bilirubin were significantly elevated in the Paracetamol-induced hepatotoxic group, while total protein and albumin levels were decreased. In the hepatotoxic group, the SGOT, SGPT, cholesterol, and bilirubin levels in MEAD-treated groups were significantly lower, while total protein and albumin points were significantly higher. In the hepatotoxic group, SGOT, SGPT, cholesterol, and bilirubin levels in the silymarin (100 mg/kg) treated group were appreciably lower, while total protein and albumin levels were appreciably higher. Liver weight and body weight changes of the extract are represented in Table 2.

Histopathology studies

Paracetamol-induced hepatotoxicity models: histopathology analysis of rat liver tissue. After being stained with hematoxylin and eosin, the pathological alterations could be observed using a light microscope (Figure 3).

- A hepatic venule runs across the middle of the hexagonal lobules that contain the liver's hepatocytes. The portal triad and bile duct both look normal. Both sinusoids and Kupffer cells look fine. There was no evidence of portal inflammation or fibrosis.
- Moderate dilation of sinusoids, hepatocyte lobular inflammation, portal triad constriction, lymphocyte infiltration, hepatocyte ballooning degeneration, and death.
- Mild portal triad constriction, moderate sinusoidal space dilation, limited lymphocyte infiltration, hepatocyte degradation, and inflammation.

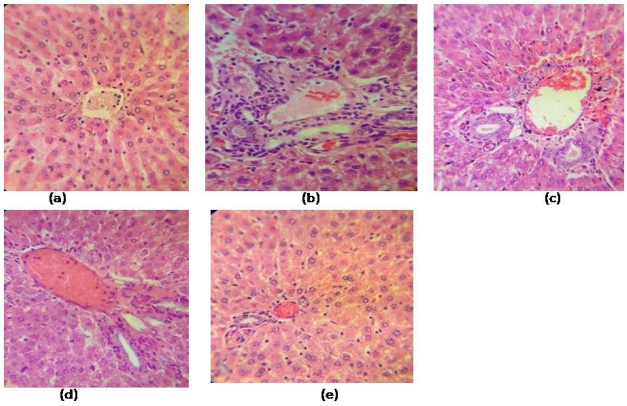

Figure 3: Histology of rat's liver (a) Vehicle group, (b) Disease control (3 g/kg), (c) MEAD (200 mg/kg), (d) MEAD (400 mg/kg), (e) Silymarin (100 mg/kg)

- Normal portal triad and mild dilatation of the sinusoidal space. Low levels of lymphocyte infiltration and no inflammation.
- Both the bile duct and the portal triad looked OK. Periportal liver tissue shows mild dilatation of sinusoidal space. Neither inflammation nor fibrosis could be seen. The Kupffer cells look fine.

Ethanol-induced hepatotoxicity model

We found elevated SGPT, SGOT, cholesterol, and bilirubin levels. In contrast, total protein and albumin levels decreased after ethyl alcohol was used to cause hepatotoxicity in rats. MEAD significantly prevented the elevation of these parameters when compared to hepatotoxic rats given in Table 3.

Total protein and albumin levels were lower in the ethanol-induced hepatotoxic group, but SGOT and SGPT levels were significantly higher, as were cholesterol and bilirubin. Compared to the ethanol-induced hepatotoxic group, SGOT, SGPT, cholesterol, and bilirubin levels in MEAD-treated groups were significantly lower, while the total protein and albumin levels were significantly higher. In the hepatotoxic group, SGOT, SGPT, cholesterol, and bilirubin levels in the standard group were appreciably lower, while total protein and albumin levels were appreciably higher.

Molecular docking studies

In-silico molecular docking technique is used to foretell how two molecules will bond to one another in order to produce a

Table 3: Hepatoprotective activity of MEAD on ethanol-induced hepatotoxicity model

Treatment	*SGOT (U/L)*	*SGPT (U/L)*	*Cholesterol (mg/dL)*	*TP (g/dL)*	*Albumin (g/dL)*	*Bilirubin (mg/dL)*
Control	34.83 ± 1.62	38 ± 2.29	36.66 ± 2.45	7.66 ± 0.27	5.13 ± 0.13	0.21 ± 0.04
Ethanol (12 mL/kg)	113.66 ± 3.22 *	98 ± 3.78 *	134.5 ± 3.17 *	3.06 ± 0.21 *	10.41 ± 0.30 *	0.88 ± 0.08 *
MEAD (200 mg/kg)	84 ± 3.12^{*aA}	71.66 ± 3.26 ^{*aA}	83.33 ± 7.06 ^{*aB}	4.78 ± 0.34 ^{*bA}	9.31 ± 0.11^{*aA}	0.58 ± 0.02 ^{*bB}
MEAD (400 mg/kg)	56.16 ± 2.42 ^{*aA}	58.66 ± 3.62 ^{**aB}	70.5 ± 2.05^{*ans}	5.48 ± 0.04 ^{*aA}	8.51 ± 0.14^{*aB}	0.53 ± 0.03 ^{**aC}
Silymarin (100 mg/kg)	36.66 ± 0.80 ^{nsa}	39.66 ± 2.09 ^{nsa}	64.33 ± 0.65^{*a}	7.31 ± 0.23 ^{nsa}	7.33 ± 0.15^{**a}	0.31 ± 0.04 ^{nsa}

Values are presented as the Mean ± SEM, with n = 6. The outcomes were contrasted with the control group (**p <0.01, *p < 0.05), the ethanol control (^{A}p <0.01, ^{B}p <0.05), and the standard (^{a}p <0.01, ^{b}p <0.05), with ns denoting non-significant.

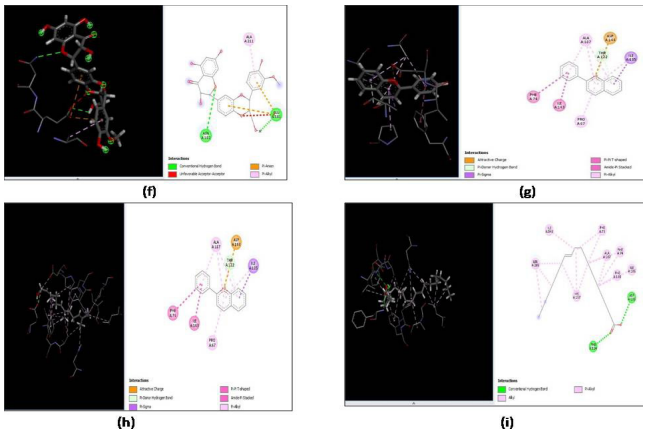

Figure 4: Hydrogen bonding of3E61 with compounds (f) Silymarin (G score -5.2), (g) Flavylium chloride (G score -7.0), (h) Farnesol isomer a (G score -6.9), (i) Erucic acid (G score -6.0).

firm intricate. The foremost binary mechanisms of the complex process known as molecular docking are ligand prediction and orientation and target affinity.

Structure-based drug design

At first, Discovery Studio generated sphere properties for the protein downloaded in PDB format. Both chains have water molecules that are evaporated. Later, molecules are drawn using ChemDraw/Chemsketch in mol format. Protein and ligand were docked against protein 3E61.

Docking results visualization

Discovery Studio was used to render the resulting docking poses. Using a glide score formula, we chose the docked structures that worked the best. The lower the glide scores, the better binding. In addition, various ligand-receptor interactions were analyzed, and docked ligand postures were visualized (Figure 4)

Docking results

An empirical scoring function called the glide score estimates the ligand binding free energy. Different ligands' poses can be ranked with its help since it represent binding free energy; the higher the negative number, the more tightly bound the simulated system is represented in Table 4.

Parameters analyzed in the study include glide score and hydrogen bonding. Results show that Flavylium chloride is having glide score (-7.0), farnesol isomer a (-6.9), erucic acid (-6.0), stearolic acid (-5.6), myristic acid (-5.6), caprylic acid (-5.2), palmitic acid (-5.1), shikimic acid (-5,0), quinic acid (-4.8), silymarin (-5.2). Binding is preferable when the glide score (G score) is low.

Table 4: mCule docking results

Compounds	*G – score*
Flavylium chloride	-7.0
Farnesol isomer a	-6.9
Erucic acid	-6.0
Stearolic acid	-5.6
Myristic acid	-5.6
Caprylic acid	-5.2
Palmitic acid	-5.1
Shikimic acid	-5.0
Quinic acid	-4.8
Silymarin	-5.2

DISCUSSION

Phytochemical investigation reveals that the methanolic extract of *A. deliciosa* peel contains active constituents such as flavonoids, phenolic compounds, terpenoids, and fatty acids. The activation of a portion of acetaminophen through liver cytochrome P-450 2E1 towards a greatly responsive intermediary, N-acetyl-P-benzoquinone imine, is linked to paracetamol's hepatotoxicity (NAPQI). The frequency of NAPQI synthesis is greater than the rate of GSH detoxification. Cellular apoptosis, a surge in the oxidation of fats, and a decrease in glutathione (GSH) levels are all indicators of liver injury. Numerous studies have shown that flavonoids represent promising natural substances for treating liver injury because they suppress the expression of CYP2E1, which may prevent the development of the reactive metabolite NAPQI.[19,20]

Through the production of exceptionally reactive oxygen species (ROS) and toxic metabolites, alcohol worsens the liver's oxidative stress, which in turn damages the organelles and hepatic cells. Furthermore, in multiple types of chronic liver illness, particularly alcoholic liver disorders, the enhanced production of ROS, such as H_2O_2, OH, and superoxide anion (O_2•), has been linked to liver injury. High levels of ROS and adducts are produced in the liver due to alcohol consumption, contributing to oxidative stress. Nitric oxide (NO) levels are raised, and the harmful oxidant peroxynitrite is produced due

to heavy alcohol consumption. Due to a lack of antioxidants, hepatic cells and organelles are injured by reactive aldehydes and reactive oxygen species. Reactive oxygen compounds (ROS), produced during ethanol oxidation by CYP2E1, were an aspect of liver damage brought on by ethanol. Hepatocytes were protected against ethanol-induced oxidative stress by quercetin's inhibition of CYP2E1 and activation of heme oxygenase-1 (HO-1). Besides that, it revealed that CYP2E1 was inactivated by carbon monoxide (CO) *via* HO-1 metabolism, which helped to explain the protective impact on human liver cells. Flavonoids and polyphenolic compounds seem to be bioactive substances proficient in significantly lowering plasma ALT and AST levels, TBARS, soft tissue, gamma-glutamyltranspeptidase (GGT), protein carbonyl content, conjugated dienes, bilirubin, ALP, lipid hydroperoxides and phase-I enzymes while enhancing the enzyme activity of SOD, CAT, GST, GPx, ADH, GRx, and ALDH, besides ascorbic acid and tocopherol levels in tissues and phase-II enzymes through rodents to ethyl alcohol-treated hepatic fibrosis. In paracetamol and ethanol-induced hepatotoxic rats, methanol extracted at double dose points effectively abridged the raised biochemical markers such as SGOT, SGPT, bilirubin, and cholesterol and increased the levels of albumin and TP. Including flavonoids, phenolic chemicals, and glycosides may be the likely mechanism by which MEAD lowered the raised blood biochemical markers in paracetamol-induced and ethanol-induced hepatotoxicity.[21,22]

The hydroxyl radical, a highly reactive free radical produced by biological processes, can disrupt DNA strands by combining the nucleosides in nearly every molecule found in a living cell. In particular, due to the removal of hydrogen atoms from the unsaturated fatty acids, these species are thought to be quick originators of the oxidation of fat process. According to several studies, plants high in phenolics, flavonoids, and similar compounds have antioxidant activity because of their redox characteristics and because hydroxyl groups make it easier to scavenge free radicals. The lipid peroxidation process is considered to be reversed by MEAD's capacity to quench hydroxyl radicals, and the extracts appear to be effective ROS scavengers.[23]

MEAD and silymarin were exposed to *in-silico* docking tests against CYP450 2E1 (PDB ID: 3E6I), which shed more light on how ligands bind to their active sites. Nine substances, including the common medication silymarin, quinic acid, flavylium chloride, farnesol isomer a, shikimic acid, palmitic acid, stearolic acid, erucic acid, myristic acid, and caprylic acid, were docked, and the glide scores were calculated. The mentioned compounds interacted with the active site of CYP450 2E1 and were found to inhibit its expression. From the results, flavylium chloride is having glide score (-7.0), farnesol isomer a (-6.9), erucic acid (-6.0), stearolic acid (-5.6), myristic acid (-5.6), caprylic acid (-5.2), palmitic acid (-5.1), Shikimic acid (-5,0), quinic acid (-4.8), silymarin (-5.2). Based on these findings, it was determined that MEAD has hepatoprotective and antioxidant activity by preventing the production of CYP2E1, the enzyme essential for the biological activation of paracetamol into reactive metabolite and ethanol oxidation in the liver.[24,25]

CONCLUSION

The present study revealed that the methanolic extract of the peel of *A. deliciosa* possesses hepatoprotective and antioxidant activity.

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