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Hepatoprotective Effect of hydroethanolic Seed Extract of *Cassia tora* Linn. in CCl_4-induced Liver Toxicity in Wistar Rats

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ABSTRACT

Cassia tora Linn. is a wild tropical plant used traditionally to treat various ailments. This study determined the hepatoprotective effect of hydroethanolic seed extract of *Cassia tora* in CCl_4-induced liver toxicity in wistar rats. The phytochemical constituents of the seed extract and acute toxicity were determined by standard methods. The concentrations of hydroethanolic seed extract of *C. tora* were 0.64±6.15% (flavonoids), 0.45±0.46% (anthraquinones) and 0.44±0.21% (saponins). The acute toxicity study indicated an LD_{50} of 2,236 mg/kg bw. Administration of 200 mg/kg hydroethanolic seed extract of *C. tora* significantly ($p<0.05$) decreased the activities of the CCl_4-elevated alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), direct bilirubin and total bilirubin to 77.0±9.31 IU/L, 81.0±3.78 IU/L, 29.62±2.68 IU/L, 6.8±0.29 mmol/L and 17.42±0.69 mmol/L respectively, while significant ($p<0.05$) increase in the levels of albumin (ALB) and total protein (TP), to 3.04±0.07 g/dL and 9.30±0.02 g/dL respectively was observed when compared with control. Similarly, administration of 400 mg/kg of *C. tora* seed extract revealed a significant ($p<0.05$) decrease in ALT, AST, ALP, direct bilirubin and total bilirubin to 71.80±7.39 IU/L, 79.30±10.01 IU/L, 28.9±0.48 IU/L, 6.98±0.14 mmol/L and 12.06±0.34 mmol/L respectively, and a significant ($p<0.05$) increase in the levels of ALB and TP with values of 3.18±0.06 g/dL and 8.80±0.61 g/dL respectively when compared with control. The study demonstrated that *C. tora*'s hydroethanolic seed extract has hepatoprotective potential, which may be related to the phytochemicals it contains.

Keywords: Hepatotoxicity, antioxidants, *Cassia tora,* secondary metabolites, ethnomedicine, traditional medicine

INTRODUCTION

Traditional medicine is a comprehensive system incorporating observational knowledge and experience of specific communities, utilizing medications, dosages, and behaviors shaped by

cultural, social, and religious practices [1]. Globally, indigenous people rely on these methods across various therapeutic settings, with studies indicating that nearly 80% of individuals in low-income countries receive primary healthcare from traditional healers [2]. In Nigeria, the escalating costs of goods and services, particularly medical supplies, coupled with reduced purchasing power and high illiteracy rates, have driven more people towards traditional medicines [2, 3]. Ethnomedicine, the study of traditional medicine, examines how different cultures perceive health, illness, and disease, including alternative healing modalities and the necessity of care. It also documents the flora, fauna, and minerals used medicinally by indigenous people in specific regions [4, 5]. Medicinal plants, which exhibit pharmacological effects or therapeutic properties, have been used either directly or as extracts due to their inherent therapeutic qualities [6]. These plants produce a variety of chemical compounds with diverse physiological effects, forming extensive archives of potential therapeutic substances. Many contemporary drugs have origins in natural remedies, with higher plants historically serving as significant sources of medicinal compounds vital to human health [7]. The increasing use of herbal therapy is attributed to its perceived safety [8]. For many years, plants and plant extracts have been used to treat various ailments, but ensuring their safety before use is crucial [9]. Without identifying potential adverse effects, approval for therapeutic use will be denied regardless of efficacy [8].

The precise mechanisms of action of herbal remedies remain largely unknown, inspite of their growing popularity as supplementary treatments for lifestyle-related disorders. This increasing interest has led to extensive research into the potential health benefits of plant products. According to Saleem [10], drug-induced liver impairment is a significant health issue posing challenges for the pharmaceutical industry, law enforcement agencies, and medical professionals. The liver, essential for digestion and excretion, plays a role in eliminating hazardous compounds, foreign substances, and chemotherapeutic drugs, making it susceptible to numerous diseases and ailments.

Many plants have been studied for their potential application in treating liver disorders [11]. Comprehensive reviews of medicinal plants commonly used for liver-related disorders have been conducted [12]. *Cassia tora* Linn., a wild maize thriving as a weed in tropical Asia and Africa, including Nigeria, is traditionally used in Ayurvedic medicine. The leaves and seeds, known for their harsh and bitter taste, have bowel movement effects and exhibit anthelmintic, ophthalmic, cardiotonic, and expectorant properties, useful in treating leprosy, ringworm, bloating, colic, dyspepsia, fecal issues, cough, and lung illness [13].

During the monsoon, *C. tora* grows widely in forests, along roadsides, and on fallow lands. Its high-protein seeds can feed fish, birds, and animals. The Cassia species have medicinal benefits, including hepatoprotective [14, 15], hypoglycemic [16], skin disorder prevention [17, 18], and anti-inflammatory and antipyretic properties [19].

Based on the traditional use and medicinal properties of this plant, this study aims to assess the hepatoprotective effects of *C. tora* hydroethanolic seed extract in wistar rats exposed to CCl_4-induced liver damage.

MATERIALS AND METHODS

Experimental Animals

Wistar rats were obtained from the Animal House of the Department of Biochemistry, University of Maiduguri, Nigeria. The animals were housed in well-ventilated areas in appropriate cages, with bedding consisting of clean, dry wood shavings. Standard growers mash/feeds (pallets made by Grand Cereals Ltd., Nigeria) and unlimited water were provided to the animals. Periodically, the experimental room was cleaned and disinfected. Regular washings were performed on the animal cages and water containers.

Plant Materials

The plant material *(C. tora)* utilised in this study was harvested from the natural environment growing behind the University of Maiduguri's Faculty of Agriculture, Maiduguri, Nigeria. A taxonomist from the Department of Biological Sciences at the University of Maiduguri, Nigeria, subsequently identified it, and the voucher specimen bearing BCHCT011 was deposited.

Plant Sample Preparation

The *Cassia tora* seeds were gathered, weighed, cleaned with tap water, air-dried, and then reweighed and dried completely. The dried seed was then ground into fine powder with a wooden pestle and mortar.

Hydroethanolic Extraction of *Cassia tora* Seed

Exactly Two hundred grams (200 g) of powdered *Cassia tora* seed were placed inside a thimble in an extractor. Using a round-bottom flask and a sample-to-solvent ratio of 1:10 w/v, 2000 ml of 70% ethanol and 30% distilled water (hydroethanolic extraction) were added during the first stage [20]. The continuous cycles were performed for three days, five hours a day until the clear white solutions from the syphon were collected. Following the Soxhlet

extraction, the extract was in the round-bottom flask with a thick, black solvent. The extract was dried on a porcelain plate before being put in desiccators. The yield percentage achieved was 12.53% (w/w). The extract was stored until required for use.

Preparation of Stock Concentration of the Extract

The solution was prepared by dissolving 20 grams of the crude extract in 100 ml of distilled water to give a concentration of 0.2 g/ml and was stored at 4 0C until required.

Qualitative and Quantitative Phytochemical Analysis of the Hydroethanolic Seed Extract of *C. tora*

Anthraquinones [21], Flavonoids [22], alkaloids [23-24], phenols [25], saponins [24], tannins [26, 21], steroids [27], and terpenoids [28] were determined. Quantitatively, the saponin content [29], anthraquinone content [30] and flavonoid content [31] were determined.

Experimental Design for the Evaluation of Hepatoprotective Effect of the Hydroethanolic Seed Extract of *Cassia tora*

The hepatoprotective effect of the hydroethanolic seed extract of *Cassia tora* was determined in rats using the method described by Tsai *et al.* [32], with some modifications.

Forty-eight (48) healthy albino rats were randomly divided into eight experimental groups (I–VIII) of six rats each, following a 5-day acclimatisation.

- The rats in Group I (Normal Control I) were orally administered distilled water and
- Group II (Normal Control II Group) was intraperitoneally administered 10 ml/kg bw of olive oil.
- Rats in Group III (CCl_4 Hepatotoxic Control Group) were intraperitoneally administered 50 % CCl_4 in Olive oil (5 ml/kg).
- The rats in Group IV (Silymarin Standard Control group) were orally administered Silymarin (100 mg/kg BW in distilled water) for 14 consecutive days.

The rats in the Treatment Groups (V and VI) and Extract groups (VII and VIII) were orally administered *C. tora* seed extract in distilled water.

- Group V (200 mg/kg),
- Group VI (400 mg/kg),
- Group VII (200 mg/kg), and
- Group VIII (400 mg/kg) respectively, for 14 consecutive days.

Each group of rats, except for groups I, II, VII, and VIII, received an intraperitoneal injection

of CCl_4 (10 ml/kg BW, in 100% olive oil) 1 hour after the final daily treatments. The rats were sacrificed under anaesthesia using chloroform vapour, and blood samples were collected by cardiac puncture into sample bottles and centrifuged at 3000 rpm for 15 minutes. The resultant supernatant was used to determine the levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), albumin (ALB), bilirubin (BIL), and total protein (TP) for hepatoprotective effects.

Acute Toxicity (LD50) Evaluation

The lethal dose (LD50) of the hydroethanolic seed extract of C. tora was determined in wistar rats using the method described by Lorke [33].

Biochemical Assays for Hepatoprotective Effect of the Hydroethanolic Seed Extract of *Cassia tora*

Alanine aminotransaminase (ALT) activity, aspartate aminotransferase activity, alkaline phosphatase (ALP) activity, total bilirubin (TBil) concentration, direct bilirubin (DBil) concentration, total serum protein, and serum albumin were determined using Quimica Clinica Applicada (QCA) test kits according to the manufacturer's instructions. Each test was done in line with the instructions in the respective kit.

Data Analysis

All data were expressed as Mean ± SEM (Standard Error of Mean). Statistical analysis of data was carried out by one-way analysis of variance (ANOVA) using SPSS version 20. The significant difference between the means was carried out by the Least Significant Difference (LSD). $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Qualitative and Quantitative Analyses of Hydroethanolic Seed Extract of *Cassia tora*

The results of the qualitative and quantitative analyses of the hydroethanolic seed extract of *C. tora* revealed the presence of flavonoids, anthraquinones, steroids, saponins, and terpenoids, as presented in Table 1. The seed extract contains flavonoids at 0.64±0.15 % (w/w), followed by anthraquinones at 0.45±0.04 % (w/w), and saponins was the least with content of 0.44±0.21 % (w/w).

Table 1: Phytochemical Analysis and Quantitative Constituents of Hydroethanolic Seed Extract of *C. tora*

Phytochemicals	Test	Observation	Inference	% (w/w)
Alkaloids	Meyer's test	Blueish black	-	-
Flavonoids	Shinoda's test	Orange	+	0.64±0.15
Anthraquinones	Bontrager's test	Pink	+	0.45±0.04
	Combined anthraquinones	Violet	+	
Phenols	Ferric acid test	Bluish black	-	-
	Lead acetate test	Yellow		
Saponins	Frothing's test	Frothing	+	0.44±0.21
Tannins	$FeCl_3$ test	Brownish green	-	-
Steroids	Salkowski's test	Yellow	+	-
Terpenoids	H_2SO_4 test	Reddish brown	+	-
Alkaloids	Meyer's test	Blueish black	-	-
Flavonoids	Shinoda's test	Orange	+	-

Data presented as the mean of triplicate (mean±SEM).

Key: Present +; Absent -

Acute toxicity studies of hydroethanolic seed extract of *C. tora* in wister rats revealed zero deaths recorded for phase 1 and phase 2 on a 10 mg/kg dose range to 2900 mg/kg. However, minor signs of toxicity were observed, including lethargy, erection of fur, sedation, and pilo erection on doses above 100 mg/kg. There was no toxicity sign at all with a dose of 10 mg/kg. A death was recorded for death on 5000 mg/kg dosage**.**

Liver Function Tests

The effect of hydroethanolic seed extract of *C. tora* on the liver function of Wistar rats is presented in Tables 2 and 3.

The ALT, AST, and ALP activities were significantly raised ($P<0.05$) due to CCl_4 administration. Administration of different doses of the extract caused a decrease in these parameters in the treatment groups. The treatment group receiving 200 mg/kg extract had ALT activity of 77.0±9.31 IU/L against 118.2±4.62 IU/L seen in the CCl_4 control group. In contrast, the 400 mg/kg extract treatment group had ALT activity of 71.8±7.39 IU/L which

was significantly ($p<0.05$) lower than what was found in the hepatotoxic control (Table 2).

In the case of AST, no significant ($p<0.05$) difference was observed in extract-treated groups, i.e 200 mg/kg and 400 mg/kg with AST activity of 81.0±3.78 IU/L and 79.3±10.01 IU/L respectively. However, both the extract treatment groups of AST were significantly ($p<0.05$) lower than that of the hepatotoxic control, with an activity of 144.20±7.05 IU/L, and there was no significant ($p<0.05$) difference between the hepatotoxic control group (144.20±7.05 IU/L) and that of STD control group (129.20±12.23 IU/L) (Table 2)

The 200 mg/kg extract treated group had ALP activity of 29.62±2.68 IU/L as against 58.64±6.83 IU/L seen in the CCl_4 hepatotoxic control group. Similarly, the 400 mg/kg extract-treated group had ALP activity of 28.9±0.48 IU/L as against 58.64±6.83 IU/L seen in the CCl_4 control group. There was no significant difference between the different doses of the extract on ALP.

Table 2. Effect of hydroethanolic Seed Extract of *Cassia tora* on the Liver Function of Wistar Rats

Experimental Groups	ALT (IU/L)	AST (IU/L)	ALP (IU/L)
DH_2O (normal control)	19.2 ± 4.69^{e}	17.0 ± 2.98^{f}	9.70 ± 1.00^{f}
Olive oil (normal control)	25.8 ± 4.32^{d}	46.0 ± 5.77^{c}	19.56 ± 0.80^{e}
CCl_4 (hepatotoxic control)	118.2 ± 4.62^{a}	144.2 ± 7.05^{a}	58.64 ± 6.83^{a}
Silymarin (STD control) + CCl_4	72.2 ± 3.63^{b}	129.2 ± 12.23^{a}	33.62 ± 2.41^{b}
200 mg/kg extract + CCl_4	77.0 ± 9.31^{c}	81.0 ± 3.78^{b}	29.62 ± 2.68^{c}
400 mg/kg extract + CCl_4	71.8 ± 7.39^{b}	79.3 ± 10.01^{b}	28.9 ± 0.48^{c}
200 mg/kg extract	26.0 ± 1.26^{d}	27.6 ± 0.20^{d}	24.38 ± 1.56^{d}
400 mg/kg extract	26.8 ± 0.80^{d}	22.6 ± 1.50^{e}	18.08 ± 2.83^{e}

Results are expressed as Mean±SEM (n = 6)

Values with different superscripts down the group are statistically ($p<0.05$) significant.

AST=Aspartate aminotransferase; ALT=alanine aminotransferase; ALP=alkaline phosphatase

The administration of CCl_4 significantly ($P<0.05$) increases the level of both the serum direct bilirubin (DBil) and total bilirubin (TBil).

In the DH_2O normal control group, the DBil level of 6.58±0.10 mmol/l was formed with a significant difference ($p<0.05$) as against 9.12±0.44 mmol/l seen in the CCl_4 hepatotoxic control group; while TBil level (12.8±0.64 mmol/l) was significantly ($p<0.05$) lower than that was observed in CCl_4 control (18.92±0.84 mmol/l) as presented in Table 3).

Similarly, the olive oil normal control group showed a DBil level of 7.94±0.07 mmol/l, which was significantly different ($p<0.05$) as against 9.12±0.44 mmol/l seen in the CCl_4 hepatotoxic control group, whereas its TBil level was found to be 16.78±0.16 mmol/l with no significance ($p<0.05$) as against 18.92±0.84 mmol/l seen in the CCl_4 hepatotoxic control group (Table 3).

The extract-treated groups showed a marked ($P<0.05$) decrease in the level of both DBil and TBil owing to the administration of seed extract of *C. tora*. The 200 mg/kg extract treated group had DBil concentration of 6.8±0.29 mmol/l as against 9.12±0.44 mmol/l as seen in the CCl_4 hepatotoxic control group, while 400 mg/kg extract treated group had DBil level of 6.98±0.44 mmol/l as against 9.12±0.44 mmol/l as seen in the CCl_4 hepatotoxic control group.

In case of TBil, the 200mg/kg extract treated group had TBil concentration of 13.18+0.34 mmol/l as against 18.92±0.84 mmol/l as seen in the CCl_4 hepatotoxic control group, while the 400 mg/kg extract treated group had TBil level of 12.06±0.34 mmol/l as against 18.92±0.84 mmol/l as seen in the CCl_4 control group.

Also, CCl_4 administration caused a significant ($P<0.05$) decrease in Albumin and Total Protein as compared with both the DH_2O normal control group and the Olive Oil normal control group, whose Albumin and Total Protein concentrations were found to be 3.04±0.07, 3.18±0.06 and 9.30±0.27, 8.8±0.61, respectively. There is a significant ($P<0.05$) increase in the Albumin concentration owing to *Cassia tora* seed extract administration; however, no significant ($P<0.05$) increase was found for Total Protein.

Administration of 200 mg/kg seed extract significantly ($P<0.05$) increased the Albumin concentration to 3.04±0.07 g/dl as against 2.14±0.05 g/dl seen in the CCl_4 hepatotoxic control group, while the 400mg/kg extract treated group had Albumin concentration of 3.18±0.06 g/dl as against 2.14±0.05 g/dl seen in the CCl_4 hepatotoxic control group (Table 3)

Both 200 mg/kg and 400 mg/kg extract-treated groups showed no significant ($P<0.05$) increase in total protein concentration of 9.3±0.27 g/dl and 8.8±0.61 g/dl, respectively, as against 8.20±1.37 g/dl seen in the CCl_4 control group (Table 3).

Table 3: Effect of hydroethanolic Seed Extract of *Cassia tora* on the Liver Marker Enzymes of Experimental Wistar Rats

Experimental Groups	TP (g/dl)	ALB (g/dl)	DBIL (mmol/l)	TBIL (mmol/l)
DH_2O (normal control)	13.78± 0.83^b	3.32± 0.22^c	6.58± 0.10^c	12.8± 0.64^b
Olive oil (normal control)	12.36±0.62^b	3.04±0.20^c	7.94±0.07^b	16.78± 0.16^a
CCl_4 (hepatotoxic control)	8.20± 1.37^a	2.14± 0.05^a	9.12± 0.44^a	18.92± 0.84^a
Silymarin (STD control) + CCl_4	9.38± 0.65^a	2.84± 0.18^b	7.82± 0.16^b	17.42± 0.69^a
200 mg/kg extract + CCl_4	9.3± 0.27^a	3.04± 0.07^c	6.8± 0.29^c	13.18± 0.34^b
400 mg/kg extract + CCl_4	8.8± 0.61^a	3.18± 0.06^c	6.98± 0.14^c	12.06± 0.34^b
200 mg/kg extract	9.18± 0.51^a	3.06± 0.27^c	8.16± 0.24^b	12.1± 0.98^b
400 mg/kg extract	11.98± 0.47^b	3.28± 0.15^c	7.58± 0.15^b	13.16± 0.64^b

Results are expressed as Mean±SEM (n=6 for each group)

Values with different superscripts down the group are statistically ($p<0.05$) significant.

ALB=Albumin; DBil= Direct Bilirubin; TBill=Total Bilirubin; TP=Total Protein

The phytochemical analysis of the extracts from *Cassia tora* seeds showed the presence of steroids, glycosides, carbohydrates, and flavonoids. These findings are consistent with those of Surana *et al.,* [34], who also reported finding these same compounds in the methanolic and aqueous extracts from *Cassia tora* seeds. According to Suradkar *et al.,* [35], *C. tora*'s ethanolic extract contains glycosides, alkaloids, terpenoids, flavonoids, and saponins. The results of this investigation are also consistent with those of Noha *et al.* [36], who found that the alcoholic seed extract of *C. tora* contains glycosides, steroids, carbohydrates, flavonoids, and saponins.

As one of the most fundamental organs, the liver helps the body get rid of drugs and xenobiotics, aids in detoxification, guards against outside dangers and is involved in substance metabolism [37]. After tissue damage, a number of these enzymes may leak into

the blood. Serum enzyme evaluations are therefore a crucial clinical diagnostic tool that indicates the kind and degree of diseased tissue damage [38].

The liver can be harmed by a variety of factors, such as autoimmune diseases, biological disorders, high dosages of paracetamol, antitubercular drugs, and lethal compounds, such as thioacetamide, carbon tetrachloride, diethylnitrosamine, 4-Dglucosamine/lipopolysaccharides, and excessive alcohol consumption [39]. Serum biochemical markers such as bilirubin, alkaline phosphatase, and serum aminotransferases may rise as a result [40].

C. tora seed demonstrated antioxidant capability, a commonly used metric for evaluating the medicinal benefits of employing plants to treat a variety of ailments. Carbon tetrachloride is one of the hepatotoxins that are most commonly used in the experimental study of liver diseases [41]. The primary cause of the compound's liver-damaging effects is the trichloromethyl radical, an active metabolite of CCl_4 [41]. This lipid peroxidative biomembrane disintegration is one of the primary mechanisms by which CCl_4 is hepatotoxic [42]. It is widely acknowledged that antioxidant activity, or the inhibition of free radical formation, is one of the most important defenses against CCl_4-induced liver damage or injury [42]. According to Oboh and Akindahusi's [43] findings, the ethanolic seed extract of *C. tora* shielded the liver from harm, even though the CCl_4 control group in the investigation was shown to have caused substantial liver damage. According to a study by Habori *et al.,* [44], the aminotransferases ALT and AST could both quantify the degree of liver damage and suggest potential liver damage. This is evident in this study, where the administration of CCl_4 results in high levels of these enzymes that were significantly reduced through the administration of the extract (Table 2). Additionally, Saravanan and Malarvannan [45] found that the methanolic seed extract of *C. tora* showed a strong hepatoprotective effect by reducing bilirubin, serum transaminases, and alkaline phosphatase (ALP) activity, as well as hepatotoxin (CCl_4)-induced liver damage. However, the hepatoprotective effect of the extract in this study was not dose-dependent. Significant drops in serum marker levels were seen in ethanolic seed extracts of *C. tora*, indicating liver cell and dose-dependent protection against acetaminophen-induced hepatocellular injury [46].

The hydroethanolic seed extract of *C. tora* had the potential to act as a free radical scavenger, as evidenced by the significant ($p<0.05$) decrease in liver enzyme activity observed in the extract-treated groups when compared to the CCl_4 control group. Additionally, the extract may be able to reduce the amount of trichloromethyl radical produced, which is

the cause of liver injury [47]. The extract may have hepatoprotective properties that help to lessen the severity of the CCl_4-induced liver damage and ulceration [48]. The extract-treated groups exhibited a substantial ($p<0.05$) reduction in ALT activity, suggesting that the hydroethanolic seed extract of *C. tora* may be able to shield liver cells against CCl_4-induced damage.

The CCl_4 hepatotoxic control group had a considerably lower ($p<0.05$) albumin concentration (2.14±0.05 g/dl) than the DH_2O and olive oil normal control groups, which showed 3.32±0.22 and 3.04±0.20 g/dl, respectively, as the negative control groups (Table 3). This suggests that liver damage is likely to have occurred. This supports the findings of Oboh and Akindahusi's [43], which showed that liver injury, lowers blood albumin concentration. It is possible that the injection of CCl_4 damaged the liver in some way, which would have prevented the liver from producing albumin. In contrast to the CCl_4 control group, the silymarin-treated group's albumin concentration increased significantly ($p<0.05$), supporting the notion that silymarin is a common antioxidant medication that may be used to treat liver damage. According to Saravanan and Malarvannan [45], rats' blood levels of albumin and total protein increased significantly ($p<0.05$) in response to the methanolic seed extract of *C. tora*. Comparing the aqueous and methanolic seed extracts of *C. tora* treated groups to the hepatotoxic group; a similar outcome was observed in terms of serum bilirubin. Thus, a balance between oxidant and antioxidant intracellular systems is critical for cell function, regulation, and adaptation to a range of developmental circumstances [49]. On the other hand, the overproduction of reactive oxygen species can result in oxidative stress, loss of cell function, and ultimately apoptosis or necrosis [49]. Dudonne *et al.,* [50] stated that oxidative damage is believed to have a role in the ageing process as well as other degenerative diseases, such as cancer, heart disease, cataracts, and cognitive loss. Numerous studies have shown that the main hepatoprotective properties of medicinal plant extracts may stem from their capacity to transfer hydrogen to free radicals, block oxidases, and activate antioxidant enzymes [51, 52].

CONCLUSION

The results of this study revealed that the hydroethanolic seed extract of *Cassia tora* may have hepatoprotective qualities, which may be related to the phytochemicals it contains. Consequently, this medicinal plant seed may be suggested to prevent liver damage. Histopathological studies are needed to validate the findings from the research. The study

recommends isolation, characterisation, and screening for the active ingredients in the hydroethanolic seed extract with hepatoprotective qualities to understand the mechanism of action of the biochemical components.

REFERENCES

[1] Tom, E.G., Silje, G., Mona, S., Ngolo, B., Sekou, B., Drissa, D. & Berit, S.P. (2008). Ethnopharmacological Survey of Six Medicinal Plants from Mali, West Africa. *Journal of Ethnobiology and Ethnomedicine,* 4, 26.

[2] Omonike, O.O. (2010). Ethnobotanical Survey of Plants Used in the Treatment of Inflammatory Diseases in Ogun State, Nigeria. *European Journal of Scientific Research,* 43(2), 183-191.

[3] Christiana, J.D., Ishaku, L.E., Nkechi, V.O., Jurbe, G.G., Olumola, O.O., Micah, S. Sunday, M. & David, S. (2012). Antidiarrheal Evaluation of Aqueous and Ethanolic Leaf Extracts of *Acacia sieberiana* DC. (*Fabaceae*) in Albino Rats. *Asian Journal of Experimental Biological Sciences* 3(4), 779-803.

[4] Savnar, H.C. (1993). *A Handbook of Ayurvedic Materia Medica. Jarthar and Sons, Balegaum Karnataka, India,* 4, 258-261.

[5] Krippner, S. (2003). Models of Ethnomedicinal Healing. *Paper Presented at the Ethnomedicine Conference, Munich, Germany*. April, 26-27: 11-12.

[6] Ashis, G., (2003). Herbal Folk Remedies of Bankura and Medinipur Districts, West Bengal. *Indian Journal of Traditional Knowledge* ; 2: 393-396.

[7] Palanivelu, S, (2015). Analysis of Bioactive Compounds in Ethanol Extracts of Argemone *mexicane* Plant Seeds Using GC-MS Techniques. *Indian Journal of Applied Research,* 5(5), 19-20.

[8] SenthamilSelvan P., Velavan S., Sagunthala P., Prakash N. & Subramanian S. (2015). Analysis of Phytochemical Component and Nutrients Component in Ethanol Extract of *Oldenlandia corymbosa*. *World Journal of Pharmaceutical Research*; 4(7), 1965 - 1967.

[9] Baris O., Gulluce M., Sahin F., Ozer H., Kilic H., Ozkan H., Sokmen M. & Ozbek T. (2006). Biological activities of the Essential Oil and Methanol Extract of *Achillea Biebersteinii Afan*. (*Asteraceae*).*Turkish Journal of Biology*, 30, 65–73.

[10] Saleem, M. (2008). Hepatoprotective Activity of *Annona squamosa* Linn. on Experimental Animal Model. *International Journal of applied Research and Natural Products*, 1(3), 1-7.

[11] Saleem M. & Naseer F. (2014). Medicinal Plants in the Protection and Treatment of Liver Diseases. *Bangladesh Journal of Pharmacology,* 9, 511-26.

[12] Muhammad I.Q. & Ahmed Z. (2017). Advances in Hepatoprotective Medicinal Research. *Bangladesh Journal of Pharmacology*. 12, 229- 242.

[13] The Wealth of India, (1992). A Raw Material, *vol. III. Revised ed. CSIR New Delhi;* 368-370.

[14] Upadhyay, K., Dixit, V.K. & Bhatt, Z.A., (2000). *In vitro* Evaluation of Hepatoprotective Activity of Leaves of *Cassia tora* Linn. *Indian Journal of Natural Products.* 16(1), 27-30.

[15] Farswan, M., Mazumder, P. M. & Percha V., (2009). Protective Effect of *Cassia glauca* Linn. on the Serum Glucose and Hepatic Enzymes Level in Streptozotocin Induced NIDDM in Rats. *Indian Journal of Pharmacology*. 41: 19–22.

[16] Daisy, P., Balasubramanian, K., Rajalakshmi, M., Eliza, J. & Selvaraj, J. (2010). Insulin Mimetic Impact of Catechin Isolated from *Cassia fistula* on the Glucose Oxidation and Molecular Mechanisms of Glucose Uptake on Streptozotocin-induced Diabetic Wistar Rats. *Phytomedicine.* 17, 28-36.

[17] Sridhar, K. R. & Bhagya, B. (2007). Coastal Sand Dune Vegetation: a Potential Source of Food, Fodder and Pharmaceuticals. *Livestock Research for Rural Development,* 19, 6.

[18] Roopashree T., Dang R., Rani RS. & Narendra C. (2008). Antibacterial Activity of Antipsoriatic Herbs: *Cassia tora, Momordica charantia* and *Calendula officinalis. International Journal of Applied Research in Natural Products,* 1, 20-8.

[19] Gobianand, K., Vivekanandan, P., Pradeep, K., Mohan, C.V.R. & Karthikeyan, S. (2010). Anti-inflammatory and Antipyretic Activities of Indian Medicinal Plant *Cassia fistula* Linn. (*Golden shower*) in Wistar Albino Rats. *International Journal of Pharmaceutical,* 6: 719-725.

[20] Azwanida N. N., (2015) A Review on the Extraction Methods Use in Medicinal Plants, Principle, Strength and Limitation. *Medicinal Aromatic Plants* 4, 196.

[21] Trease G. E. & Evans W. C., (2002). Edition. A *Textbook of Pharmacognosy. Bailliere Tindal. London*. 76-87.

[22] Harbone, J.B. (1988). Phytochemical Methods. *Chapman and Hall Ltd. London, UK.*, 49-188.

[23] Sofowora A. (1984). Medicinal Plants and Traditional Medicine in Africa, 2nd Edition, *Spectrum Books Limited (Publisher), Ibadan, Nigeria*. 134-156.

[24] Awe I. S. & Sodipo O. A. (2001). Purification of Saponin in Root of *Blighoi sopida* KOEEHLG-HOLL. *Nigerian Journal of Biochemistry and Molecular Biology,* 16(3), 201-204.

[25] Evans, W.C. (1996). *Trease Evans Pharmacognosy.*, 14th Ed, London: WB Saunders Ltd, 119-159.

[26] Sofowora, E.A. (1993). Medicinal Plants and Traditional Remedies in Africa. *University of Ile-ife press, Nigeria. Spectum Books Ltd. Ibadan, Nigeria* 1-23

[27] Akinyeye, A.J., Solanke, E.O. & Adebiyi, I.O. (2014). Phytochemical and Antimicrobial Evaluation of Leaf and Seed of *Moringa olifera* Extract. *International Journal of Research in Medicinal and Health Science,* 4 (6), 307-2083.

[28] Geisssman, T.A, (193). Flavonoids Compounds, Tannins, Lignins and Related Compounds, In M. Florkimn and Stotz (ed) Pyrro Pigments, *Isoprenoid Compound and Phenolic Plant constituent*: 9 (1) 256.

[29] Obdoni B.O. & Ochuko P.O. (2001). Phytochemical Studies and Comparative Efficacy of the Crude Extracts of some Homostatic Plants in Edo and Delta States of Nigeria. *Global Journal of Pure and Applied Sciences*. 8 b: 203-208.

[30] Fairbairn, J. W. (1972). *Chemotaxonomy of Anthraquinones in Rumex Phytochemistry*; 11; 263.

[31] Krishnaiah, D., Devi, T., Bono A. & Sarbatly, R. (2009). Studies on Phytochemical Constituents of Six Malaysian Medicinal Plants. *Journal of Medicinal Plants Research,* 3(2), 67-72.

[32] Tsai J. C., Peng W. H., Chiu T. H., Huang S. C., Huang T. H. & Lai S. C. (2010), Hepatoprotective Effect of *Scoparia dulcis* on Carbon Tetrachloride-induced Acute Liver Injury in Mice. *American Journal of Chinese Medicine,* 38 (4) 761-775

[33] Lorke D (1983). A New Approach to Acute Toxicity Testing. *Archives of Toxicology.* 54: 275-287.

[34] Surana V.S., Satani B., Shah P.D. & Shah D.R. (2012) Hepatoprotective Effect of *Cassia tora* Seeds on Experimental Animal Model. *American Journal of Pharmaceutical and Technological Research*, 2(2)

[35] Suradkar V.B., Wankhade B.B. & Dabbe P.G. (2017). Phytichemical Analysis of Some Contents of *Cassia tora* and *Xanthium Strumarium* Plant Seeds. *International Journal of Advanced Research in Science, Engineering and Technology,* 4.

[36] Noha F., Mokhtar B., Abdel N. S. & Osama S. (2015). Phytochemistry and Biological Evaluation of *Cassia tora* L. Seeds. *Journal of Pharmacology and Biological Sciences,* 10, 1-8.

[37] Sagar R, Bhaiji A, Toppo F.A, Rath B. & Sahoo H.B. (2014). A Comprehensive Review on Herbal Drugs for Hepatoprotection of 21st century. *International Journal of Nutrition, Pharmacology and Neurological Diseases,* 4, 191-97.

[38] Wills, D. E. (1985): *Biochemical Bases of Medicine*. John Wright and Sons Ltd Bristol, England, 267-268.

[39] Khan M.Z., Jogeza N., Tareen J.K., Shabbir M.I., Malik M.A. & Khan AUR. (2016). Compilation on Medicinal Plants with Hepatoprotective Activity. *Israel Medical Journal*, 8, 196-202.

[40] Chaudhari N.B., Chittam K. & Patil V. (2009). Hepatoprotective Activity of *Cassia fistula* Seeds against Paracetamol-induced Hepatic Injury in Rats. *Archive Pharmaceutical Science Research,* 1, 219-21.

[41] Liu, K.X., Kato, Y., Yamazaki, M., Higuchi, O., Nakamura, T. & Sugayama, Y. (1995). Decrease in the Hepatic Clearance of Hepatocyte Growth Factor in CCl_4-induced Rats *Hepatology*, 17 (4), 651-660.

[42] Watkins P. B., Kaplowitz N. & Slattery J. T. (2006). Aminotransferases Evaluation in Heallthy Adults Receiving 4 Grams of Acetaminophen Daily: A Randomised Controlled Trial. *The Journal of American Medical Association*. 296(1), 87-93.

[43] Oboh G. & Akindahusi A. A. (2005). Nutritional and Toxicological Evaluation of *Saccormyces cerevisiae* fermented cassava fluor. *Journal of Food Composition and Analysis*. 18, 731-731

[44] Habori, M., L-Aghbari, A., Al-Mamary, M. & Bukar, M. (2002). Toxicological Evaluation of *Cathedillis* Leaves a Long Term Feeding Experiment in Anikalo. *Journal of Ethnopharmacology,* 83, 209-217

[45] Saravanan G. & Malarvannan L. (2016). Hepatoprotective activity of *Cassia tora* on Carbon Tetrachloride-induced Hepatotoxicity. *Asian Journal of Innovative Research,* 1, 1-5.

[46] Ingle A, Ranaware P, Ladke A. & Damle M. (2012). *Cassia tora* Phytochemical and Pharmacological Activity. *International Imperial Journal of Pharmacognosis and Natural Product.* 2(1), 14-23.

[47] Vozenin-Botons M. C., Sivan V., Gualt N., Ronard C., Geffrotin C., Delanian S., Lefiax J.L. & Martin M. (2001). Antifibrotic Action of Cu/Zn SOD is Mediated by TGF-betal Repression and Phenotypic Reversion of Myofibroblasts. *Free Radical in Biology and Medicine*. 30 (1), 30-42.

[48] Sodipo O. A., Abdulrahman F. I., Akan J. C. & Akinniyi J. A. (2008). Phytochemical Screening and Elemental Composition of *Solanum macrocarpon L*. *Continental Journal of Applied Sciences*. 3, 85-94.

[49] Bobrowski, K., (2005). Free Radicals in Chemistry, Biology and Medicine: *Contribution of Radiation Chemistry*. Nukleonik, 50, 67S–S76.

[50] Dudonne, S., Vitrac, X., Coutiere, P. Woillez, M. & Merillon, J.M. (2009). Comparative Study of Antioxidant Properties and Total Phenolic Content of 30 Plant Extracts of Industrial Interest Using DPPH, ABTS, FRAP, SOD, and ORAC Assays. *Journal of Agriculture and Food Chemistry*, 57, 1768–1774.

[51] Bourogaa, E.,Nciri, R., Mezghani-Jarraya, R., Racaud-Sultan, C., Damak, M. & El Feki A. (2013). Antioxidant Activity and Hepatoprotective Potential of *Hammada scoparia* against Ethanol-induced Liver Injury in Rats. *Journal of Physiology and Biochemistry,* 69, 227–237.

[52] Hsu, Y.W. Tsai, C.F. Chen, W.K. & Lu, F.J. (2009). Protective Effects of Seabuckthorn (*Hippophae rhamnoides* L.) Seed Oil against Carbon Tetrachloride-induced Hepatotoxicity in Mice. *Food Chemistry and Toxicology*, 47, 2281–2288.