



Protective Effect of Herbal Medicinal Plant Extract against Carbon Tetrachloride (CCl₄)-Induced Liver Injury in Rats

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ABSTRACT

The objective of the current investigation was to investigate the hepatoprotective effect of *Curcuma amada rhizome* extracts against carbon tetrachloride (CCl₄)-induced liver injury in rats. The Methanolic & Hydroethanolic extracts of *Curcuma amada rhizome* were administered orally at a dosage of 500 mg/kg body weight to Wistar albino rats, with Silymarin serving as the standard. Methanolic and Hydroethanolic extract showed a strong hepatoprotective effect by restoration of functional parameters, physical parameters, biochemical parameters and reducing blood enzymes alkaline phosphatase (ALP), and total bilirubin (TBL) in the chosen animal. The chemical contents of the plant include alkaloids, flavonoids, glycosides, steroids, terpenoids, phenolics, and saponins, among others. The overall experimental findings imply that bioactive phytoconstituents, such as flavonoids and alkaloids found in the Methanolic and Hydroethanolic extracts of *Curcuma amada rhizome*, may be responsible for the plant's substantial hepatoprotective action. Consequently, the findings support the use of *Curcuma amada rhizome* as a hepatoprotective agent.

Keywords: Carbon tetrachloride, Hepatoprotective activity, *Curcuma amada rhizome*.

Introduction

Curcuma name was coined by Linnaeus in 1753 in his Species Plantarum. The word likely gets its reference from the Arabic word 'kurkum', which means yellow colour. *Curcuma amada* Roxb. (Family: Zingiberaceae) is enduring rhizomatic fragrant herb which is known as Mango ginger and is available from month November to April. Mango ginger (*Curcuma amada* Roxb.) is an antique spice which has morphological resemblance with ginger but it imparts a raw mango flavour. The genus originated in the Indo-Malayan region, and is broadly distributed in the tropics of Asia to Africa and Australia. [1]. In India it is found in regions of West Bengal, Madhya Pradesh,

Chattisgarh Orissa, and Uttar Pradesh. It prospers well in wet deciduous woodland regions. Rhizomes of another species *Curcuma amada* (Mango ginger) normally known as Amba Haldi, grown in west Bengal and on the slopes of West coast of India. Mango ginger is grown in regions of Gujarat and discovered wild in pieces of West Bengal, U.P, Karnataka and Tamil Nadu. [2,3], *Curcuma amada* Roxb. is a rhizomatous fragrant spice with a leafy tuft and grows upto height of 60-90 cm. Leaves are long, petiolate, oval lanceolate, tightening at the two closures, glabrous and green on the two sides. [4, 5]. Rhizome is small in size, 3×1 cm, cone like brownish; roots many, some ending in root tubers. Flowers are

longer than the bracts, 4.5-5.5 cm; bract 3-4 cm; light yellow. Calyx 1-1.2 cm, 3 lobed at peak, violet dabbled, thickly pubescent. Corolla tube light yellow, Seeds 3.5-5 mm long obovate; aril white [6,7,8]. Indian medication utilizes turmeric powder for the treatment of biliary issues, cold and flu, anorexia, hepatic problems, diabetic injuries, rheumatics and sinusitis. The rhizome is very pungent, healing, bitter, laxative, vulnerary anthelmintic, tonic and emollient. It is also used as a medicine in various kapha and vata blood diseases. It is used in the treatment of bronchitis, vertigo, dropsy, skin diseases, elephantiasis, burns, boils, sprains, fevers, swellings, chronic gonorrhoea, bruises, chicken pox, small pox, snake bites, scabies, dyspepsia, ring worm, etc. [9-14]. Here, we tested the efficacy of methanol and hydroethanol extracts of *Curcuma amada* on CCl₄-induced liver damage in rats to see whether they might prevent or lessen the severity of the disease.

Procurement and Authentication of the Plant

The *Curcuma amada* rhizome were gathered from the surrounding region of Alwar, Rajasthan, and then sent to Sunrise University, Alwar, Rajasthan, where they were certified by Dept. of Botany, Sunrise University, Alwar, Rajasthan.

Preparation of extracts of *Curcuma amada*

In a Soxhlet apparatus, 500g of powdered *Curcuma amada* rhizome were extracted with solvent in order to increasing polarity. The materials were concentrated by evaporation [15].

Animals

Wistar albino rats (150-200 g) were procured from Central Drug Research Institute, Lucknow, India. The animals were fed with standard pellet diet (Hindustan lever Ltd. Bangalore) and water *ad libitum*. All the animals were acclimatized for a week before use. The experimental protocols were approved by Institutional Animal ethics Committee after scrutinization. Animals were received the drug by oral gavages tube. All the animals were care of under ethical consideration as per the CPCSEA guidelines with regular inspections of

rats. The laboratory conditions duly undertaken by registered veterinary practitioner [16].

Chemicals

All the chemicals and solvents were of analytical grade. Silymarin was obtained as gift sample from Micro Lbs, Goa, India. Standard kits for SGOT, SGPT and ALP etc. were obtained from Span Diagnostics Ltd., India.

Preliminary phytochemical analysis

To determine which phytoconstituents were present in each extract, a preliminary phytochemical study was performed.

Toxicity studies

All of the extracts were subjected to an acute toxicity test in accordance with OECD 423 guidelines [16]. Research on acute toxicity was conducted on female albino rats. Before administering the extract orally at dosages of 100, 200, and 500mg/kg b.w., the animals were fasted for 24 hours with only water provided, and then monitored for toxic symptoms for up to 72 hours. The therapeutic oral dosage for all extracts was 500 mg/kg body weight.

Carbon tetrachloride induced hepatotoxicity

The rats, of both sexes, were split up into 6 groups of six each. ($n = 6$) [16, 17]

1. Group I (Control): administered water (5 mililitre/kilogram, p.o.) o.d. for nine days.

2. Group II (-ve control): administered water (5 mililitre/kilogram, p.o.) o.d. for nine days, meanwhile on the seventh day, carbon tetrachloride (1 ml/kg in 50% v/v olive oil, s.c.) was given.

3. Group III (+ve control): administered the normal medicine silymarin (25 mg/kg, p.o.) o.d. for nine days, meanwhile on the seventh day, carbon tetrachloride (1 ml/kg in 50% v/v olive oil, s.c.) was given.

4. Group IV and V (Test Sample) administered The Methanolic (MECA) & Hydroethanolic (HEECA) (500 mg/kg) extracts of *Curcuma amada* rhizome o.d. for nine days, meanwhile on the seventh day, carbon tetrachloride (1 ml/kg in 50% v/v olive oil, s.c.) was given.

On last day, blood was obtained from animals by puncturing retro orbital plexus. Blood

samples were allowed to clot for 45 min at room temperature. Serum was separated by centrifugation at 2500 rpm at 30°C for 15 min and utilized for the estimation of various biochemical parameters including SGOT & SGPT [18], ALP [19], serum bilirubin [20] and serum protein [21]. After collection of blood samples, the animals were sacrificed under deep ether anesthesia. Morphological parameters like weight of animals, weight of liver have also been used to evaluate the protective effect of the drug. Hepatoprotective chemical causes loss in liver weight/100 gm body weight of rats [22, 23].

Histopathology studies

A portion of liver tissue of all the animal groups was excised and then washed with normal saline. The liver tissues were fixed in 10% buffered neutral formalin for 48 hrs and then with bovine solution for 6 hrs and were then processed for paraffin embedding. By using a microtome, sections of 5 mm thickness were taken and stained with hematoxylin and eosin. These sections were examined under light microscope using a magnification of 100X [24].

Statistical Significance

The results of the study were expressed as mean \pm SEM, n=6. ANOVA [25] was used to analyze and compare the data, followed by Dunnett's [26] test for multiple comparisons.

Results

Chemical testing identified the presence of the phytoconstituents in the different extracts. The findings demonstrate that *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* contain the greatest amount of pharmacologically active compounds, such as glycosides, sponins, phytosterols, and flavonoids. As a result, these extracts were chosen for the pharmacological research. The findings are shown in **Table 1**. There was no mortality found amongst the graded dose groups of animals and they did not show any toxicity or behavioural changes at a dose level of 5000 mg/kg. This finding suggests that *Methanolic (MECA) & Hydroethanolic (HEECA)* (500 mg/kg) extracts of *Curcuma amada rhizome* were safe or non-toxic to rats and hence doses of 500 mg/kg, *p.o.* were

selected for the study. All groups of animals tested fell asleep after receiving an intramuscular injection of thiopentone sodium (40 mg/kg). When CCl₄ was administered to rats, the beginning of sleep was significantly delayed (measured in seconds) and the total amount of time spent in sleeping was increased (measured in minutes). Pretreatment with *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, *p.o.*) and silymarin, substantially improved sleep onset but dramatically reduced sleep duration in rats compared to a CCl₄ treatment group. The outcomes are shown in **Table 2**. An increase in liver weight and liver volume were seen in the CCl₄ treated group, indicating that the livers of these individuals had grown in size. Liver weight was significantly restored in the groups given *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, *p.o.*) together with silymarin. The findings are shown in **Table 3**. There was a significant elevation in the levels of serum marker enzymes like SGOT, SGPT and ALP content of CCl₄ treated groups, But pretreatment with *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, *p.o.*) and silymarin (25 mg/kg, *p.o.*) exhibited an ability to counteract the hepatotoxicity by decreasing serum marker enzymes. The findings are shown in **Table 4**. In CCl₄ treated groups, there was a significant increase in total bilirubin and significant reduction in total protein content. Whereas, pretreatment with *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, *p.o.*) caused significant reduction in total bilirubin and significant increase in total protein. The findings are shown in **Table 4**.

5. Histopathological studies of liver also provided a supportive evidence for biochemical analysis. Histological changes such as steatosis (fatty changes in hepatocytes) and perivenular fibrosis were observed in CCl₄ treated (toxic) control group. Both the extracts has prevented these histological changes. The results were showed in **Figure 1**.

Table 1: Preliminary Phytochemical studies of Extracts of *Curcuma amada* rhizome

Constituents	Methanolic Extract (MECA)	Hydroethanolic Extract (MECA)
Carbohydrate	+	+
Glycosides	-	-
Oil and fats	-	+
Proteins	+	+
Saponins	-	-
Phenolic comp. and tannins	+	+
Phytosterols	+	+
Alkaloids	+	+
Gums and mucilage	+	-
Flavonoids	+	+

Table 2: Effect of Methanolic (MECA) & hydroethanolic (HEECA) extract of *Curcuma amada* rhizome on functional parameters in CCl₄ induced hepatotoxic rats.

Treatment/ Dose	Onset of sleep(Sec.)	Duration of sleep (Min.)
Normal	158.7 ± 4.10	105.4 ± 3.42
Induced (CCl ₄)	76.14 ± 3.57*	277.5 ± 6.22*
Standard (Silymarin)	166.72 ± 3.22***	137.2 ± 2.35***
MECA (500 mg/kg)	137.20 ± 3.40**	150.12 ± 5.80**
HEECA (500 mg/kg)	141.01 ± 5.67***	165.8 ± 4.70***

Values are mean ± SEM, n = 6. (One way ANOVA Followed by Dunnette multiple comparisons test). Statistically significance of

** P<0.01, *** P<0.001, when compared with CCl₄ induced group and * P<0.05, when compared with normal group.

Table 3: Effect of Methanolic (MECA) & hydroethanolic (HEECA) extract of *Curcuma amada* rhizome on Physical Parameters in CCl₄ induced hepatotoxic rats.

Treatment/ Dose	Liver Weight	Liver Volume
Normal	7.45 ± 0.15	7.49 ± 0.12
Induced (CCl ₄)	16.02 ± 1.96*	14.12 ± 2.51*
Standard (Silymarin)	8.97 ± 1.10***	9.14 ± 1.70***
MECA (500 mg/kg)	8.64 ± 1.52**	8.35 ± 1.78**
HEECA (500 mg/kg)	9.79 ± 1.38***	9.92 ± 1.50***

Values are mean ± SEM, n = 6. (One way ANOVA Followed by Dunnette multiple comparisons test). Statistically significance of

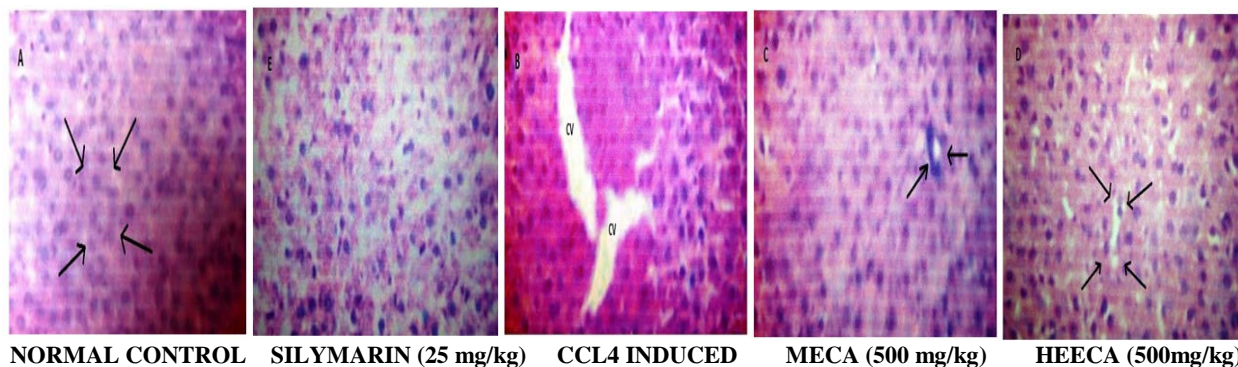
** P<0.01, *** P<0.001, when compared with CCl₄ induced group and * P<0.05, when compared with normal group.

Table 4: Effect of Methanolic (MECA) & hydroethanolic (HEECA) extract of *Curcuma amada* rhizome on serum enzyme parameter in CCl₄ induced hepatotoxic rats.

Treatment/ Dose	SGPT U/L	SGOT U/L	ALP U/L	Total Bilirubin (mg/dl)	Total Protein (gm/dl)
Normal	81.12 ± 3.71	164.25 ± 2.50	181.21 ± 6.02	1.53 ± 0.07	9.54 ± 0.23
Induced (CCl ₄)	179.21 ± 8.25*	389.21 ± 6.24*	397.35 ± 5.55*	5.62 ± 6.04*	4.55 ± 0.14*
Standard (Silymarin)	81.12 ± 3.51***	178.64 ± 4.57***	194.14 ± 8.26***	1.48 ± 2.47***	9.64 ± 4.70***
MECA (500 mg/kg)	95.25 ± 3.69***	262.22 ± 4.63***	270.14 ± 6.21***	1.64 ± 4.32***	7.92 ± 3.07**
HEECA (500 mg/kg)	79.24 ± 5.68***	196.45 ± 8.64***	219.42 ± 7.27***	1.62 ± 0.22	8.77 ± 0.53

Values are mean \pm SEM, n = 6. (One way ANOVA Followed by Dunnette multiple comparisons test). Statistically significance of ** P<0.01, *** P<0.001, when compared with CCl₄ induced group and * P<0.05, when compared with normal group.

Figure 1: Effect of Methanolic (Meca) & Hydroethanolic (Heeca) Extract of Curcuma Amada Rhizome on Histopathological Diagram of Liver Tissue in Ccl4 Induced Hepatotoxic Rats.



Discussion

There are many factors which are responsible for the liver damage or injuries such as chemicals and drugs. In the present study, CCl₄ was used to induce hepatotoxicity, since it is clinically relevant. Elevated levels of serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) are indications of hepatocellular injury [27].

In CCl₄ induced hepatotoxicity, CCl₄ is metabolized in human cell (endoplasmic reticulum and mitochondria) with the formation of CCl₃O-, the reactive oxidative free radical intermediate generated by cytochrome P450. The nascent oxygen O- resulting from lipoperoxidation causes an increase in intracellular reactive Fe+2 ions, aldehyde, GSH depletion, and calcium restoration. In addition to direct covalent contact, oxidative CCl₃ O- causes degeneration of Ca+2 sequestrations. Failure to sequester leads in increased intercellular Ca+2, aggregation by proteolytic enzymes, and a rise in Fe+2 ions, which precipitates aldehyde cytotoxicity through lipid peroxidation [28].

Administration of CCl₄ to experimental animals produced statistically significant rise in the enzymes levels, namely SGOT, SGPT, ACP, ALP, etc indicating the chemical induced hepatocellular toxicity. The inhibitory effect of the *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.) on hepatotoxicity were

compared to that of positive control group. The significant protection in the biochemical parameters like SGOT, SGPT, ACP and ALP against CCl₄ induced elevations in pretreatment of the animals with the *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.). Further there was increase in weight of the liver treated with the CCl₄ were seen as compared to the normal. The treatment with the *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.) retains the liver weight near to the normal. Liver section of control rat showing a normal hepatic architecture wall brought about from the central vein. The liver samples of CCl₄ treated rats showed gross necrosis of the centrilobular hepatocytes characterized by gross necrosis, degeneration, karyolysis and eosinophilic infiltration which are significantly prevented by treatment with the *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.) that showed the hepatoprotective activity. The histopathological pattern of the livers of the rats treated with CCl₄ plus extracts showed minimal necrosis in centrilobular and regeneration of hepatocytes. A number of scientific reports indicated that certain flavonoids, triterpenoids and steroids have protective effect on liver due to its antioxidant properties. Administration of *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.) that showed significant

hepatoprotective activity; while qualitative phytochemical investigations on the *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.) also showed test positive for flavonoids by chemical tests. Further, it has been reported that the flavonoid constituents of the plant possess antioxidant properties and was found to be useful in the treatment of liver damage .[29]

The administration of hepatoprotective drugs may induce the hepatocytes to resist the toxic effect of CCl₄. The results indicated that the *Methanolic (MECA) & Hydroethanolic (HEECA)* extract of *Curcuma amada rhizome* (500 mg/kg, p.o.) has significant hepatoprotective activity. The obtained results indicated a high degree of protection against the hepatotoxic effect of CCl₄.

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