



# **Evaluation of Hepatoprotective Activity of Whole Fruit Extracts of *Luffa Acutangula*. Var. Amara and Rhizome Extracts of Rheum Emodi in CCl<sub>4</sub> - Induced Chronic Hepatotoxicity**

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## **Authors' contributions**

This work was carried out in collaboration among all authors. Authors MA and MI wrote the paper and organized the figures. All authors read and approved the final manuscript.

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## **ABSTRACT**

To investigate the hepatoprotective activity of whole fruit extracts of *Luffa acutangula*. var. amara and rhizome extracts of Rheum emodi in CCl<sub>4</sub> treated rats. The dried powders of L. amara and R. emodi were extracted successively with petroleum ether, ethanol and distilled water. The hepatoprotective capacity of the extract of the whole fruits of L. amara and the rhizomes of R. emodi was analyzed in liver injured CCl<sub>4</sub>- treated male rats. The present study explored the possibilities of using low doses of both plant extracts (150mg/kg, and 300mg/kg bw, po route) to treat CCl<sub>4</sub> intoxicated albino rats in both acute and chronic models of hepatic damage, evident by increased serum levels of glutamate pyruvate transaminase (SGPT), glutamate oxaloacetate transaminase (SGOT), alkaline phosphatase (ALP), direct bilirubin, total bilirubin, cholesterol and triglycerides, all being implicated in considerable hepatic damage. Histopathological examination in CCl<sub>4</sub> treated rats revealed collapse of liver parenchyma with early fibrosis and chronic inflammatory cell infiltration in patchy areas around central vein (Pic.group-2)

when compared to the control group. Histopathological and physical examinations also indicated their effectiveness with their dose tolerability and liver protection.

Ethanollic and aqueous extracts of the whole fruits of *L. amara* and rhizomes of *R. emodi* were indicative of more hepatoprotective properties when compared to the petroleum ether extracts of both plants against  $\text{CCl}_4$  induced liver damage as confirmed from hepatic serum marker enzyme activities and histopathological studies.

**Keywords:** *Histopathology; Hepatoprotective activity; liver parenchyma; hepatotoxicity, Hepatoprotective activity; L. amara and Rheum emodi; pet ether extract; alcoholic extract; aqueous extract; CCl<sub>4</sub> - induced chronic hepatotoxicity.*

## 1. INTRODUCTION

The liver is an important unique organ with considerable regenerative capacity, as even a moderate cell injury remains the same but there will be measurable changes in its metabolic functions. Apart from its significant role in the metabolism and disposition of the chemicals to which it is exposed directly or indirectly, it also aids in the metabolism of carbohydrates, proteins, fats, and immunomodulation. Conversely, some abnormalities start appearing in liver functions owing to their sensitivity towards the nature and the degree of initial damage.

Various factors such as nutritional, biochemical, bacteriological, viral, or environmental aberration affect the etiology of liver disorders. The liver function is generally impaired by xenobiotics, excessive exposure to various pharmacological and chemical agents, and viral or protozoal infections. The severity of cellular injury is detrimental in the pathogenesis of acute to chronic hepatitis, which eventually results in cirrhosis.

or malignant lesions if remained untreated. The possibility of altered liver functions is indicative of changes in its chemical composition of liver or its subcellular organelles. A slightly altered hepatic structure and function might cause portal hypertension, ascites, jaundice, increased bleeding; further, it can lead to multiple metabolic changes affecting other organs as well. Medical studies indicate high incidences of hepatic diseases are being adjudged as a serious public health problem [1,2]. Selective hepatotoxins like  $\text{CCl}_4$  induce reactive free radical initiating cell damage via two different mechanisms of covalent binding membrane proteins precipitating lipid peroxidation [3]. Numerous investigations have been performed using  $\text{CCl}_4$  as hepatotoxicant for inducing hepatic fibrosis and cirrhosis in experimental animals. Though advances in modern medicine has improved to

treat many diseases, no effective drug has been established or discovered to improve liver function and aid or induce liver regeneration in hepatic fibrosis. Generally, its vital to prevent liver fibrosis and cirrhosis in hepatology [4]. The magnitude of derangement of liver by disease or hepatotoxins is normally measured by the level of glutamate pyruvate transaminase (ALT), glutamate oxaloacetate transaminase (AST), alkaline phosphatase (ALP), bilirubin, albumin, and whole liver homogenate.

With increased importance towards health and lifestyle changes, herbal medicine as is gaining momentum globally with herbal remedies prescribed along with allopathic drugs ranging from common cold to more organ specific diseases. Both Ayurveda and Unani systems assign much clinical importance to the pharmacological efficacy of medicinal plants. Plants with hepatoprotective action of some plants like *Acacia catechu*, *Zingiber officinale*, and *Garcinia indica* have been established [5]. Conversely, there is a lack of satisfactory plant formulations for treating hepatic diseases. Generally, chemically induced hepatic damage in animal models is used for the study of plants with hepatoprotective actions [6].

*Luffa acutangula*.var.*amara* (Cucurbitaceae) family, known as karvi turai, is an annual herb found in all parts of India and more towards the western peninsula and is used as a carminative, laxative, tonic for intestines, digestible, used to cure the *vata* and *kapha*, biliousness, liver complaints, leukoderma, piles, ascites, tumour useful in bronchitis and asthma and the seed kernels are used to treat dysentery [7,8]. It is also used in treating jaundice when taken in the form of very fine powder through nose, while its seeds show emetic, expectorant, and demulcent properties. The ancient literature also revealed that the plant is significantly used as abortifacient and antifungal agent. The reported chemical examination of *Luffa acutangula* showed the

presence of carbohydrates, carotene, fat, protein, phytin, aminoacids, alanine, arginine, cystine, glutamicacid, glycine, hydroxyproline, leucine, serine, tryptophan, pipercolic acid, flavonoids and saponins [9].

*R. emodi* of family Polygonaceae, known as Indian or Himalayan Rhubarb, found in India, *Rheum emodi* is considered as purgative, stomachic, and astringent tonic, possesses aperient, emmenagogue and diuretic properties. Root is used as expectorant, appetizer, as powder applied on cuts, wound, and muscular swelling, toothache, tonsillitis, mumps and ulcers [10]. It is used to heal skin sores and scabs. While larger doses are used as laxative, small doses are used to treat dysenteric diarrhea [11] Chinese medicine uses rhubarb for ulcer remedy, as a bitter, cold, dry herb used to "clear heat" from the liver, stomach and blood, also to expel helminthes and to treat cancer, fever, upper intestinal bleeding (ulcers), and headache [12,13]. Its also used in of spring tonics or blood cleansing cures [14,15].

The extracts from both plants *L. amara* (whole fruit including seeds) and rhizomes of *R. emodi* were selected to evaluate the hepatoprotective potential of these plant extracts against CCl<sub>4</sub> induced liver damage liver *in* chronic model.

## 2. MATERIALS AND METHODS

### 2.1 Plant Materials

Both plants, viz, the rhizomes of *R. emodi* and dried fruits of *L. amara* were identified and procured from by Dr. K.Madhava.Chetty, Assistant Professor, Dept.of Botany, Sri Venkateshwara University, Tirupati, Andhra Pradesh, India.

### 2.2 Animals

Wistar rats of 160-200 g were supplied from the animal house of Deccan College of Medical Sciences, Hyderabad and housed in cages with free access to standard pellet chow and water ad libitum. Rats, 6 in a group, were housed in clean polypropylene cages under standard conditions of humidity (60%-70%), temperature (25 ± 2°C) and light (12 hr light: 12 hr dark cycle) and free access to food and water ad libitum. Experiments were conducted after obtaining the approval from Institutional Animal Ethics Committee constituted as per CPCSEA guidelines. Protocols for all experiments

described below were approved by the ethical board.

### 2.3 Extraction of the Plant Materials

For phytochemical analysis, approximately 100 g of dried whole fruits of *L.amara* and rhizomes of *R. emodi* were separately chopped, air dried at 35-40°C and pulverized in electric grinder. The powders obtained were successively extracted with the following solvents, petroleum ether (PE) (50°C), ethanol, and distilled water respectively. The extracts obtained were powdered by using rotary evaporator under reduced pressure. The dried extracts of the fruits of *L. amara* and rhizomes of *R. emodi* were subjected to phytochemical screening.

### 2.4 Preliminary Phytochemical Investigations

The extraction and preliminary phytochemical investigations were carried out on the petroleum ether, alcoholic and aqueous extracts of fruits of *Luffa amara* for presence of phytoconstituents such as sterols, glycosides, saponins, flavonoids, amino acid proteins, tannins, carbohydrates and triterpenes using standard methods described in practical pharmacognosy by K.R. Khandelwal ,Dr. C.K. Kokate, and Trease G.E, Evans [16,17,18].

### 2.5 Animals

Wistar rats weighing 160-200g, obtained from the Deccan College of Medical Sciences, Hyderabad, TS, India, were maintained by housing them under controlled temperature, humidity and 24- hr light and dark cycle before acclimatising them for seven days under controlled temperatures (23-25°C), humidity (60-70%) and dividing them in groups of 6 animals each for carrying out hepatoprotective studies using crude extracts- after approval of all experimental protocols from the ethics committee.

### 2.6 Chronic Toxicity Induced by CCl<sub>4</sub>

A 30 days study was carried out using CCL<sub>4</sub> (1 ml/kg b.w, p.o route) toxicant and silymarin (25mg/kg, b.w,p.o route) as reference [19,20] on both LA and RE plant extracts. Rats were divided into 15 groups of 6 each and treated in the following way:

Group 1: control, received vehicle daily (10 ml/kg, po) for 30 days.

Group 2: received vehicle daily (10 ml/kg, po) for 30 days + CCl<sub>4</sub> (1 ml/kg, po) weekly twice for 30 days.

Group 3: silymarin (25 mg/kg, po) for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 4: LAPE 150, received 150 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 5: LAPE 300, received 300 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 6: LAEE 150 received 150 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 7: LAEE 300 received 300 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 8: LAEE 150 received 150 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 9: LAEE 300 received 300 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 10: REPE 150 received 150 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 11: REPE 300 received 300 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 12: REEE 150 received 150 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 13: REEE 300 received 300 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 14: REAE 150 received 150 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

Group 15: REAE 300 received 300 mg/kg, po for 30 days + CCl<sub>4</sub> (1ml/kg, po) weekly twice for 30 days

All animals were sacrificed 24 hr after the last treatment. Blood samples were collected from

orbital sinuses, and the separated serum from the centrifuged blood samples were used for assay of the marker enzymes. After isolating livers, they were washed in normal saline, blotted with filter paper and weighed [21,22,23]. The liver tissues were prepared for histopathological deductions.

## 2.7 Statistical Analysis

The statistical significance was assessed using one-way analysis of variance (ANOVA) followed by (Armitage, 1987) and students t- test for control and test groups. The two tailed unpaired student t- test using the computer programme Prism Pad. Changes in the Mean  $\pm$  SEM serum hepatic parameters of the test (plant extracts) were compared with that of the control, the P-values expressed as  $P \leq 0.05$  or less was considered significant.

## 3. RESULTS

### 3.1 Preliminary Investigation

### Phytochemical

The preliminary phytochemical investigation of the fruit extracts of *L. amara* showed that petroleum ether extract contained triterpenes and fixed oil; ethanolic extract had carbohydrates, glycosides, saponins, flavonoids, sterols, amino acids and proteins; aqueous extract tested positive for carbohydrates, glycosides, saponins, flavonoids, sterols, amino acids and proteins.

For rubarb extracts of *R. emodi*, petroleum ether extract showed the presence of triterpenes ethanolic extract had alkaloids, flavonoids, glycosides, tannins, saponins, and terpenes; aqueous extract tested positive for alkaloids, saponins, flavonoids, terpenes and carbohydrates, proteins.

### 3.2 Hepatoprotective Activity

The serum test results of all the plant extracts petroleum further confirmed the aqueous and ethanolic extracts significant protective action against CCl<sub>4</sub> by reducing most of the elevated hepatic parameters (excluding serum HDL, albumin, and total proteins which were elevated following treatment with silymarin and the plant extracts) following CCl<sub>4</sub> treatment. Both alcoholic and aqueous extracts of both plants showed significant hepatoprotective activity than petroleum extract.

**Table 1. Serum Biochemical parameters showing changes in the means of CCl<sub>4</sub> induced hepatic injury in rats (Mean ± SEM)**

Groups	Treatment/ Concentration	Biochemical parameters				
		SGPT (U/L)	SGOT (U/L)	ALP (U/L)	Triglycerides U/l	TB (U/L)
1	Vehicle control	63.66 ± 1.54	61.35 ± 0.53	103.12 ± 0.36	122.80 ± 2.58	0.22 ± 0.003
2	Vehicle+ CCl <sub>4</sub> (1ml/kg b.w)	a*** 210.28±2.29	a *** 186.04 ± 2.04	a *** 310.14 ± 2.18	a*** 311.15 ± 1.615	a *** 2.95 ± 0.048
3	Silymerin(25mg/kg b.w) + CCl <sub>4</sub>	b *** 88.71± 0.46	b *** 85.16 ± 0.51	b *** 139.60 ± 1.43	b *** 130.28 ± 0.66	b *** 0.30 ± 0.090
4	LAPE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b ** 140.39 ± 2.44	b ** 135.62 ± 2.26	b ** 282.01± 2.05	b** 238.32 ± 0.62	b ** 1.58 ± 0.010
5	LAEE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b *** 109.21 ± 1.13	b *** 106.10 ± 1.65	b *** 170.64 ± 2.51	b*** 207.05 ± 0.71	b *** 0.65 ± 0.006
6	LAAQ 150 (150mg/kg b.w) +CCl <sub>4</sub>	b *** 97.98 ± 1.05	b *** 94.03 ± 1.20	b *** 179.32 ± 1.36	b*** 212.54 ± 0.66	b *** 0.67 ± 0.028
7	LAPE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b ** 121.12± 1.26	b ** 115.52 ± 1.52	b ** 281.16 ± 2.64	b*** 225.63 ± 0.85	b ** 1.56 ± 0.18
8	LAEE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b *** 95.46 ± 0.52	b *** 91.64 ± 2.36	b *** 145.12 ± 0.65	b *** 139 .12± 0.64	b *** 0.36 ± 0.05
9	LAAE 300 (300mg/kg b.w) +CCl <sub>4</sub>	b *** 98.52 ± 0.18	b *** 93.92 ± 1.29	b *** 149.09 ± 1.38	b *** 142.86 ± 0.77	b *** 0.38 ± 0.01
10	REPE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b ** 141.17 ± 2.52	b ** 137.41 ± 1.36	b ** 283.31 ± 2.06	b *** 243.51 ± 1.25	b ** 1.60 ± 0.04
11	REEE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b *** 111.01± 1.54	b *** 106.05± 2.24	b *** 172.24 ± 1.31	b *** 217.25 ± 0.84	b *** 0.66 ± 0.006
12	REAQ 150 (150mg/kg b.w) +CCl <sub>4</sub>	b *** 98.02 ± 1.75	b *** 95.29 ± 1.61	b *** 181.03 ± 1.65	b *** 245.16 ± 0.55	b *** 0.71 ± 0.02
13	REPE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b ** 123.04 ± 2.23	b ** 117± 1.65	b ** 282.78 ± 2.56	b *** 228.16 ± 0.84	b ** 1.59 ± 0.004
14	REEE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b *** 94.16 ± 0.51	b *** 92.43 ± 0.64	b *** 147.07 ± 0.58	b *** 138.38 ± 0.95	b *** 0.39 ± 0.010
15	REAE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b *** 99.23 ± 0.12	b *** 94.24 ± 0.58	b *** 151.34 ± 0.64	b *** 142.86 ± 0.77	b *** 0.42 ± 0.090

P Values: <sup>a</sup>group 2 vs 3; <sup>b</sup>group 2 vs 3 – 15 \*\*\* p< 0.001 and \*\* p<0.01

**Table 2. Effect of the extracts of *L.amara* and *R.emodi* on the hepatic parameters in albino rats in chronic model (Mean ± SEM)**

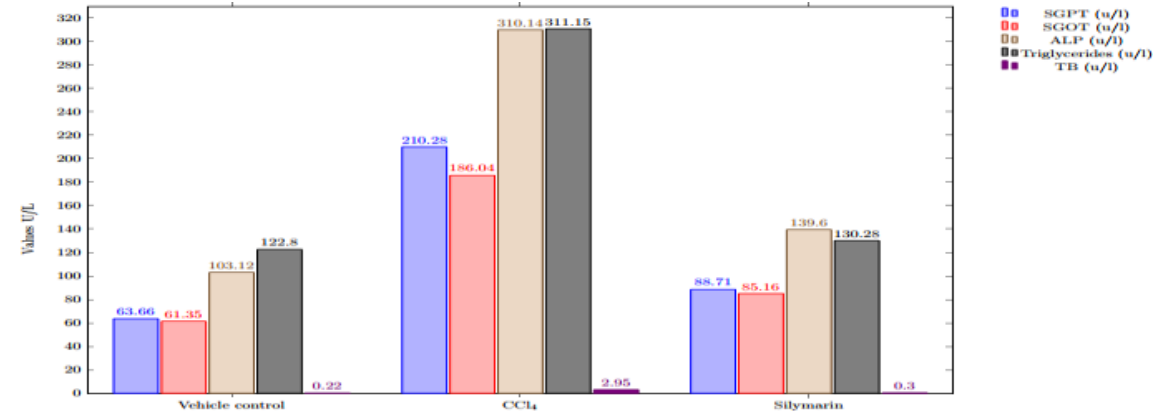
Group	Treatment/ Concentration	Biochemical parameters ;				Liver weight (mg/100g of rat) <sup>(b)</sup> After Treatment
		DB (U/L)	Cholesterol U/l	Total protein mg/dl	Serum albumin mg/dl	
1.	Vehicle control	0.19 ± 0.35	71.61 ± 0.87	6.98 ± 0.36	3.70 ± 0.28	34.15 ± 0.63
2	CCl <sub>4</sub> (1ml/kg b.w)	a *** 1.08 ± 0.32	a *** 54.70 ± 0.25	a *** 3.28 ± 0.13	a*** 1.98 ± 0.17	a*** 59.90 ± 0.06
3.	Silymerin(25mg/kg b.w) + CCl <sub>4</sub>	b*** 0.14 ± 0.12	b *** 68.12 ± 0.22	b*** 6.81 ± 0.08	b *** 4.2 ± 0.47	b*** 37.80 ± 0.45
4.	LAPE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b *** 0.46 ± 0.02	b ** 58.5 ± 0.50	b ** 4.05 ± 0.34	b *** 2.61 ± 0.148	b** 47.20 ± 1.65
5	LAEE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b *** 0.31 ± 0.02	b *** 61.87 ± 1.32	b*** 5.58 ± 0.12	b *** 3.405 ± 0.30	b** 42.30 ± 0.90
6.	LAAE 150 (150mg/kg b.w) +CCl <sub>4</sub>	b *** 0.33 ± 0.12	b *** 60.46 ± 0.91	b *** 5.14 ± 0.17	b *** 3.10 ± 0.55	b** 45.85 ± 0.60
7.	LAPE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b ** 1.08 ± 0.34	b *** 59.02 ± 0.54	b *** 4.35 ± 0.08	b *** 2.8 4 ± 0.32	b** 46.10 ±0.25
8.	LAEE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b *** 0.57 ± 0.04	b *** 63.98 ± 0.18	b *** 6.58 ± 0.14	b *** 3.9 ± 0.54	b*** 41.00 ±0. 90
9.	LAAE 300 (300mg/kg b.w) +CCl <sub>4</sub>	b *** 0.19 ± 0.35	b *** 61.50 ± 0.27	b *** 6.40 ± 0.16	b *** 3.50 ± 0.81	b*** 41.85 ± 0.65
10.	REPE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b ** 0.87 ± 0.05	b *** 57.25 ± 0.30	b *** 4.05 ± 0.14	b *** 2.43 ± 0.57	b** 48.00 ± 1.06
11.	REEE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b *** 0.35 ± 0.21	b *** 62.78 ± 0.45	b *** 5.36 ± 0.18	b *** 3.75 ± 0.66	b** 41.40 ± 0.65
12.	REAE 150 (150mg/kg b.w) +CCl <sub>4</sub>	b *** 0.39 ± 0.18	b *** 60.90 ± 0.15	b *** 5.06 ± 0.05	b *** 3.76 ± 0.12	b** 41.95 ± 1.02
13.	REPE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b ** 0.81 ± 0.42	b *** 56.40 ± 0.39	b *** 4.30 ± 0.12	b *** 3.22 ± 0.56	b*** 47.80 ± 0.90
14.	REEE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b *** 0.19 ± 0.36	b *** 63.40 ± 0.76	b *** 6.49 ± 0.17	b *** 3.62 ± 0.43	b*** 41.60 ± 0.55
15.	REAE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b *** 0.29 ± 0.31	b *** 60.85 ± 0.20	b *** 6.20 ± 0.05	b *** 3.84 ± 0.53	b*** 41.95 ± 0.80

P-Values: <sup>a</sup>group 1 vs 2; <sup>b</sup>group 2 vs 3– 15 \*\*\* p< 0.001 and \*\* p<0.01.

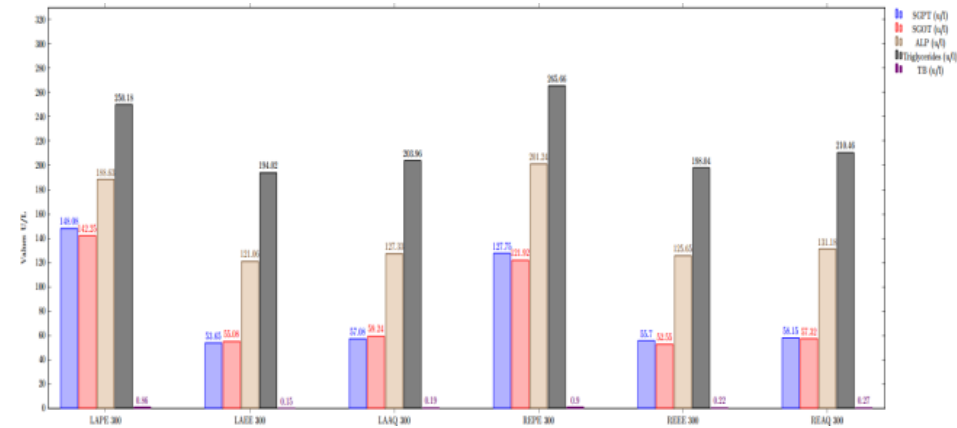
**Table 3. Mean changes in body weight and organ weight in chronic CCl<sub>4</sub> liver injury in animals**

Groups	Treatment /Concentration	Body weight changes in weekly intervals (gms) (a)				Liver weight (mg/100g of rat) (b)
		1	2	3	4	
1	Vehicle control	2.06 ± 0.41	2.95 ± 0.32	3.96 ± 0.50	4.75 ± 0.47	34.15 ± 0.63
2	CCl <sub>4</sub> (1ml/kg b.w)	16.10 ± 0.17 <sup>a***</sup>	25.10 ± 1.62 <sup>a***</sup>	36.98 ± 0.22 <sup>a***</sup>	54.64 ± 0.58 <sup>a***</sup>	59.90 ± 0.06 <sup>***</sup>
3	Silymerin(25mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		2.25 ± 0.62 <sup>***</sup>	3.90 ± 0.32 <sup>***</sup>	5.96 ± 0.42 <sup>***</sup>	11.08 ± 0.21 <sup>***</sup>	37.80 ± 0.45 <sup>***</sup>
4	LAPE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		13.02 ± 1.50 <sup>**</sup>	21.98 ± 0.48 <sup>**</sup>	31.00 ± 0.65 <sup>**</sup>	36.12 ± 0.52 <sup>**</sup>	47.20 ± 1.65 <sup>**</sup>
5	LAEE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		09.34 ± 1.25 <sup>**</sup>	17.25 ± 0.55 <sup>**</sup>	22.15 ± 0.90 <sup>**</sup>	27.02 ± 0.35 <sup>**</sup>	42.30 ± 0.90 <sup>**</sup>
6	LAAE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		10.24 ± 0.98 <sup>**</sup>	18.65 ± 1.25 <sup>**</sup>	23.45 ± 1.05 <sup>**</sup>	28.13 ± 0.72 <sup>**</sup>	45.85 ± 0.60 <sup>**</sup>
7	LAPE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		12.50 ± 1.05 <sup>**</sup>	20.22 ± 1.08 <sup>**</sup>	30.06 ± 0.52 <sup>**</sup>	37.05 ± 1.05 <sup>**</sup>	46.10 ± 0.25 <sup>**</sup>
8	LAEE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		4.03 ± 0.21 <sup>***</sup>	8.15 ± 0.36 <sup>***</sup>	10.10 ± 0.15 <sup>***</sup>	12.06 ± 0.26 <sup>***</sup>	41.00 ± 0.90 <sup>***</sup>
9	LAAE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		5.15 ± 0.06 <sup>***</sup>	9.02 ± 0.60 <sup>***</sup>	11.04 ± 0.72 <sup>***</sup>	13.18 ± 0.12 <sup>***</sup>	41.85 ± 0.65 <sup>***</sup>
10	REPE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		13.58 ± 0.26 <sup>**</sup>	23.37 ± 0.92 <sup>**</sup>	32.04 ± 0.25 <sup>**</sup>	36.93 ± 1.12 <sup>**</sup>	48.00 ± 1.06 <sup>**</sup>
11	REEE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		9.90 ± 0.74 <sup>**</sup>	18.96 ± 1.02 <sup>**</sup>	22.98 ± 0.08 <sup>**</sup>	28.00 ± 0.52 <sup>**</sup>	41.40 ± 0.65 <sup>**</sup>
12	REAE 150 (150mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		10.91 ± 1.08 <sup>**</sup>	19.04 ± 0.21 <sup>**</sup>	23.87 ± 0.70 <sup>**</sup>	28.73 ± 0.18 <sup>**</sup>	41.95 ± 1.02 <sup>**</sup>
13	REPE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		13.02 ± 0.63 <sup>***</sup>	22.70 ± 0.47 <sup>***</sup>	32.83 ± 0.32 <sup>***</sup>	37.37 ± 0.54 <sup>***</sup>	47.80 ± 0.90 <sup>***</sup>
14	REEE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		4.88 ± 0.47 <sup>***</sup>	8.93 ± 0.55 <sup>***</sup>	11.00 ± 0.25 <sup>***</sup>	12.83 ± 0.48 <sup>***</sup>	41.60 ± 0.55 <sup>***</sup>
15	REAE 300 (300mg/kg b.w) + CCl <sub>4</sub>	b	b	b	b	b
		5.94 ± 0.21 <sup>***</sup>	9.66 ± 0.42 <sup>***</sup>	11.60 ± 0.54 <sup>***</sup>	13.83 ± 1.05 <sup>***</sup>	41.95 ± 0.80 <sup>***</sup>

P-Values: <sup>a</sup>group 1 vs 2; <sup>b</sup>group 2 vs 3 – 15<sup>\*\*\*</sup> p < 0.001 and <sup>\*\*</sup>p < 0.01

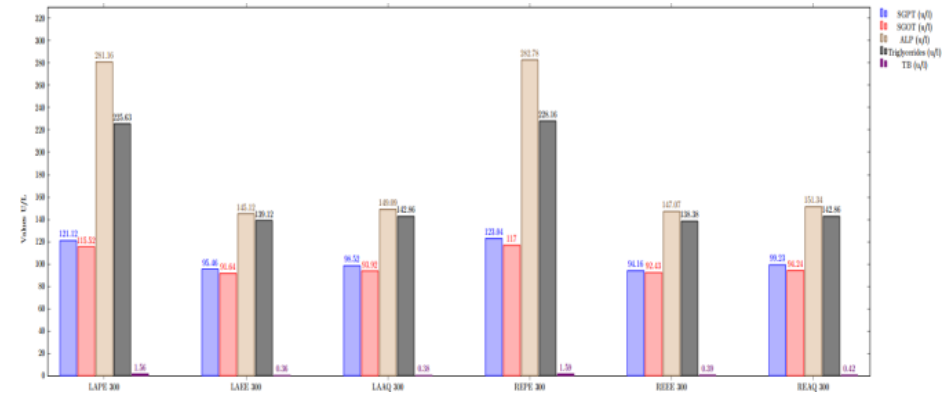


Vehicle (10ml/kg bw,po), CCl<sub>4</sub> (1ml/kg bw,po), silymarin (25mg/kg bw,po)

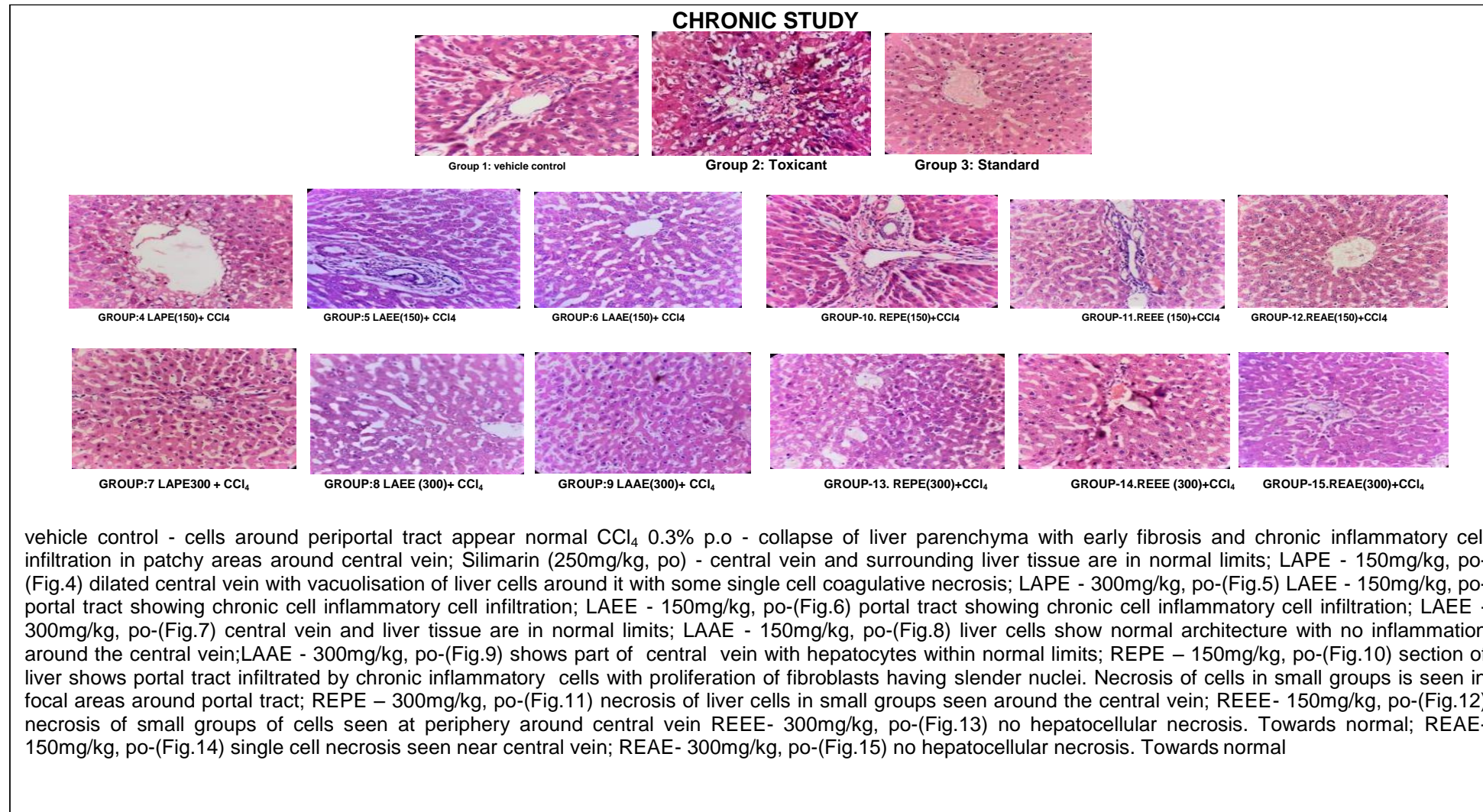


LAFE 150= *L. amar* petroleum ether extract at dose 300mg/kg body weight  
 LAEE 150= *L. amara* ethanolic extract at dose 300mg/kg body weight  
 LAAQ 150=*L. amara* aqueous extract at dose 300mg/kg body weight  
 REPE 150= *R. emodi* pet ether extract at dose 300mg/kg body weight  
 REEE 150= *R. emodi* ethanolic extract at dose 300mg/kg body weight  
 REAQ 150=*R. emodi* aqueous extract at dose 300mg/kg body weight





LAPE 300= *L.amara* petroleum ether extract at dose 300 mg/kg body weight  
 LAEE 300 = *L.amara* ethanolic extract at dose 300 mg/kg body weight  
 LAAQ 300= *L.amara* aqueous extract at dose 300 mg/kg body weight  
 REPE 300= *R.emodi* pet ether extract at dose 300 mg/kg body weight  
 REEE 300= *R.emodi* ethanolic extract at dose 300 mg/kg body weight  
 REAQ 300= *R.emodi* aqueous extract at dose 300mg/kg body weight



**Fig. 1. Graphical presentation of the means of the hepatic parameters observed in chronic study for the extracts of *L.amara* and *R.emodi* and silymarin reference against CCl<sub>4</sub> intoxicated liver cells**

Both ANOVA and student 't' test confirms significant activity of aqueous and alcoholic extracts and least activity of petroleum ether extracts respectively against  $\text{CCl}_4$  hepatotoxicant. The alcoholic and aqueous extracts of both plants, *L.amara* and *R.emodi*, reduced the elevated levels of SGPT, SGOT, ALP, TG, CHO, BID, BIT, and elevated the reduced levels of total proteins, HDL, and albumin. Results are given in Tables - 1, 2, 3.

#### 4. DISCUSSION

The present study explored the possibilities of using low doses of both plant extracts (150mg/kg, and 300mg/kg bw, po route) to treat  $\text{CCl}_4$  intoxicated albino rats in both acute and chronic models of hepatic damage, evident by increased serum levels of glutamate pyruvate transaminase (SGPT), glutamate oxaloacetate transaminase (SGOT), alkaline phosphatase (ALP), direct bilirubin, total bilirubin, cholesterol and triglycerides, all being implicated in considerable hepatic damage.

As established earlier that accumulated  $\text{CCl}_4$  in hepatic parenchymal cells get activated by cytochrome P450 dependant monooxygenases form free radicals of ( $\cdot \text{CCl}_3$ ), which simultaneously attacks polyunsaturated fatty acids in presence of oxygen producing lipid peroxides and further alkylates cellular proteins, inclusive of P450 and other macromolecules leading to hepatic damage and cirrhosis. Thus,  $\text{CCl}_4$  is one of the most commonly used hepatotoxins in pharmacological experiments [24-27].

$\text{CCl}_4$  induced hepatotoxicity study, both alcoholic (LAEE150 and LAEE300, REEE150, REEE300) and aqueous extracts (LAEE150, LAEE300, REEE150, REEE300) of both plants *Luffa amara* (LA) (fruit pulp including seeds) and *Rheum emodi* (RE) rhizomes respectively, showed significant reduction in the elevated levels of all serum enzymes as afore mentioned (Tables 3 and 4). with subsequent reduction in body and liver weight and as well (Table 5). Though, the pet ether treated groups (LAPE150, LAPE300, REPE150 and REPE300) when compared to both alcoholic and aqueous groups, didn't show much significant hepatoprotection.

Histopathological examination in  $\text{CCl}_4$  treated rats revealed collapse of liver parenchyma with early fibrosis and chronic inflammatory cell infiltration in patchy areas around central vein

(Pic.group-2) when compared to the control group (Pic.group-1). With sylimarin and  $\text{CCl}_4$  treatment, the central vein and surrounding liver tissue are in normal limits (Pic.group-3). The ethanolic extract treated groups LAEE 150 showed portal tract showing chronic cell inflammatory cell infiltration (Pic.group-5) and REEE150 showed necrosis of small groups of cells seen at periphery around central vein (Pic.group-11). While in high doses, LAEE300 shows central vein and liver tissue are in normal limits (Pic.group-8) and REEE300 showed central vein with surrounding hepatic tissue within normal limits (Pic.group-14). Similarly, the aqueous extracts of LA and RE, LAEE150 showed liver cells show normal architecture with inflammation around the central vein (Pic.group-6) and RAAE150 represented single cell necrosis seen near central vein (Pic.group-12). Conversely, the higher doses of aqueous extracts LAEE300 had observations of central vein and liver tissue in normal limits (Pic.group-9) and with REAE300 showed no hepatocellular necrosis with liver architecture appearing towards normal (Pic.group-15). Thus, in low doses of (150 mg/kg, po route), the alcoholic and aqueous extracts of both plants showed less hepatoprotection when compared to high doses (300 mg/kg, po route) which showed significant protection against  $\text{CCl}_4$  intoxication of hepatocytes. Body and liver weight changes were observed in the same manner with  $\text{CCl}_4$  treated group showing maximum increase in body and weight, compared to the control group. The petroleum ether treated group showing least changes, while the alcoholic and aqueous groups showed significant restoration in body and wet liver weights when compared to  $\text{CCl}_4$  treated group at the end of chronic  $\text{CCl}_4$  induced hepatotoxicity study.

#### 5. CONCLUSION

Thus, the curative and prophylactic hepatoprotective efficiencies of both alcoholic and aqueous extracts of both plant extracts of *L. amara* and *R.emodi* at 300mg/kg bw not only revealed in restoring normal hepatic functioning, evident by serum analysis, and further supported by histopathological and physical examinations, but also indicated their effectiveness with their dose tolerability and liver protection. The order of hepatoprotection of both LA and RE was observed with alcoholic extracts being significantly more compared to the aqueous extracts. While the petroleum ether extracts showing least or no significant changes. With

conclusive findings of both plants providing good hepatoprotection individually, it can provide a window to further study their summative hepatoprotectiveness using either crude extracts or their isolated active constituents for providing more proficient formulations in treating liver disorders like cirrhosis.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

The approval from Institutional Animal Ethics Committee constituted as per CPCSEA guidelines. Protocols for all experiments described below were approved by the ethical board.

## NOTE

The study highlights the efficacy of "herbal" which is an ancient tradition, used in some parts of India. This ancient concept should be carefully evaluated in the light of modern medical science and can be utilized partially if found suitable.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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