Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Pharmacology & Therapeutics

The Protective Effect of Extracts of Curcuma Longa Rhizomes on Paracetamol Induced Hepatotoxicity in Rat

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DOI: https://doi.org/10.36347/sjams.2026.v14i11.013 | **Received:** 25.08.2026 | **Accepted:** 28.10.2026 | **Published:** 26.11.2026

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Abstract **Original Research Article**

Background: Paracetamol (acetaminophen) is one of the most commonly used over-the-counter medications globally. Portant and thiourea derivatives as antioxidants have attracted great attention in hepatoprotective area. This study was designed to screen the protective effects of aqueous and ethanol extracts of Curcuma longa rhizomes on paracetamol-induced liver injury in experimental rats. ***Methods:*** 30 adult rats were separated into five groups (n=6 each) normal control, paracetamol-treated, control for extract and two experimental groups of the rats treated with aqueous and ethanol extracts of Curcuma longa. Hepatotoxicity was caused by the use of paracetamol (2 g/kg body weight). Biochemical parameters such as serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and bilirubin were determined. The change in liver weight was also determined. ***Results:*** Paracetamol significantly increased serum levels of ALT, AST, ALP; bilirubin ($p<0.001$) confirming hepatotoxicity. It is important to note that pretreatment of rats with the aqueous and ethanol extracts of Curcuma longa showed significant reduction in these biochemical markers in comparison to paracetamol-treated group. Highly significant reductions were observed with the aqueous extract ($p<0.001$), and although the ethanol extract also exhibited considerable hepatoprotective effect. Moreover, extract treated groups showed normalization of liver weight with respect to the paracetamol group. ***Conclusion:*** Curcuma longa rhizome extracts have high hepatoprotective effects against the liver injury caused by paracetamol and probably because of their antioxidant effects. Before clinical use, it is suggested that more research be done to isolate active compounds and understand the mechanisms involved.

Keywords: Curcuma longa, hepatotoxicity by Paracetamol, Hepatoprotective effect, liver enzymes, experimental rats.

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INTRODUCTION

In spite of impressive innovations in modern medicine, liver diseases are still the threatening problems of our country. Acute viral hepatitis has become a burning problem now-a-days. Beside these, drug and toxin induced liver diseases are not uncommon. The liver is the major organ involved in metabolism of protein, carbohydrates, and fats, but is also the major organ for detoxification. Many drugs and toxins can be detoxified by conjugation with glutathione. When the levels of these drugs or toxins, however, exceed the liver concentration of reduced glutathione; such components become acutely hepatotoxic. In several kinds of liver disorders, glutathione levels are decreased, for example: in hepatitis, where the grade of activity of the liver disease is correlated with reduction of GSH in acute liver toxification, e.g. acetaminophen intoxication, and in alcoholics with liver failure [1]. Acetaminophen (Paracetamol: N-acetyl-p-aminophen) is an effective analgesic - antipyretic drug which is often used to treat pain and fever. Acetaminophen is available without prescription in many parts of the world [1]. General public is not aware of drug abuse and its antidotal management under such circumstances paracetamol induced liver and kidney damage may go unnoticed and affected individual may die. The most serious adverse effect of acute overdose of acetaminophen is dose-dependent, potentially fatal hepatic necrosis which may be associated with renal tubular necrosis [1,2]. The herbal renaissance has produced a profound effect on the Western medicine which is now trying to acknowledge methods of healing that have existed for millennia in the traditional medicine throughout the world, especially Asia. The surge in research on drugs from natural sources is now moving out of the herbalists' shop away from the core texts into the drugs research laboratories. A number of herbs are traditionally used in different countries during drug or toxin induced hepatic and renal disorders. In previous work, the hepatoprotective activity of

Moringa oleifera, Caseria ecseria ecsulenta, Andrographis paniculata, Carica papaya against paracetamol induced hepatotoxicity had been found [3,4,5,6]. Curcuma longa (turmeric), a yellow food color and an ingredient in curry powder, for long time has been used in Asian traditional medicine as a stomach tonic and blood purifier, and for the treatment of skin disease and wound healing. In recent years, many studies have shown that Curcuma longa possesses antioxidant, anti-tumor, and hepato-protective properties. In spite of long use of Curcuma species in traditional medicine, little work has been done on phytomedicinal properties of this plant [7]. Dietary intake of curcumin may protect against CCI, -induced hepatic CYP inactivation via its antioxidant properties, without inducing hepatic CYPs [8]. Curcumin significantly protects the liver from injury by reducing the activities of serum aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase, and by improving the histological architecture of the liver. Curcumin dramatically suppresses inflammation by reducing levels of inflammatory cytokines, including interferon-gamma, tumor necrosis factor-alpha, and interleukin-6 [9]. These findings suggest that curcumin prevents acute liver damage by at least two mechanisms: acting as an antioxidant and by inhibiting NF-kappa B activation and thus production of pro inflammatory cytokines [10]. Curcumin, the major polyphenolic compound in turmeric, has been shown to attenuate hepatic damage in several animal models of liver injury. The aim of the present study was to examine the efficacy of curcumin in preventing paracetamol-induced hepatotoxicity in rats [11]. The ethanol extracts of Curcuma longa decreased the paracetamol induced elevated levels of enzymes, AST, ALT, and ALP. That indicates the production of structural integrity of hepatocytic cell membrane or regeneration of damaged liver cells by the extracts [12]. The rhizomes of Curcuma longa is relatively cheap and easily available in all around the Bangladesh. Dry rhizomes powder used as curry powder in our daily life. In this background of the potentially effective basis of prevention of hepatotoxicity, this study of the effects of Curcuma Longa on paracetamol induced hepatotoxicity in rats has been taken up. Considering the limitations, if we get some significant results, undoubtedly it will bring some benefits for medical science.

MATERIALS AND METHODS

This prospective experimental study was conducted in the Department of Pharmacology and Therapeutics, Dhaka Medical College, and Dhaka in collaboration with Departments of Pathology of Dhaka Medical College, Dhaka and the Department of Chemistry of Dhaka University, Dhaka during the period of January 2008 to December 2008. A total number of 30 adult Rattans Norvigicus rats of both sexes were used for the present study. The rats were divided into 5 groups (Group A, Group B, Group C, Group D, and Group E), each group comprising of 6 rats, treated for 7 days and sacrifice on 9th day.

Inclusion Criteria:

- Participants who fulfilled the predefined study population characteristics
- Persons who signed a consent document after being fully informed
- Eligible participants during the study period

Exclusion Criteria:

- Individuals unwilling to participate
- Data for participants who had incomplete or missing measurements
- Participants with previously known comorbid illnesses that may confound study endpoints
- Patients who are on drugs or interventions which may bias results

Data Collection Procedures

All relevant information's for each rat were recorded in a predesigned data collection sheet. Collected data were screened, compiled and edited. Sociodemographic data, clinical history and relevant variables were recorded using face-to face interviews and review of medical records when appropriate. Anthropometric measurements were obtained using standardized instruments and appropriate calibration procedures. Clinical/laboratory data collection followed standard operating procedures to avoid bias.

Statistical Analysis

Data were summarized by descriptive statistics; continuous variables as mean ± SD, and categorical variables as frequency and percentage. Appropriate statistical analyses, such as unpaired Student's 't' test, LSD were applied. $P < 0.05$, $P < 0.01$ and $P < .001$ were taken as level of significance.

RESULT

Table 1: Hepatotoxic effect of paracetamol in experimental rats

Groups	ALT (U/I)	AST (U/I)	ALP (U/I)	Bilirubin (mg/dl)
Group A Normal control	39.17 0.98	52.17 ± 1.60	280.00 ± 47.93	0.58 ± 0.03
Group B Paracetamol treated	543.67 ± 16.21	288.33± 16.02	413.33 ± 8.16	0.80 ± 0.02

Table 1 showed that the mean ± SD bilirubin in group A (Normal control) and group B (Paracetamol treated) were 0.58 ± 0.03 and 0.80 ± 0.02 mg/dl respectively. Increase in serum bilirubin level in the paracetamol treated group was highly significant ($p<0.001$) in comparison with the normal control group. The Mean ± SD of serum ALT, AST and ALP in group A were 39.17 ± 0.98, 52.17 ± 1.60, and 280.00 ± 47.93 (u/l) respectively and serum ALT, AST and ALP in group B were 543.67 ± 16.21, 288.33 ± 16.02, 413.33 ± 8.16 and 0.80 ± 0.02 (u/l) respectively. Significant difference of ALT, AST and ALP present between group A and group B. The increase in mean serum ALT, AST, ALP levels in the paracetamol treated group was highly significant ($p<0.001$) in comparison with normal control group.

Table 2: Effects of pretreatment Curcuma longa on mean serum bilirubin, ALT, AST, and ALP levels in paracetamol treated rats

Groups	ALT (U/L)	AST (U/L)	ALP (U/L)	Bilirubin (mg/dl)
Group C (Control group)	53.75 ± 12.94	285.83 ± 18.82	413.33 ± 12.91	0.82 ± 0.02
Group D (Experimental group)	183.33 ± 22.73	204.17 ± 8.01	299.17 ± 7.36	0.63 ± 0.03
Group E (Experimental group)	243.00 ± 30.69	221.67 ± 47.29	296.83 ± 12.27	0.67 ± 0.04

Table 2 showed that the Mean SD of serum ALT in group D (Aqueous extract of Cucuma longa) and in group C (Control group for Cucuma longa) were 243.00 30.69 and 537.50 12.94 (u/1). The decrease in mean ALT in the aqueous extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group. Mean ± SD of serum AST in group D (Aqueous extract of Cucuma longa) and in group C (Control group for Cucuma longa) were 221.67 ± 47.29 and 285.83 18.82(u/l). The decrease in mean AST in the aqueous extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group. Mean ± SD of serum ALP in group D (Aqueous extract of Cucuma longa) and in group C (Control group for Cucuma longa) were 296.83 ± 12.27 and 413.33 ± 12.91. The decrease in mean ALP in the aqueous extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group. Serum bilirubin in group D (Aqueous extract of Cucuma longa) and in group C (Control group for Cucuma longa) was 0.67 ± 0.04 and 0.82 ± 0.02 (mg/dl) respectively. The decrease in mean serum bilirubin in the aqueous extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group. Mean ± SD of serum ALT in group C (Control group for Cucuma longa) and in group E (Ethanol extract of Cucuma longa) were 537.50 ± 12.94and 243.00 ± 30.69(u/l). The decrease in mean serum ALT in the ethanol extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group. Mean ± SD of serum AST in group C (Control group for Cucuma longa) and in group E (Ethanol extract of Cucuma longa) were 285.83 ± 18.82 and 221.67 ± 47.29(u/l). The decrease in mean serum AST in the ethaanol extract of Cucuma longa pretreated group was significant ($p<0.05$) in comparison with paracetamol treated group. Mean ± SD of serum ALP in group C (Control group for Cucuma longa) and in group E (Ethanol extract of Cucuma longa) were 413.33 ± 12.91 and 296.83 ± 12.27(u/l). The decrease in mean serum ALP in the ethanol extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group. Serum bilirubin in group C (Control group for Cucuma longa) and in group E (Ethanol extract of Cucuma longa) was 0.82 ± 0.02 and 0.67 ± 0.04 (mg/dl) respectively. The decrease in mean serum bilirubin in the ethanol extract of Cucuma longa pretreated group was highly significant ($p<0.001$) in comparison with paracetamol treated group.

Table 3: Effect of paracetamol on liver weight variation in experimental rats.

Groups	Liver weight (g/100 g body weight)
Group A (Normal control)	7.47 ± 0.34
Group B (Paracetamol treated)	8.35 ± 0.46**

Table 33 showed that the mean ± SD of liver in g/100g body weight in group A (Normal control) and group B (Paracetamol treated) were 7.47 ± 0.34 and 8.35 ± 0.46 respectively. Increase in liver weight in g/100g body weight in the paracetamol treated group was very significant ($p<0.01$) in comparison with normal control group.

Table 4: Effects of Curcuma longa on Liver Weight Variation in Experimental Rats

Groups	Liver weight (g/100 g body weight)
Group C (Control group)	8.33 ± 0.46
Group D (Experimental group)	7.95 ± 0.50 (NS)
Group E (Experimental group)	7.70 ± 0.50*

Table 4 showed that the mean ± SD of liver in g/100g body weight in group C (Control group for Cucuma longa), group D (Aqueous extract of Cucuma longa) and in group E (Ethanol extract of Cucuma longa) were 8.33 ± 0.46, 7.95 ± 0.50 NS and 7.70 ± 0.50* respectively. Increase in liver weight in g/100g body weight in the paracetamol treated group was significant ($p<0.05$) except in group D.

DISCUSSION

The protective effect of extracts of curcuma longa rhizomes on paracetamol induced hepatotoxicity in rat was studied in healthy adult Ratins Norvigicus rats. In this present study, a total number of 30 rats were used and the experiment experiment-I as designed and experiment-II. Experiment-I was performed to see the hepatotoxic effect of paracetamol and experiment-II was designed to evaluate the hepatoprotective effects of aqueous and ethanol extracts of curcuma longa rhizomes.

In this study, hepatotoxicity was induced in adult Rattans Norvigicus rats by administrating single dose of paracetamol at a dose of 2gm/kg body wt. on 7th day. The hepatotoxicity was evidenced by a significant increase ($p <0.001$) in serum ALT, AST and ALP levels of experimental rats which were compared to that of control group. Similarly, Eva demonstrated hepatotoxicity in experimental rats by given single dose of paracetamol at a dose of 2gm/kg body wt. on 7th day [5]. Her study showed that paracetamol increased serum bilirubin, ALT, AST, ALP levels of experimental rats. Similar findings were also found in rats and mice by Walker *et al.,* Mehrotra *et al.,* and Alam [13-15]. Deshpande *et al.,* in a study showed the protective effect of turmeric extract (TE) in diet on CC14-treated experimental rats [16]. In their study rats were divided into 5 groups: (1) untreated, (2) CC14 treated, (3) pre-TE for 2 weeks followed by CC14, (4) TE and CC14 given concurrently and (5) 5% TE as positive control. The serum levels of bilirubin, cholesterol, aspartate aminotransferase (AST), alamine amino transferase (ALT), and alkaline phosphatase (ALP) were estimated after 1, 2 and 3 months. CC14 caused a maximum increase (2-3-fold in all the above parameters. As compared to CC14 group, a short pre-treatment of TE showed reduction in cholesterol, bilirubin, AST, ALT and alkaline phosphatase activity whereas concurrent treatment of TE and CC14 reduced to a greater extent the levels of all parameters except ALT. They conclude, concurrent treatment of TE gave significant protection against CC14 though the values did not reach the normal levels. Present study showed that short pretreatment with turmeric extract for 7 days gives hepatoprotection to paracetamol induced hepatotoxicity. Here Liver enzymes were estimated and they showed significant decrease in turmeric extract pretreated group though the values did not reach the normal levels. Park *et al.,*carried out a study to investigate the protective effects of curcuma on acute and subacute CC14 induced liver damage in experimental rats [17]. In acute hepatotoxicity was induced by intraperitoneal injection of carbon tetrachloride after 4 consecutive days of curcumin treatment. Subacute hepatotoxicity was induced by oral administration of carbon tetrachloride twice a week during 4 weeks of curcumin treatment. In rats with acute liver injury, curcumin (100 to 200 mg/kg b.w.) lowered the activity of serum alanine aminotransferase to 52-53% ($P<0.05$) and aspartate aminotransferase to about 62% ($P<0.05$). In rats with subacute liver injury, curcumin (100 mg /kg b.w.) lowered the activity of serum alanine aminotransferase to 34% ($P<0.01$) and alkaline phosphatase to 53% ($P<0.05$). They concluded that curcumin improved both acute and subacute liver injury induced by carbon tetrachloride in rats. In the present study, the aqueous extract of Curcuma longa rhizomes decreased paracetamol induced elevated levels of the enzymes were statistically significant (for aqueous extract $p<0.001$, $p<0.001$, $p<0.001$ and for ethanol extract $p<0.001$, $p<0.05$, $p<0.001$ in ALT, AST, ALP respectively) compared to control group. Here hepatotoxicity was induced by paracetamol and pre treatment for 7 days. Hamza, in a study showed that curcuma longa along with Glycyrrhiza glabra L and Moringa oleifera Lam inhibit Diclofenac induced hepatotoxicity [18]. The hepatoprotective activity of the ethanol extract of Curcuma longa was investigated by Somchit *et al.,* against paracetamol induced liver damage in rats [19]. In their study pretreatment of rats with the ethanolic extract of Curcuma longa (100 mg/kg b.w.) prior to paracetamol dosing lowered serum liver enzyme activities. Their results suggested that ethanolic extract of Curcuma longa has potent hepatoprotective effect against paracetamol-induced liver damages in rats. Fu *et al.,* showed that curcumin protect the liver against injury and fibrogenesis caused by carbon tetrachloride (CC14) in rats [9]. Their report demonstrates that curcumin significantly protects the liver from injury by reducing the activities of serum aspartate aminotransferase, alanine. aminotransferase, and alkaline phosphatase, and by improving the histological architecture of the liver. The supplementation of curcumin on protective effect against CCl4-induced liver injury by attenuating hepatic lipids and lipid peroxidation and enhancing antioxidant defense. They showed that curcumin had additive effects on hepatoprotection except for greater improvement in the total glutathione level and antioxidant status [20]. In the present study, due to lack of laboratory facilities, the active constituent of Curcuma Longa, Curcumin could not be isolated in present study. Some advance parameter like total glutathione level and antioxidant status could not be seen due to lack of facilities. Studies showed that Curcuma Longa protects CCL4, paracetamol and diclofenac induced hepatotoxicity in rats. Present study showed hepatoprotective effect of both aqueous and ethanol extract of Curcuma longa. Somchit et al, investigated with only ethanolic extract [19]. It was observed that the size of the liver was enlarged in paracetamol treated rats but it was normal in drug treated groups. A significant reduction liver weight supports this

finding. Histological examination of liver sections treated with paracetamol showed diffuse hepatocyte necrosis. But pretreated with extracts of Curcuma Longa showed sign of hepatoprotection against paracetamol. These findings are similar to study of Rajkapoor *et al.,*[21]. The current study was basically a pharmacological one and both the modern drugs and herbal products were used to influence the biological system. It was evident that the biological systems have certain limitations like individual variations, interference in the response with the variability in models and other factors which might have interfered with the primary findings. However, the results obtained in this experiment may not represent the exact effect. Despite all this limitations, interpretation of the results obtained in this study was made carefully and cautiously anybody can perform study on this aspect in future.

CONCLUSION

The objective of present study was to evaluate the hepatoprotective effects of both the aqueous and ethanol extracts of Curcuma longa rhizomes on paracetamol induced hepatotoxicity in experimental rats and the results and observations of this present study demonstrated hepatoprotection against paracetamol. Further studies should be carried out to determine the active constituents responsible for the hepatoprotective effects of curcuma longa rhizomes and its cellular mechanism of action. Toxicological studies of extracts of curcuma longa rhizomes in animals should also be carried out before any clinical trial for suitability of using in man.

REFERENCES

1. L. Jackson, Robert II and Jason D. Morrow, Analgesic-Antipyretic and Anti- inflammatory Agents and Drugs Employed in the Treatment of Gout, in Goodman L.S. and Gilmann A.: The pharmacological basis of therapeutics, McMillan publishing Co. NY, 10th edition, 2001, Chapter-27; 687-732.
2. Thomas SH. Paracetamol (acetaminophen) poisoning, Pharmacol. Ther. 1993; 60: 91-120
3. Ruckmani K, Kavimani S, Anandan R, Jayakar B. Effect of Moringa Oliefera Linn on paracetamol induced hepatotoxicity. Indian J Pharm Sci 1998;60 (1):33-35
4. Jayakar B, Dubes R, Kavimani S, Effects of various extracts of Caseria esculenta on paracetamol induced hepatotoxicity. Indian Drugs Jollow 1999;36(4):264-265
5. Eva EO. Comparative hepatoprotective effects of Andrographis paniculata and alpha tocopherol in paracetamol induced liver damage in rats (M Phil thesis), Dhaka, Dhaka Medical College, 2004.
6. Sadeque MZ. The protective effect of dried fruits of Carica papaya Linn on carbon tetrachloride induced hepatotoxicity in Rats, (M. Phil thesis), Dhaka, Dhaka University, 2007
7. Khorsandi L and Orazizadeh M, Protective effect of Curcuma longa extract on acetaminophen induced nephrotoxicity in mice DARU 2008; 6 (3): 155-159.
8. Sugiyama T, Nagata J, Yamagishi A, Endoh K, Saito M, Yamada K, *et al.,* Selective protection of curcumin against carbon tetrachloride-induced inactivation of hepatic cytochrome P450 isozymes in rats, Life Sci. 2006; 78 (19): 2188-93.
9. Fu Y, Zheng S, Lin J, Ryerse J, Chen A, Curcumin protects the rat liver from CC14-caused injury and fibrogenesis by attenuating oxidative stress and suppressing inflammation, Mol Pharmacol. 2008; 73 (2): 399-409.
10. Reyes-Gordillo K, Segovia J, Shibayama M, Vergara P, Moreno MG, Muriel P, Curcumin protects against acute liver damage in the rat by inhibiting NF- kappaB, proinflammatory cytokines production and oxidative stress, Biochim Biophys Acta. 2007; 1770 (6): 989-96.
11. Bruck R, Ashkenazi M, Weiss S, Goldiner I, Shapiro H, Aeed H, *et al.,* Prevention of liver cirrhosis in rats by curcumin, Liver Int. 2007; 27: 373-83.
12. Somchit MN, Sulaiman MR, Noratunlina R, Ahmad Z, Hepatoprotective effects of curcuma longa rhizomes in paracetamol-induced liver damage in rats, Proceedings of the Regional Symposium on Environment and Natural Resourc, 2002; 1: 698-702.
13. Walker B.U., Kelleher J., Dixon M.F. and Losowsky M.S.: Vitamin E protection of the liver from Paracetamol in the rat. Clin Sci Mol Med. 1974; 47: 449-459.
14. Mehrotra R., Nath P., Chaturvedi R. and Pandey R.K.: Experimental study on Paracetamol induced hepatotoxicity. Indian Journal Med Res 1982; 76: 479-487.
15. Alam M.K.; Effect of Prednisolone on Paracetamol induced Hepatotoxicity, IPGMR Thesis (Pharmacology), 1987.
16. Deshpande UR, Gadre SG, Raste AS, Pillai D, Bhide SV, Samuel AM, Protective effect of turmeric(Curcuma Longa L.) extract on carbon tetrachloride-induced liver damage in rats, Indian J Exp Biol. 1998 Jun; 36 (6) :573-7.
17. Park E-J, Jeon CH, Ko G, Kim J, Sohn DH, Protective Effect of Curcumin in Rat Liver Injury Induced by Carbon Tetrachloride, Journal of Pharmacy and Pharmacology. 2000; 52 (4): 437-440.
18. Hamza AA, Curcuma longa, Glycyrrhiza glabra and Moringa oleifera Ameliorate Diclofenac-induced Hepatoxicity in Rats, American Journal of Pharmacology and Toxicology. 2007; 2 (2): 80-88.
19. Somchit MN; A. Zuraini A, Bustamam AA, Somchit N, Sulaiman MR, Noratunlina R, Protective Activity of Turmeric (Curcuma longa) in Paracetamol-induced Hepatotoxicity in Rats, International Journal of Pharmacology. 2005; 1(3): 252-256.
20. Wu SJ, Lin YH, Chu CC, Tsai YH, Chao JC, Curcumin or saikosaponin a improves hepatic antioxidant capacity and protects against CC14-induced liver injury in rats, J Med Food. 2008; 11(2): 224-229.
21. Rajkapoor B, Jaykar B, Kavimani S, and Murugesh N. Effect of dried fruits of Carica Papaya linn on hepatotoxicity. Biol. Pharm. Bull. 2002:25(12):1645-1646.