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Original Research Article

Experimental evaluation of the safety and hepato-protective activity of Raktaphaladi Vati against ethanol induced hepatotoxicity in Wistar rats: an *in vivo* study

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ABSTRACT

Background: Ethanol-induced hepatotoxicity is characterized by oxidative stress, inflammation, hepatocellular injury, and impairment of hepatic function. Raktaphaladi Vati is a classical Ayurvedic formulation traditionally indicated in disorders associated with Yakrit Dushti. However, its hepatoprotective potential against ethanol-induced hepatic injury has not been adequately evaluated experimentally. Objectives were to evaluate the safety and hepatoprotective activity of Raktaphaladi Vati against ethanol-induced hepatotoxicity in Wistar albino rats and to compare its efficacy with the standard hepatoprotective drug, Silymarin.

Methods: An experimental study was conducted on healthy Wistar albino rats weighing 150-250 g. Acute oral toxicity was evaluated according to OECD guideline 423 at doses of 300 and 2000 mg/kg body weight. Thirty rats were randomly allocated into five groups (n=6): normal control, ethanol-induced disease control, standard control receiving Silymarin (25 mg/kg), curative Raktaphaladi Vati (87.3 mg/kg), and preventive Raktaphaladi Vati (87.3 mg/kg). Hepatotoxicity was induced by ethanol administration for 28 days. Serum SGOT, SGPT, ALP, bilirubin, total protein and albumin, along with organ weights and hepatic histopathology, were evaluated. Data were analyzed using one-way ANOVA followed by Bonferroni post-hoc test.

Results: Raktaphaladi Vati was safe up to 2000 mg/kg, with no mortality or observable signs of toxicity. Ethanol administration resulted in marked elevation of SGOT, SGPT and ALP, increased liver weight, and histopathological evidence of hepatocellular degeneration and inflammatory infiltration. Raktaphaladi Vati treatment attenuated these alterations, improved hepatic biochemical parameters, normalized liver weight, and preserved hepatic architecture. The preventive regimen demonstrated comparatively greater protection than the curative regimen and showed effects approaching those of Silymarin.

Conclusions: Raktaphaladi Vati demonstrated a favorable safety profile and significant hepatoprotective activity against ethanol-induced hepatic injury in Wistar albino rats. Its protective effect may be associated with antioxidant, anti-inflammatory, detoxifying and Rasayana properties. The greater efficacy of preventive administration suggests its potential role in preventing ethanol-induced hepatocellular injury.

Keywords: Raktaphaladi Vati, Hepatoprotection, Ethanol, Hepatotoxicity, Ayurveda, Oxidative stress, Liver enzymes

INTRODUCTION

In Ayurveda, Visha is described as a substance capable of producing harmful effects on the body by vitiating the Dhatus and disturbing normal physiological functions. Ayurvedic classics describe various categories of Visha, including Sthavara, Jangama, Mahavisha, Upavisha, Kritrima, Akritrima, Gara Visha, and Dushi Visha,

according to their origin, properties, and effects on the body.[1-3] Excessive and improper consumption of Madya (alcohol) adversely affects physiological systems, particularly the liver, which plays a central role in alcohol metabolism and detoxification.[1]

Alcohol consumption represents a major global public health concern due to its direct link with morbidity, premature mortality, and chronic diseases. Alcohol-related liver disease contributes substantially to the global burden of liver-related mortality and disability.[4] The liver is particularly vulnerable to ethanol-induced injury as the primary site of alcohol degradation. Persistent ethanol intake produces a progressive spectrum of hepatic damage, progressing from hepatic steatosis to alcoholic hepatitis, fibrosis, and cirrhosis.[4]

The liver executes key physiological processes, including carbohydrate, protein, lipid, and vitamin metabolism; plasma protein synthesis; bile production and secretion; nutrient storage; and biotransformation of toxic compounds.[5] Bile contains bile salts, cholesterol, phospholipids, and pigments crucial for lipid digestion and waste elimination. Accordingly, hepatic injury disrupts systemic metabolic homeostasis and compromises multi-organ function.[5]

Following ingestion, ethanol is absorbed via the gastrointestinal tract and delivered to the liver for enzymatic oxidation by alcohol dehydrogenase and aldehyde dehydrogenase. This pathway alters the hepatic $NADH/NAD^+$ ratio and yields acetaldehyde-a toxic intermediate that disrupts lipid, carbohydrate, protein, and purine metabolism.[6,7] Chronic ethanol exposure induces intrahepatic lipid accumulation, oxidative stress, inflammatory cascades, and cell membrane damage, culminating in hepatocellular degeneration and structural hepatic damage.[7,8]

Addressing alcohol-induced hepatic injury requires rigorous evaluation of targeted therapeutic interventions. Ayurveda outlines specific traditional formulations for liver-related (Yakrit) disorders.[1] Scientific investigation of these classic preparations is necessary to evaluate their safety profile and validate their traditional therapeutic rationale through objective experimental models.

Raktaphaladi Vati is an Ayurvedic formulation prepared according to Anubhut Yoga. It comprises Rohitaka, Raktaphala, Udumbara, Ashwattha, and Suvarna Bhasma. While its classic background offers a historical rationale, systematic experimental evaluation using biochemical and histopathological markers is required to establish its safety and hepatoprotective efficacy against ethanol-induced toxicity.

Accordingly, the present study, entitled "experimental evaluation of the safety and hepato-protective activity of Raktaphaladi Vati against ethanol induced hepatotoxicity in wistar rats: an *in vivo* study," was conducted to evaluate the safety and potential hepatoprotective action of Raktaphaladi Vati in Wistar albino rats subjected to ethanol-induced liver injury. The study assessed alterations in serum biochemical markers and hepatic architecture in both preventive and curative treatment protocols, using a standard hepatoprotective agent for comparison. This work provides experimental evidence regarding the safety and therapeutic potential of Raktaphaladi Vati as a basis for further pharmacological research.

Previous work done

Several clinical and experimental studies have investigated the hepatoprotective potential of Ayurvedic formulations, medicinal plants, and their bioactive constituents. Pawle et al conducted a clinical study evaluating Rohitakadya Churna and Guduchyadi Kwatha in the management of Yakrit-Vikar, with reference to hepatomegaly, providing clinical evidence relevant to Ayurvedic approaches to liver disorders.[9] Nanji et al demonstrated that curcumin attenuated alcohol-induced liver injury in rats, reducing pathological and biochemical changes through mechanisms associated with inhibition of NF-κB-dependent inflammatory gene expression.[10] Shah et al evaluated Punarnavashtak Kwath using *in vitro* antioxidant assays and an *in vivo* ethanol-induced hepatotoxicity model in rats, reporting antioxidant and hepatoprotective effects.[11] Abraham reviewed hepatoprotective herbs described in Ayurveda and summarized reported experimental evidence and possible mechanisms of action.[12] Singh et al reviewed preclinical research on herbal interventions for ethanol-induced hepatotoxicity, highlighting findings related to oxidative stress, inflammation, hepatic degeneration, and necrosis.[13]

Further experimental studies have examined individual Ayurvedic formulations and medicinal plants. Goyal et al investigated Rohitaka Ghrita in a rat model of paracetamol-induced liver injury and reported improvements in biochemical, antioxidant, and histopathological parameters.[14] Balakrishna and Lakshmi evaluated the ethanolic extract of Terminalia chebula fruit against ethanol-induced hepatotoxicity in rats and reported improvements in antioxidant parameters and liver histology.[15] Chavan et al investigated Satwa preparations from three Tinospora species in rats exposed to acetaminophen and alcohol, assessing lipid metabolism and inflammatory markers.[16]

Rejitha et al reported that the 50% ethanolic extract of Sida cordifolia roots attenuated alcohol-induced hepatotoxicity, with improvements in liver enzyme levels, antioxidant status, lipid peroxidation, inflammatory markers, and histopathological findings.[17]

Jain et al evaluated mangiferin herbosomes in ethanol-induced hepatic injury in rats and reported enhanced absorption and improved biochemical and antioxidant outcomes compared with plain mangiferin.[18]

Need and novelty of the study

Alcohol-induced hepatotoxicity is a major health concern, while effective and safe hepatoprotective therapies remain limited. Although Raktaphaladi Vati is traditionally used for liver disorders, its hepatoprotective potential against ethanol-induced hepatic injury has not been adequately validated. Therefore, the present study aimed to provide experimental validation of its safety and hepatoprotective activity, uniquely evaluating both preventive and curative effects through biochemical and histopathological parameters in Wistar albino rats, thereby providing preliminary scientific support for its traditional use in hepatic disorders.

Pharmacological basis of hepatoprotection

The ingredients of Raktaphaladi Vati possess hepatoprotective, antioxidant, anti-inflammatory, detoxifying, and immunomodulatory activities. Rohitaka improves liver function, Nyagrodha supports blood purification, Udumbara reduces inflammation, Ashwattha exhibits antioxidant effects, and Suvarna Bhasma promotes tissue regeneration and metabolic efficiency.[19-23] Their synergistic action may contribute to the hepatoprotective efficacy observed against ethanol-induced liver injury.

Aim

Aim was to evaluate the hepatoprotective activity of Raktaphaladi Vati against ethanol-induced hepatotoxicity in Wistar albino rats.

Objectives

Primary objective

Primary objective was to assess the hepatoprotective activity of Raktaphaladi Vati in ethanol-induced hepatotoxicity.

Secondary objectives

"The study was designed to evaluate the safety profile of Raktaphaladi Vati and compare its therapeutic efficacy with Silymarin. To achieve these aims, researchers assessed key biochemical liver function parameters alongside detailed histopathological changes in liver tissue."

METHODS

Study design

An experimental animal study was conducted using healthy adult Wistar albino rats weighing 150-250 g. The experimental work was conducted at the SCITESLA laboratory, Navi Mumbai, from 10 September 2025 to 27 October 2025.

Inclusion criteria

Healthy Wistar albino rats of either sex weighing 150-250 g, with normal liver-function parameters and successful acclimatization to laboratory conditions, were eligible for inclusion.

Exclusion criteria

Animals were excluded if they were diseased or injured, pregnant or lactating, showed behavioural abnormalities, or failed to comply with the approved experimental protocol.

Ethical approval and animal welfare

The experimental protocol was reviewed and approved by the Institutional Animal Ethics Committee (IAEC) of SCITESLA Private Limited, Navi Mumbai, India, registered with the Committee for the Control and Supervision of Experiments on Animals (CPCSEA) under Registration No. 2166/PO/RcBi/S/22/CPCSEA, dated 19 May 2022. The study received IAEC approval under Approval No. SCI/IAEC/2025-26/177, dated 23 August 2025. All animal experimental procedures were conducted at the SCITESLA laboratory in accordance with the approved study protocol and applicable CPCSEA guidelines for the care and use of laboratory animals. The experimental work was conducted from 10 September 2025 to 27 October 2025.

Acute toxicity study

Acute oral toxicity testing was performed according to OECD Guideline 423. Raktaphaladi Vati was administered at doses of 300 mg/kg and 2000 mg/kg body weight. Animals were observed for mortality, behavioral changes, and signs of toxicity.

Experimental groups

Thirty rats were randomly allocated to five groups of six animals each. Group I served as the normal control. Group II received ethanol and served as the disease control. Group III received ethanol with Silymarin 25 mg/kg and served as the standard group. Group IV received ethanol followed by Raktaphaladi Vati 87.3 mg/kg as the curative regimen. Group V received Raktaphaladi Vati 87.3 mg/kg before ethanol exposure as the preventive regimen. Ethanol-induced hepatotoxicity was produced over 28 days according to the study protocol.

Outcome assessment

Body weight was recorded on days 1, 14, 21, 28, 35 and 42. Serum SGOT (AST), SGPT (ALT), ALP, total protein, total bilirubin, direct bilirubin, indirect bilirubin and albumin were assessed. Liver, kidney and spleen weights were recorded and gross pathological examination was performed. Liver and kidney tissues were processed,

stained with haematoxylin and eosin and examined microscopically.

Statistical analysis

Data were expressed as mean±SD as reported in the study dataset. One-way analysis of variance followed by Bonferroni post-hoc testing was specified for comparison among groups, with $p<0.05$ considered statistically significant. Because the manuscript dataset does not report individual-animal observations or the calculated p values, only the supplied group means and dispersion measures are presented in the results; statistical significance is not newly inferred from the summary data.

RESULTS

Acute toxicity. No mortality or observable clinical signs of toxicity were recorded at doses up to 2000 mg/kg during the acute oral toxicity assessment, indicating a favourable acute safety profile under the conditions of the study.

The ethanol disease-control group showed the highest SGOT, SGPT and ALP values. Relative to the disease-control means, the curative regimen reduced SGOT by approximately 41%, SGPT by 45% and ALP by 21%, whereas the preventive regimen reduced SGOT by approximately 55%, SGPT by 57% and ALP by 18%.

Thus, the preventive regimen showed a clearer numerical advantage for SGOT and SGPT, but not for ALP.

Total protein changed little across groups. Albumin was markedly lower in the disease-control group and was restored in the Silymarin and curative groups; the preventive group also improved albumin compared with disease control, although its mean remained below the curative and Silymarin groups.

Table 1: Experimental groups and treatment regimens.

Groups	Treatment regimen	Dose
Ficus bengalensis	Normal control	-
Ficus bengalensis	Ethanol disease control	Ethanol
Ficus bengalensis	Ethanol + Silymarin	Silymarin 25 mg/kg
Ficus bengalensis	Ethanol + Raktaphaladi Vati, curative	Raktaphaladi Vati 87.3 mg/kg
Ficus bengalensis	Raktaphaladi Vati + ethanol, preventive	Raktaphaladi Vati 87.3 mg/kg

Table 2: Body weight of experimental animals at different observation points (g, mean±SD).

Groups	Day 1	Day 14	Day 21	Day 28	Day 35	Day 42
Normal control	203.5±7.2	216.8±9.4	227.5±9.8	240.2±12.5	252.6±14.7	263.3±17.4
Disease control-ethanol	209.8±6.6	222.8±7.0	233.1±6.8	243.2±7.4	264.6±8.9	286.5±11.0
Ethanol + Silymarin	206.3±10.1	219.8±9.0	230.5±9.4	244.3±9.8	258.0±9.3	274.4±9.7
Ethanol+Raktaphaladi vati, curative	207.8±6.7	221.3±8.1	232.7±8.5	243.0±8.7	254.0±9.4	276.3±10.4
Raktaphaladi vati+ethanol, preventive	209.5±7.6	223.0±6.1	234.2±7.9	246.8±7.4	260.5±7.5	268.7±8.2

Table 3: Serum biochemical parameters in experimental groups (mean±SD).

Groups	SGOT (IU/L)	SGPT (IU/L)	ALP (IU/L)	Total protein (g/dL)	Total bilirubin (mg/dL)	Direct bilirubin (mg/dL)	Indirect bilirubin (mg/dL)	Albumin (g/dL)
Normal control	120.8±10.5	85.0±14.9	300.3±13.5	6.30±0.29	0.22±0.10	0.10±0.00	0.12±0.04	4.21±0.38
Disease control ethanol	297.8±34.6	268.3±53.0	426.3±31.1	6.20±0.46	0.28±0.15	0.15±0.05	0.20±0.00	1.62±0.51
Ethanol + Silymarin	142.2±15.5	109.7±10.4	307.8±15.3	6.25±0.27	0.25±0.08	0.13±0.05	0.12±0.04	4.43±0.63
Ethanol+Raktaphaladi Vati, curative	175.3±24.1	146.5±21.3	336.4±23.0	6.30±0.32	0.25±0.10	0.15±0.05	0.15±0.05	4.38±0.43
Raktaphaladi Vati + ethanol, preventive	133.3±12.9	116.0±15.3	349.6±13.4	6.15±0.10	0.20±0.06	0.15±0.05	0.13±0.05	3.90±0.32

Table 4: Organ weights at the end of the experiment (g, mean±SD).

Groups	Liver weight (g)	Kidney weight (g)	Spleen weight (g)
Normal control	11.18±0.19	0.76±0.04	0.42±0.04
Disease control-ethanol	13.35±1.37	1.21±0.10	0.51±0.03
Ethanol + Silymarin	11.27±0.47	0.93±0.11	0.49±0.01
Ethanol + Raktaphaladi Vati, curative	11.88±0.45	1.02±0.07	0.54±0.22
Raktaphaladi Vati + ethanol, preventive	11.87±0.33	0.90±0.04	0.48±0.14

The disease-control group had higher liver and kidney weights than the normal-control group. Both Raktaphaladi Vati regimens reduced liver weight toward the normal range, while the preventive regimen produced the lower kidney weight of 2 Raktaphaladi Vati groups. Spleen-weight differences were small and variable.

Histopathological findings

The normal-control liver sections showed preserved hepatic architecture and intact hepatocytes.

The ethanol disease-control sections showed granular degeneration and inflammatory infiltration with disturbed architecture.

The Silymarin-treated sections showed mild degeneration and minimal inflammation.

Both Raktaphaladi Vati groups showed reduced cellular degeneration, decreased inflammatory infiltration and preservation of hepatic architecture; the preventive group showed the more favourable qualitative appearance.

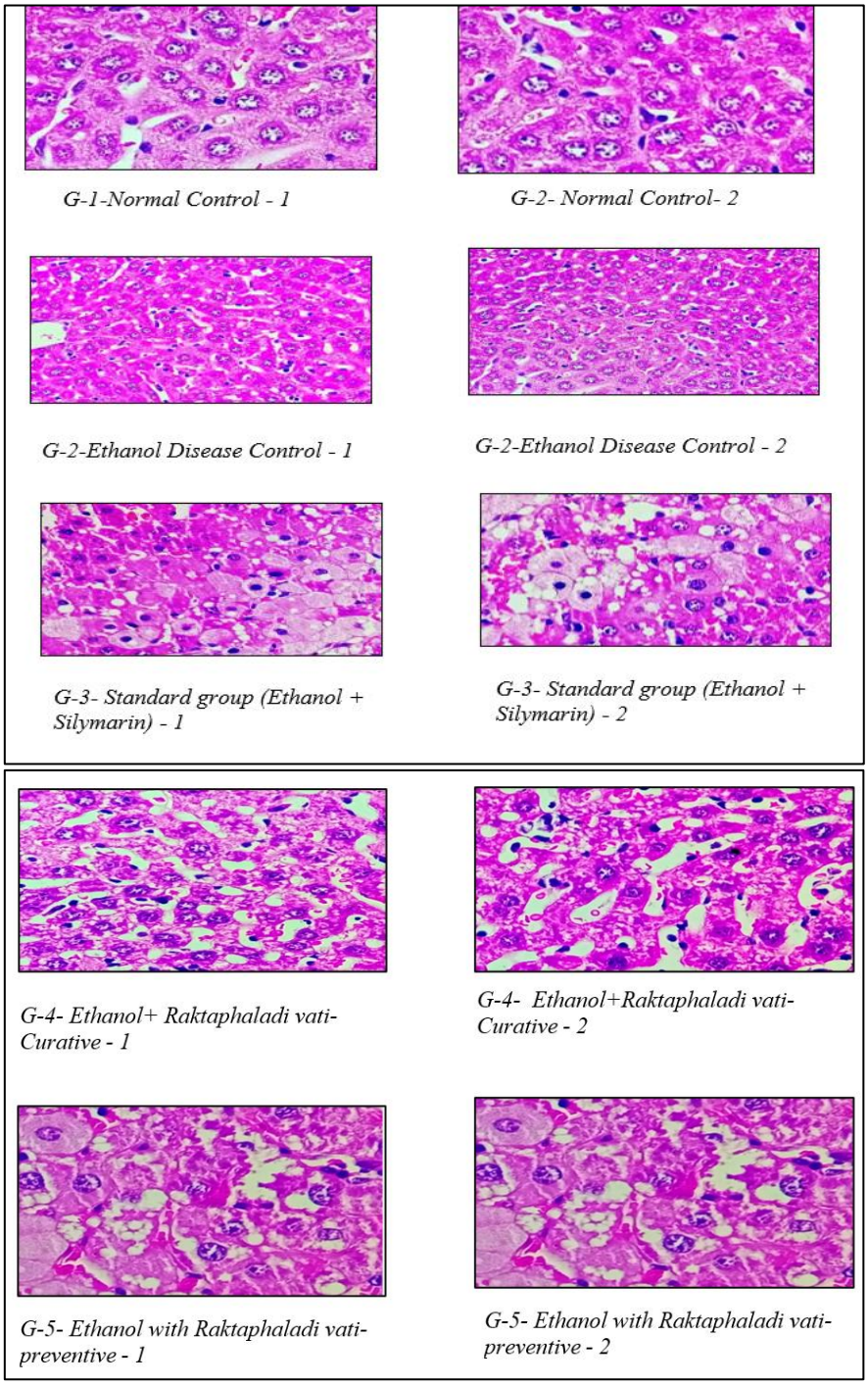


Figure 1: Histopathological findings for liver.

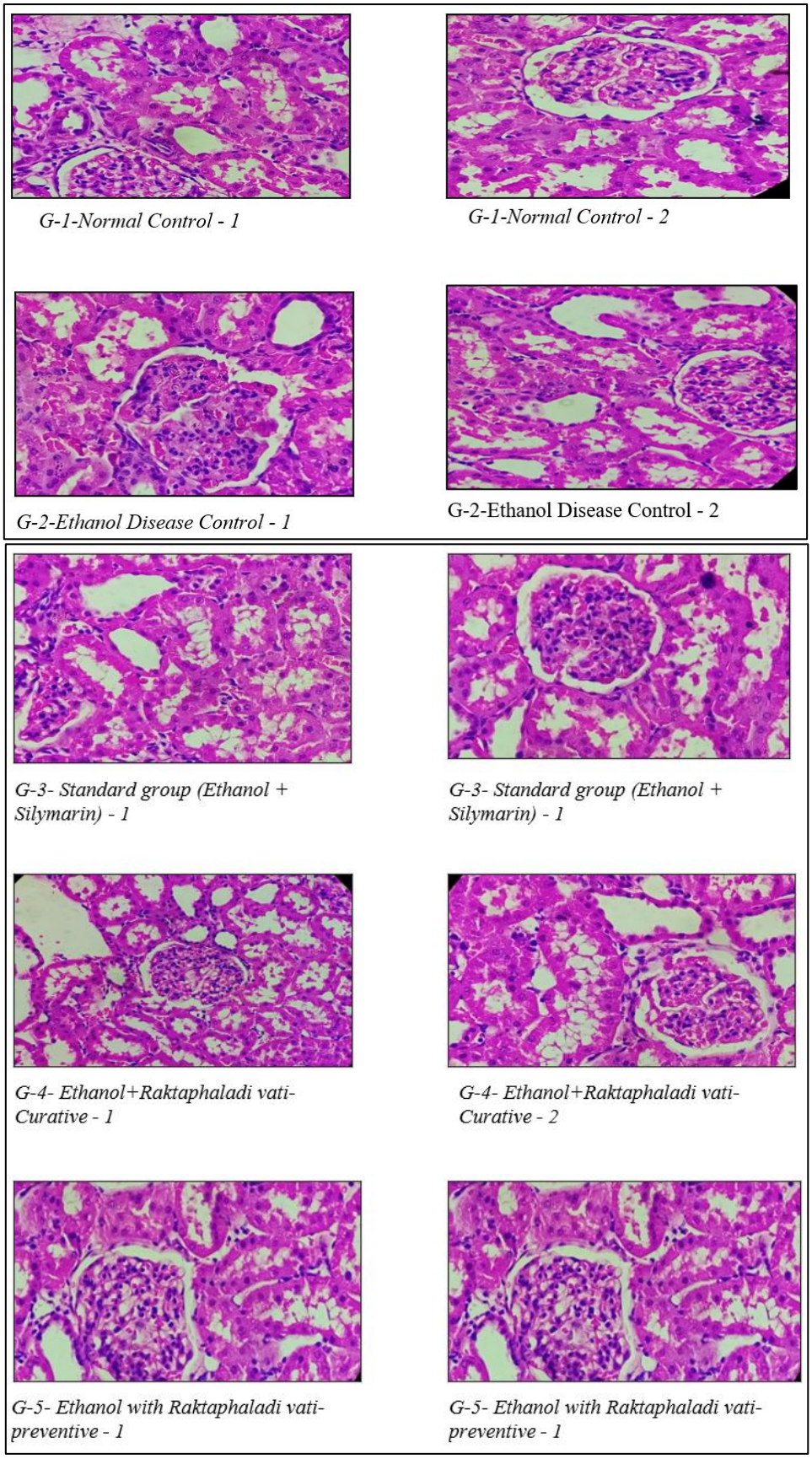


Figure 2: Histopathological findings for Kidney.

Mechanism of action of Raktaphaladi Vati

The hepatoprotective activity of Raktaphaladi Vati may be attributed to the combined antioxidant, anti-inflammatory, membrane-stabilizing, and regenerative actions of its ingredients. By reducing ethanol-induced oxidative stress and lipid peroxidation, the formulation may protect hepatocytes and reduce leakage of SGOT, SGPT, and ALP. Its Vishaghna, Pittashamaka, Raktaprasadaka, and Rasayana properties may further support hepatic tissue protection and functional restoration. The comparatively better SGOT and SGPT response in the preventive group suggests a potential protective effect against ethanol-induced hepatocellular injury.

DISCUSSION

The present study evaluated the acute oral tolerability and hepatoprotective activity of Raktaphaladi Vati in ethanol-induced hepatotoxicity in Wistar albino rats. Ethanol exposure increased SGOT, SGPT, ALP, liver weight and hepatic degeneration, while reducing serum albumin. Both preventive and curative regimens improved several biochemical and histopathological parameters. Previous studies have demonstrated the protective potential of interventions targeting oxidative stress and inflammation in alcohol-induced liver injury.[7,10]

No mortality or observable clinical signs of toxicity were reported up to 2000 mg/kg body weight, indicating favourable acute tolerability under the tested conditions. However, these findings do not establish long-term safety, which requires repeated-dose and other appropriate toxicological investigations.

SGOT increased from 120.8±10.5 IU/l in the normal-control group to 297.8±34.6 IU/l in the ethanol disease-control group, while SGPT increased from 85.0±14.9 to 268.3±53.0 IU/l. Curative Raktaphaladi Vati reduced these values to 175.3±24.1 and 146.5±21.3 IU/l, respectively, whereas preventive treatment reduced them to 133.3±12.9 and 116.0±15.3 IU/l. These correspond to approximate reductions of 41% and 45% with curative treatment and 55% and 57% with preventive treatment, respectively. These findings suggest a greater numerical improvement with preventive administration. Nanji et al similarly reported attenuation of alcohol-induced liver injury by curcumin through effects associated with NF-κB-dependent inflammatory pathways.[10] However, differences in interventions and experimental protocols prevent direct equivalence between the studies.

The Silymarin group showed SGOT and SGPT values of 142.2±15.5 and 109.7±10.4 IU/l, respectively. Preventive Raktaphaladi Vati produced a lower SGOT value, whereas Silymarin produced a slightly lower SGPT value. Thus, preventive treatment approached the reference treatment for these parameters, but equivalence or superiority cannot be established without statistical comparisons.

ALP increased from 300.3±13.5 IU/l in normal controls to 426.3±31.1 IU/l in disease controls. Curative and preventive Raktaphaladi Vati reduced it to 336.4±23.0 and 349.6±13.4 IU/L, representing approximate reductions of 21% and 18%, respectively. Silymarin produced the lowest treatment-group value (307.8±15.3 IU/l). Unlike the aminotransferases, ALP showed a greater numerical reduction with curative treatment. Previous research on *Ficus racemosa* leaf extract also evaluated liver enzymes and other biochemical markers in experimental hepatic injury, although its carbon-tetrachloride model differed from the present ethanol model.[21]

Albumin decreased from 4.21±0.38 g/dl in normal controls to 1.62±0.51 g/dl in disease controls. It increased to 4.43±0.63 g/dl with Silymarin, 4.38±0.43 g/dl with curative Raktaphaladi Vati and 3.90±0.32 g/dl with preventive treatment. Curative treatment therefore showed better numerical albumin restoration than preventive treatment, indicating that the treatment response varied across parameters. Total protein remained comparatively stable at 6.15-6.30 g/dl. Albumin is influenced by hepatic synthesis, nutrition, inflammation and protein loss; therefore, its improvement alone does not establish restoration of hepatic synthetic function.

Total bilirubin ranged from 0.20 to 0.28 mg/dl, with relatively small differences among groups compared with the aminotransferase changes. However, the reported direct and indirect bilirubin fractions do not consistently sum to total bilirubin. These values should be verified against the original laboratory records before interpretation.

Liver weight increased from 11.18±0.19 g in normal controls to 13.35±1.37 g in disease controls. It decreased to 11.27±0.47 g with Silymarin and 11.88±0.45 g and 11.87±0.33 g with curative and preventive Raktaphaladi Vati, respectively. These changes were consistent with the biochemical and histopathological improvements, although absolute organ weight is nonspecific and should ideally be interpreted alongside body-weight-adjusted organ ratios.

Kidney weight increased from 0.76±0.04 g in normal controls to 1.21±0.10 g in disease controls, compared with 0.93±0.11 g with Silymarin, 1.02±0.07 g with curative treatment and 0.90±0.04 g with preventive treatment. These descriptive findings suggest a lower kidney weight with preventive treatment than with curative treatment, but kidney weight alone cannot establish renal protection. Spleen weights ranged from 0.42 to 0.54 g, with variable dispersion in the treatment groups; therefore, no firm treatment-related conclusion can be drawn.

Normal-control liver sections showed preserved architecture and intact hepatocytes, whereas ethanol disease-control sections demonstrated granular degeneration, inflammatory infiltration and disturbed architecture. Silymarin-treated sections showed mild

degeneration and minimal inflammation. Both Raktaphaladi Vati groups showed reduced degeneration and inflammatory infiltration, with qualitatively better preservation in the preventive group.

Previous studies reported hepatoprotective effects of *Tecomella undulata* stem-bark preparations and betulinic acid in experimental hepatic injury, while Mandal et al demonstrated hepatoprotective activity of *Ficus racemosa* leaf extract in carbon-tetrachloride-induced liver damage.[19,21] These findings support the biological plausibility of investigating the formulation's ingredients but do not establish the efficacy or mechanism of the complete formulation. Because the present histopathology was qualitative and no validated scoring system or blinded quantitative assessment was reported, the apparent difference between preventive and curative treatment cannot be considered statistically established.

The hepatoprotective response may involve antioxidant, anti-inflammatory and membrane-stabilizing actions. Ethanol-related oxidative stress and inflammatory pathways have been investigated in previous experimental research, including the study by Nanji et al.[7,10] However, the present study did not measure malondialdehyde, glutathione, antioxidant enzymes, inflammatory cytokines or molecular signalling pathways. These mechanisms therefore remain hypotheses requiring direct validation.

Within the Ayurvedic framework, the findings may be discussed in relation to Madya, Visha and Yakrit Dushti, consistent with the traditional background described in the Introduction.[1-3] These concepts provide a traditional interpretive framework but should not be equated with specific molecular mechanisms established by the present experiment.

Preventive Raktaphaladi Vati produced lower SGOT and SGPT values than curative treatment, whereas curative treatment showed better numerical albumin restoration and a lower ALP value. Liver weights were nearly identical between the two regimens. Thus, preventive administration showed advantages for selected parameters but was not uniformly superior across all outcomes.

Strengths and limitations

The study incorporated an acute toxicity assessment, disease and Silymarin control groups, preventive and curative treatment regimens, biochemical measurements, organ weights and histopathological examination. However, the sample size was six animals per group, and individual-animal data and complete statistical output were unavailable for this revision. Quantitative oxidative-stress markers, molecular mechanisms, dose-response relationships and validated histopathological scores were not reported. The bilirubin fractions also require verification, and findings in rats cannot be directly extrapolated to humans.

CONCLUSION

Raktaphaladi Vati demonstrated favorable acute safety up to 2000 mg/kg in rats and effectively attenuated ethanol-induced hepatotoxicity in both preventive and curative regimens. The formulation significantly mitigated hepatic injury by suppressing elevated liver enzymes (SGOT, SGPT and ALP), reducing liver enlargement, restoring serum albumin, and mitigating histopathological tissue damage. Overall, preventive administration offered superior control over transaminase levels and architectural preservation, whereas curative treatment achieved better albumin recovery.

These findings validate the traditional rationale for Raktaphaladi Vati in managing liver disorders. However, multi-dose toxicity studies, quantitative biomarker profiling (oxidative and inflammatory markers), and clinical trials are required to elucidate its underlying molecular mechanisms and establish human therapeutic safety and efficacy.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Murthy KRS, translator. Sushruta Samhita. Vol. 2. Varanasi: Chaukhambha Orientalia. 2010;419.
2. Murthy KRS, translator. Ashtanga Hridaya. 5th ed. Vol. 3. Varanasi: Chaukhambha Krishnadas Academy. 2009:329.
3. Joglekar VP. Textbook of Agadtantra. 1st ed. Rashtriya Shikshan Mandal. 2008;17-19.
4. Rehm J, Samokhvalov AV, Shield KD. Global burden of alcoholic liver diseases. J Hepatol. 2013;59(1):160-8.
5. Sembulingam K, Sembulingam P. Essentials of Medical Physiology, 6th ed. Jaypee Brothers Medical Publishers. 2013:255.
6. Singhal SK. Toxicology at a Glance. 8th ed. The National Book Depot. 2012;94.
7. Lieber CS. Biochemical mechanisms of ethanol-induced hepatic injury. Alcohol Suppl. 1991;1:283-90.
8. Harsh Mohan. Textbook of Pathology. 6th ed. Jaypee Brothers Medical Publishers. 2013.617.
9. Pawle TS, Baghel PK, Ojha A, Tripathi RN, Rout OP. A clinical study on the efficacy of Rohitakadya Churna and Guduchyadi Kwatha in the management of Yakrit-Vikar w.s.r. to hepatomegaly. World J Pharm Pharm Sci. 2017;6(9):2021-33.
10. Nanji AA, Jokelainen K, Tipoe GL, Rahemtulla A, Thomas P, Dannenberg AJ. Curcumin prevents alcohol-induced liver disease in rats by inhibiting the expression of NF-κB-dependent genes. Am J Physiol Gastrointest Liver Physiol. 2003;284(2):G321-7.

11. Shah VN, Shah MB, Bhatt PA. *In vivo* and *in vitro* antioxidant and hepatoprotective effects of classical Ayurvedic formulation Punarnavashtak Kwath against ethanol-induced hepatotoxicity. Pharmacogn J. 2010;2(16):43-52.
12. Abraham G. A review on hepato-protective herbs used in Ayurveda. Glob J Res Med Plants Indig Med. 2014;3(7):303-11.
13. Singh M, Hussain T, Firdous H, Shaikh S, Rizvi SMD, Moin A, et al. Preclinical hepatoprotective effect of herbalism against ethanol-induced hepatotoxicity: a review. Curr Drug Metab. 2018;19(12):1002-11.
14. Goyal R, Ravishankar B, Shukla VJ, Singh M. Hepatoprotective activity of Rohitaka Ghrita against paracetamol-induced liver injury in rat. Pharmacologia. 2012;3(7):227-32.
15. Balakrishna V, Lakshmi T. Hepatoprotective activity of ethanolic extract of *Terminalia chebula* fruit against ethanol-induced hepatotoxicity in rats. Asian J Pharm Clin Res. 2017;10(11):55-8.
16. Chavan TC, Ghadge AA, Kuvalekar AA. Effect of Satwa from three Tinospora species on lipid metabolism and inflammatory markers in acetaminophen and alcohol-induced hepatotoxicity in rats. Int J Pharm Sci Res. 2020;11(8):3876-90.
17. Rejitha S, Prathibha P, Indira M. Amelioration of alcohol-induced hepatotoxicity by the administration of ethanolic extract of *Sida cordifolia* Linn. Br J Nutr. 2012;108(7):1256-63.
18. Jain PK, Kharya M, Gajbhiye A. Pharmacological evaluation of mangiferin herbosomes for antioxidant and hepatoprotection potential against ethanol-induced hepatic damage. Drug Dev Ind Pharm. 2013;39(11):1840-50.
19. Jain M, Kapadia R, Jadeja RN, Thounaojam MC, Devkar RV, Mishra SH. Hepatoprotective potential of Tecomella undulata stem bark is partially due to the presence of betulinic acid. J Ethnopharmacol. 2012;143(1):194-200.
20. Singh RK, Mehta S, Jaiswal D, Rai PK, Watal G. Antidiabetic effect of *Ficus bengalensis* aerial roots in experimental animals. J Ethnopharmacol. 2009;123(1):110-14.
21. Mandal SC, Maity TK, Das J, Pal M, Saha BP. Hepatoprotective activity of *Ficus racemosa* leaf extract on liver damage caused by carbon tetrachloride in rats. Phytother Res. 1999;13(5):430-2.
22. Chandrasekar SB, Bhanumathy M, Pawar AT, Somasundaram T. Phytopharmacology of *Ficus religiosa*. Pharmacogn Rev. 2010;4(8):195-9.
23. Biswas S, Dhumal R, Selkar N, Bhagat S, Chawda M, Thakur K, et al. Physicochemical characterization of Suvarna Bhasma, its toxicity profiling in rat and behavioural assessment in zebrafish model. J Ethnopharmacol. 2020;249:112388.

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