WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 15, 1647-1660. Research Article ISSN 2277–7105

EXPERIMENTAL ASSESSMENT OF SHLESHMATAKADHYA AGAD AS A NATURAL HEPATOPROTECTIVE AGENT IN PARACETAMOL TREATED RATS

Dr. Manish Kumar[1], Dr. O. P. Singh[2], Dr. Ramesh Chandra Tiwari[*3], Dr. Bhawana Mittal[4] and Dr. Pooja Sharma[5]

[1]Post Graduate Scholar, P.G. Department of Agad Tantra evam Vidhi Vaidyaka, Uttarakhand Ayurved University, Rishikul Campus, Haridwar, Uttarakhand, India.

[2]Guide and HOD, P.G. Department of Kayachikitsa, Uttarakhand Ayurved University, Rishikul Campus, Haridwar, Uttarakhand, India.

[*3]Professor & HOD, P.G. Department of Agad Tantra evam Vidhi Vaidyaka, Uttarakhand Ayurved University, Rishikul Campus, Haridwar, Uttarakhand, India.

[4]Assistant Professor, P.G. Department of Agad Tantra evam Vidhi Vaidyaka, Uttarakhand Ayurved University, Rishikul Campus, Haridwar, Uttarakhand, India.

[5]Director, Bilwal Medchem and Research Laboratory, Reengus, Sikar, Rajasthan, India.

Article Received on
19 June 2025,

Revised on 09 July 2025,
Accepted on 29 July 2025,

DOI: 10.20959/wjpr202515-37848

***Corresponding Author**
Dr. Ramesh Chandra Tiwari
Professor & HOD, P.G. Department of Agad Tantra Evam Vidhi Vaidyaka, Uttarakhand Ayurved University, Rishikul Campus, Haridwar, Uttarakhand, India.

ABSTRACT

Introduction: Liver disease, particularly drug-induced hepatotoxicity, poses a major public health challenge, especially in developing countries. Paracetamol (Acetaminophen), although safe at therapeutic doses, can cause acute liver failure in overdose due to the accumulation of N-acetyl-p-benzoquinone imine (NAPQI), which depletes hepatic glutathione and induces oxidative stress. *Shleshmatakadhya Agad*, a classical *Ayurvedic* formulation indicated in *Visha Chikitsa*, is traditionally used against *Dushi Visha*—a concept analogous to chronic toxic injury. This study aimed to evaluate the hepatoprotective activity of *Shleshmatakadhya Agad* in a Wistar rat model of paracetamol-induced hepatotoxicity. **Material and Methods:** An experimental study was conducted on 18 Wistar rats divided into three groups (n = 6): Control (distilled water), Test *(Shleshmatakadhya Agad,* 12 gm/kg), and Standard (Mucinac, 54 mg/kg). Hepatotoxicity was induced by oral administration of paracetamol (1000 mg/kg) for seven days.

Treatments continued for 30 days, followed by evaluation of serum SGOT, SGPT, ALP, total protein, albumin, and direct bilirubin. Histopathological analysis of liver tissues and acute toxicity testing (300mg/kg up to 2000 mg/kg) were also performed. **Results:** showed significant reductions ($p < 0.001$) in hepatic enzymes and improved biochemical parameters in both the Test and Standard groups compared to control. Histology revealed mild hepatic changes in treated groups versus moderate necrosis in controls. No toxicity signs were observed in the acute study. **Conclusion:** *Shleshmatakadhya Agad* demonstrated significant hepatoprotective potential, with efficacy comparable to Mucinac, supporting its role as a safe and effective herbal intervention against drug-induced liver injury.

KEYWORDS: liver, Paracetamol, Hepatotoxicity, *Shleshmatakadhya Agad*, *Dushi Visha*.

INTRODUCTION

The liver, plays a pivotal role in numerous physiological processes, including metabolism, detoxification, and the synthesis of essential proteins. It is an integral part of the body that maintains cellular homeostasis, defending against infections, and supplying energy and nutrients to various tissues. According to projections by the World Health Organization (WHO), the prevalence of hepatic disorders is on the rise and is anticipated to emerge as a leading cause of morbidity and mortality worldwide.[1,2]

Severe hepatic pathologies are frequently associated with exposure to hepatotoxic agents, including chronic alcohol intake, overdose of pharmacological compounds such as paracetamol (acetaminophen), anti-tubercular medications, and chemotherapeutic agents. Despite the widespread use of conventional synthetic therapeutics, their clinical efficacy remains limited, and their administration is often accompanied by a range of adverse effects.

Paracetamol, a commonly used analgesic and antipyretic, is often available without prescription and is widely misused. In 2003, it was the most dispensed pharmaceutical agent globally, with over 89 million prescriptions.[3] In India, paracetamol is frequently used inappropriately at high doses to manage fever in both adults and children, often without adequate dosage guidance on packaging. Its widespread misuse has made it a leading cause of acute liver failure, particularly in the United States.[4] The hepatotoxic effects of paracetamol are primarily attributed to the accumulation of its toxic metabolite, N-acetyl-p-benzo quinone imine (NAPQI), which induces oxidative stress and depletes hepatic glutathione levels, leading to cellular damage.[5]

In *Ayurveda*, toxic substances are classified into three main categories: *Sthavara Visha*, *Jangama Visha*, and *Kritrima Visha*. A specific subtype, *Dushi Visha*, refers to latent or residual toxins derived from the above categories. These toxins are partially neutralized—through prior exposure to detoxifying agents or environmental factors such as heat and air—and remain dormant in the body, encapsulated by *Kapha dosha*. Though not acutely lethal, *Dushi Visha* accumulates over time, leading to chronic toxicity. Repeated or prolonged exposure to certain drugs can give rise to such latent toxicity, thus paracetamol-induced hepatotoxicity can be conceptually correlated with the *Ayurvedic* notion of *Dushi Visha*.[6,9]

In light of this understanding, there is a growing interest in exploring hepatoprotective agents derived from traditional medicine. *Shleshmatakadhya Agad*, a classical polyherbal formulation described in the *Yogaratnakara* under the *Visha Chikitsa* chapter for its detoxifying effects (*Sarva Visha Nashanam*),[10] contains herbs traditionally recognized for their liver-protective properties. Its ingredients—*Shleshmataka* (*Cordia dichotoma*), *Guduchi* (*Tinospora cordifolia*), *Apamarga* (*Achyranthes aspera*), *Nripdruma* (*Cassia fistula*), *Kantakari* (*Solanum surattense*), and *Brihati* (*Solanum indicum*)—are known for their hepato-protective, analgesic, anti-inflammatory, antioxidant, and hepatoregenerative activities.[11,14]

This study aims to evaluate the hepatoprotective efficacy of *Shleshmatakadhya Agad* in an in-vivo model of paracetamol-induced hepatotoxicity. By assessing its capacity to reduce oxidative stress, normalize liver enzyme levels, and prevent histopathological damage, the study seeks to provide scientific validation for its potential as a natural therapeutic agent in the management of drug-induced liver injuries.

MATERIALS AND METHODS

PREPARATION OF DRUGS AND SOLUTIONS

Test Drug: In *Shleshmatakadhya Agad*, no specific proportions (*pramana*) of the ingredients are mentioned. Therefore, in accordance with *Sharangadhara Samhita*, "when proportions are not specified, all ingredients in a formulation should be taken in equal quantities." Each ingredient was taken in equal proportion, powdered separately, and then uniformly mixed to produce a fine, homogeneous powder.[15]

Dose calculation of *Shleshmatakadhya Agad*: Dose of *Churna* in *Sharangadhara Samhita* was given as 1 Karsh or 12 gm.[16]

So, Human dose of *Shleshmatakadhya Agad* = 12gm
Conversion factor of rat (200gm) = 0.018 X 5
Dose of *Shleshmatakadhya Agad* in rat = 12gm X 0.018 X 5 i.e. dose of rat = 1.08 gm/200g body weight with distilled water to form a uniform 20% solution.

Toxicant (Paracetamol): Paracetamol was used to induce hepato toxicity as per the established protocol, at a dosage of 1000 mg/kg body weight.

Standard Drug: Mucinac (N-acetylcysteine) was used as the standard hepatoprotective agent and was administered orally at a dose of 54 mg/kg body weight.
Mucinac- Rat dose = 54 mg/kg Body wt. mixed in distilled water to prepare a 10 % solution.

ADMINISTRATION OF DOSES

The test drug (*Shleshmatakadhya Agad*), Standard drug (Mucinac) and toxicity drug (paracetamol) was administered orally by using oral gavage feeding tube fixed to the syringe.

ANIMALS

The experimental animal room had a temperature of 22°C ± 3°C. Artificial light was provided to replicate a 12-hour light and 12-hour dark cycle. Regular laboratory diets and supply of drinking water was allowed for feeding.

The Wistar rats were randomly selected, marked with Picric acid as H (marking on head), B (marking on the back), T (marking on the tail), HB (marking on the head and tail), BT (marking on the back tail), HT (marking on the head tail) for individual identification and kept in their cages 7 days prior to dosing to allow for acclimatization to the laboratory conditions.

STUDY PROTOCOL

IEC: The experimental protocol was approved by Rishikul Campus, Uttarakhand Ayurved University Registration NO- UAU/RC/IEC/2024.PG.189.

IAEC: The experimental protocol was approved by the Institutional Animal Ethics Committee (IAEC) of Drug Innovative Centre, A unit of Bilwal Medchem and Research Laboratory Pvt. Ltd., Jaipur, Rajasthan, on 18/07/2024 (Reference No.: BMRL/DIC/CCSEA/IAEC/2024/I/06). The study was conducted in accordance with the

guidelines of the Committee for the Control and Supervision of Experiments on Animals (CCSEA), under registration number 2304/PO/Rc/S/2024/CCSEA.

The acute oral toxicity study was conducted in accordance with OECD Guideline 423 (Annexure 2c) and the evaluation of hepatoprotective activity was performed following the protocols outlined in OECD Guideline 407.

STUDY DESIGN

Acute oral toxicity test: 6 Wister rats were divided in two groups each group have 3 Wistar rats.

Group 1 –Received test drug i.e. *Shleshmatkadhya Agad* at dose 300 mg/kg orally

Group 2 –Received test drug i.e. *Shleshmatakadhya Agad* at dose 2000 mg/kg orally

Evaluation of Hepatoprotective Activity of *Shleshmatakadhya Agad*

Eighteen healthy Wistar rats were divided in three groups, each group containing six rats. "To induce hepatotoxicity, all rats received an oral dose of paracetamol at 1000 mg/kg body weight for 7 days."

Control Group - 1: Six Hepatotoxicity induced Wistar rats received distilled water 5 ml/kg/P.O. for 30 days.

Test Group - 2: Six Hepatotoxicity induced Wistar rats received *Shleshmatakadhya Agad* 12 gm/kg/P.O. for 30 days

Standard Group - 3: Six Hepatotoxicity induced Wistar rats received Mucinac 54 mg/kg/P.O. for 30 days.

ASSESSMENT PARAMETERS

Acute oral toxicity study includes changes in Behavioural, Haematological parameters.

"After administration, each animal was observed individually at least once during the first 30 minutes, monitored periodically over the next 24 hours—especially during the initial 4 hours—and then observed daily for the following 14 days."

- **Behavioural changes**- Skin and fur, eyes, mucous membranes, salivation, diarrhoea, lethargy, sleep, coma, convulsions, tremors, mortality, morbidity were observed.
- **Haematological parameters-** Finding of Complete blood count shown in table no 1. Hepatoprotective study includes changes in Biochemical parameters and histopathological changes

- **Biochemical Parameters** - Liver function tests - including SGOT, SGPT, Protein, Serum alkaline phosphates (ALP), Albumin, Protein, Serum Bilirubin with the help of automatic biochemistry analyser. Blood samples were collected from animals through retro orbital plexus under aseptic conditions. The biochemical finding is presented in Table no 2 and 3
- **Collection of organs** - At the end of the experimental period, three animals of each group were sacrificed by cervical dislocation and Liver was carefully dissected out, cleaned to remove extraneous tissues, blotted to eliminate blood stain and weighed.
- **Histopathological studies** - A portion of liver tissue was preserved in 10% buffered formalin for histopathological examination these changes presented in figure no 1.

ASSESSMENT CRITERIA

All the observation were analysed statistically. Mean, standard error for each group was calculated. Statistical evaluation of the data was done by Two-way ANOVA and Dunnett's Multiple Comparison Tests. All the groups were compared with Control group, Test group (*Shleshmatakadhya Agad*) and Standard group (Mucinac). The Multiple Comparison Test was performed only if the P value obtained from ANOVA was less than 0.0001. (P value < 0.0001 was considered significant).

OBSERVATIONS

Acute oral toxicity study- According to OECD Guideline 423 (Annexure 2c).

Table 1: Showing haematological parameter in Acute oral toxicity study.

S.no	Parameters	Group 1	Group 2
1.	**WBC**	4.53±1.335	4.33±0.895
2.	**LYM%**	72.53±1.991	82.43±1.737
3.	**MID%**	7.33±0.533	6.27±1.299
4.	**NEUT%**	20.13±2.146	8.97±3.028
5.	**RBC**	6.48±0.610	5.82±0.496
6.	**HGB**	11.57±1.477	11.67±0.953
7.	**HCT**	38.10±4.813	26.40±6.102
8.	**MCV**	58.53±1.832	60.27±0.617
9.	**MCH**	17.73±0.601	20.00±0.208
10.	**MCHC**	30.33±0.612	33.27±0.296
11.	**PLT**	323.33±56.846	607.33±25.129
12.	**MPV**	12.60±2.804	8.90±0.551
13.	**PDW**	16.53±0.797	15.43±0.318
14.	**PCT**	0.39±0.068	0.54±0.057
15.	**P-LCR**	40.50±12.492	21.20±5.292

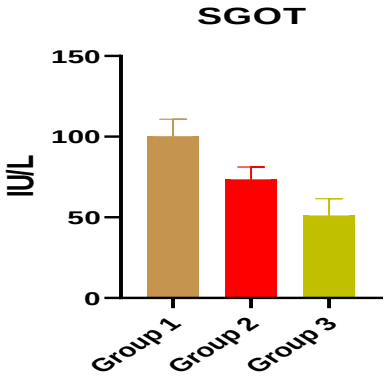
Evaluation of Hepatoprotective Activity of *Shleshmatakadhya Agad*

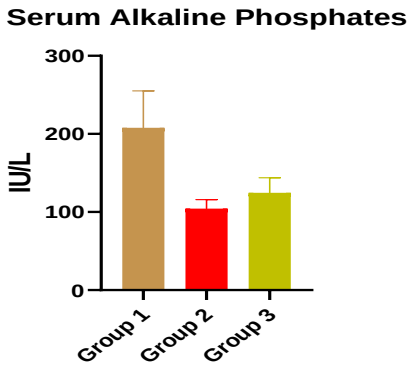
- Present study was aimed to check the Hepatoprotective activity of *Shleshmatakadhya Agad* on Paracetamol induced hepatotoxicity.
- Hepatotoxicity was induced by oral administration of PCM 1000 mg/kg for 7 consecutive days. Therefore, all the groups received their respective treatment for a period of 30 days. On the 31st day, Liver function tests and histopathology examination were conducted to evaluate the hepatic changes.

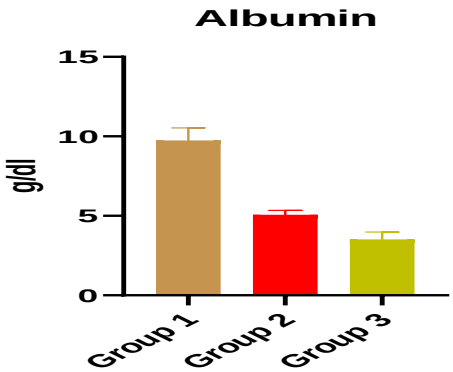
Liver Function Test

Table 2: Effect of *Shleshmatakadhya Agad* on biochemical parameter.

Observation	Group 1 (Control group)	Group 2 (SA)	Group 3 (Mucinac)
SGOT	100.34±4.704	73.56±3.425	51.17±4.653
SGPT	128.65±4.447	97.52±5.702	71.86±3.978
Serum Alkaline Phosphate	207.86±21.116	124.63±8.592	104.25±5.224
Protein	8.90±0.253	7.24±0.180	6.59±0.215
Albumin	9.74±0.354	5.07±0.122	3.52±0.204
Direct bilirubin	1.43±0.183	0.68±0.038	0.36±0.033







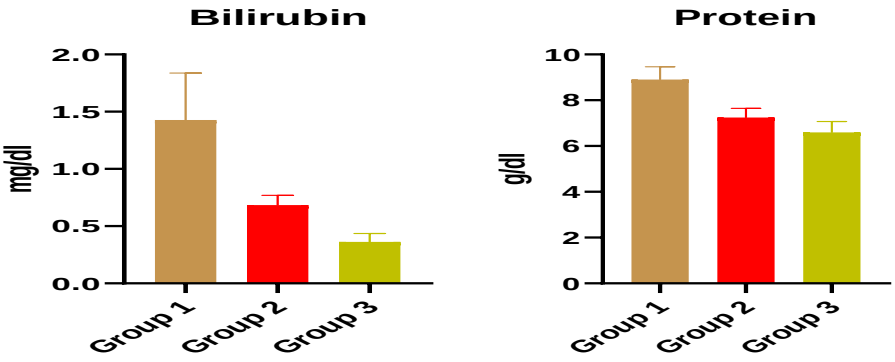


Table no 3: Two-way ANOVA followed by Dunnett's Multiple Comparisons Test finding for biochemical paramters.

Dunnett's multiple comparisons test	Mean Diff.	95.00 % CI of diff.	Significant?	Summary	Adjusted P Value
SGOT					
Group1 vs. Group 2	26.78	11.56 to 42.00	Yes	**	0.0016
Group 1 vs Group 3	49.17	33.95 to 64.39	Yes	****	<0.0001
SGPT					
Group 1 vs. Group 2	56.79	39.93 to 73.65	Yes	****	<0.0001
Group 1 vs. Group 3	31.13	14.26 to 47.99	Yes	**	0.0011
Serum alkaline phosphates					
Group 1 vs. Group 2	103.6	55.82 to 151.4	Yes	***	0.0003
Group 1 vs. Group 3	83.23	35.44 to 131.0	Yes	**	0.0018
Protein					
Group 1 vs. Group 2	1.658	0.8871 to 2.429	Yes	***	0.0003
Group 1 vs. Group 3	2.306	1.535 to 3.077	Yes	****	<0.0001
Albumin					
Group 1 vs. Group 2	4.674	3.803 to 5.545	Yes	****	<0.0001
Group 1 vs. Group 3	6.218	5.347 to 7.089	Yes	****	<0.0001
Direct bilirubin					
Group 1 vs. Group 2	0.7440	0.3562 to 1.132	Yes	***	0.0008
Group 1 vs. Group 3	1.066	0.6782 to 1.454	Yes	****	<0.0001

RESULTS

Serum Glutamate Oxaloacetate Transaminase (SGOT)

Administration of paracetamol in Group 1 resulted in a significant elevation of SGOT levels (100.34 ± 4.70 IU/L), indicative of hepatocellular injury. In contrast, Group 2, which received the test drug (*Shleshmatakadhya Agad*), exhibited a statistically significant reduction in SGOT levels (73.56 ± 3.42 IU/L; $p = 0.0016$ vs. Group 1). Group 3, treated with the standard drug (Mucinac), showed the most pronounced reduction (51.17 ± 4.65 IU/L; $p < 0.0001$ vs. Group 1), indicating a high degree of hepatoprotection.

Serum Glutamate Pyruvate Transaminase (SGPT)

SGPT levels were significantly elevated in Group 1 (128.65 ± 4.45 IU/L), indicating acute hepatic injury. Treatment with *Shleshmatakadhya Agad* in Group 2 resulted in a marked reduction in SGPT levels (97.52 ± 5.70 IU/L; $p < 0.0001$ vs. Group 1). Group 3, treated with the standard drug (Mucinac), showed a further decrease to 71.86 ± 3.97 IU/L ($p = 0.0011$ vs. Group 1), suggesting enhanced stabilization of liver function.

Serum Alkaline Phosphatase (ALP)

Group 1 exhibited significantly elevated ALP activity (207.86 ± 21.11 IU/L), indicative of biliary dysfunction. Administration of *Shleshmatakadhya Agad* in Group 2 led to a marked reduction in ALP levels (124.63 ± 8.59 IU/L; $p = 0.0003$). Similarly, the standard drug (Mucinac) in Group 3 significantly lowered ALP levels to 104.25 ± 5.22 IU/L ($p = 0.0018$), demonstrating effective amelioration of cholestasis.

Protein

In the paracetamol-induced group (Group 1), serum protein levels were elevated (8.90 ± 0.25 g/dL), likely reflecting hepatic stress. Treatment with *Shleshmatakadhya Agad* (Group 2) resulted in a significant decrease to 7.24 ± 0.18 g/dL ($p = 0.0003$). Group 3 showed a further reduction to 6.59 ± 0.21 g/dL ($p < 0.0001$), consistent with normalization of hepatic protein synthesis.

Serum Albumin

Group 1 demonstrated a notable increase in serum albumin levels (9.74 ± 0.35 g/dL), possibly due to altered hepatic protein metabolism. Administration of *Shleshmatakadhya Agad* (Group 2) significantly reduced albumin levels to 5.07 ± 0.12 g/dL ($p < 0.0001$). A

comparable decrease was observed in Group 3 (6.59 ± 0.21 g/dL; $p < 0.0001$), indicating restoration of hepatic synthetic function.

Direct Bilirubin

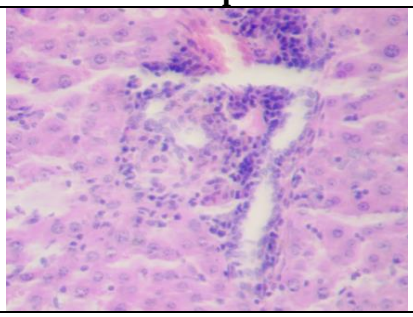
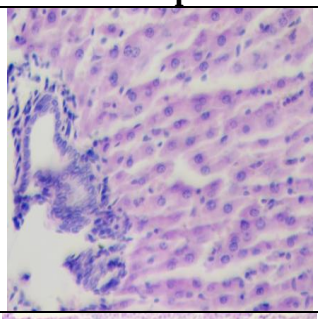
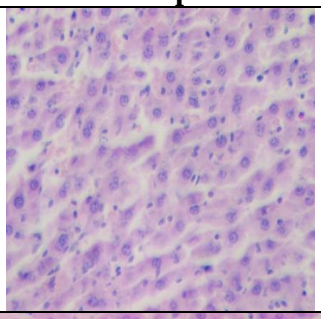
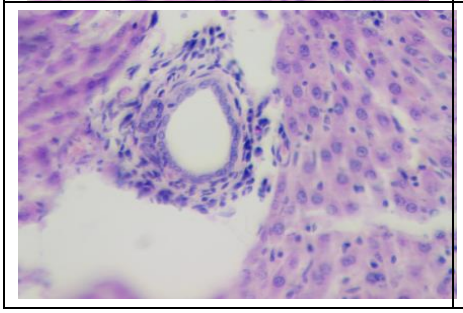
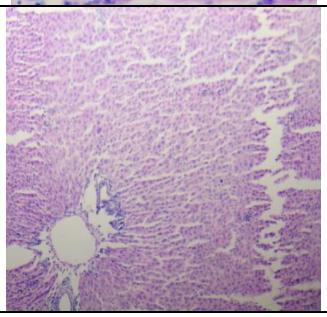
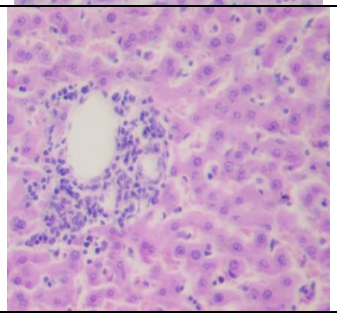
Direct bilirubin levels were significantly elevated in Group 1 (1.43 ± 0.18 mg/dL), indicating impaired hepatic excretory function. Treatment with *Shleshmatakadhya Agad* (Group 2) significantly reduced bilirubin levels to 0.68 ± 0.03 mg/dL ($p = 0.0008$). Group 3 exhibited an even greater reduction (0.36 ± 0.03 mg/dL; $p < 0.0001$), reflecting enhanced recovery of biliary clearance.

Histopathological changes

Control group 1- Observed moderate degeneration of the central and portal veins, along with necrosis and inflammation in histopathological examination.

Test group 2- Mild degeneration of the central and portal veins was found in histopathological examination.

Standard group 3- Mild degeneration of the central and portal veins was observed in histopathological examination.

Group 1	Group 2	Group 3
		
		

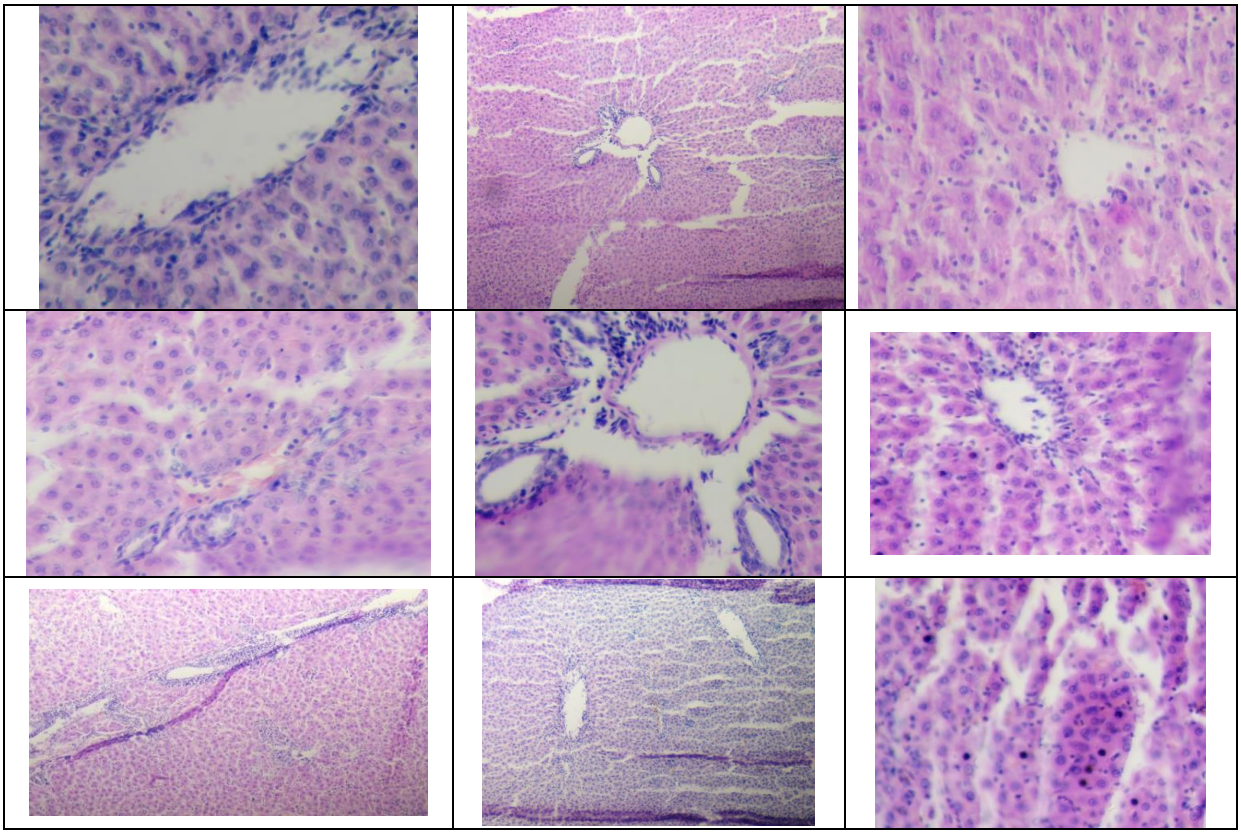


Figure 1: Histopathology in Liver.

DISCUSSION

Paracetamol, being considered safe at therapeutic doses, becomes hepatotoxic when consumed in excessive quantities. The hepatotoxicity is primarily mediated through the bioactivation of paracetamol by the cytochrome P450 enzyme system to form a reactive metabolite, N-acetyl-p-benzo quinone imine (NAPQI).

From an *Ayurvedic* perspective, the hepatotoxic effects of paracetamol may be conceptually linked to *Dushi Visha*, a type of latent toxicity that persists in the body over time, especially following repeated exposure to harmful substance. *Shleshmatakadhya Agad* has the potential to pacify *Pitta* and *Kapha doshas*, stimulate *Agni* (digestive and metabolic fire), and act as a *Vishaghna* (detoxifying agent), thereby reflecting to the Ayurvedic understanding of *Dushi Visha* pathology. Each ingredient of the formulation contributes uniquely to its hepatoprotective effect; *Tinospora cordifolia* and *Cordia dichotoma* possess *Rasayana* (rejuvenative), *Pittahara*, and *Raktaprasadana* properties that protect and regenerate liver tissue; *Achyranthes aspera* and *Cassia fistula* promote bile flow and purification through *Lekhana, Bhedana*, and *Mriduvirechana* actions; *Solanum surattense* and *Solanum indicum*

act as anti-inflammatory and hepatostimulant agents through *Shothahara* and *Yakritbalya* effects.

The present study demonstrates that paracetamol-induced hepatotoxicity in Wistar rat's results in significant biochemical alterations, including elevated levels of SGOT, SGPT, Serum alkaline phosphatase (ALP), Protein, Albumin, and Direct bilirubin. These changes reflect hepatic cellular damage, biliary dysfunction, and impaired metabolic and excretory function. Treatment with the test drug *(Shleshmatakadhya Agad)* significantly ameliorated these alterations, with effects comparable to the standard drug, Mucinac (N-acetylcysteine).

"A significant elevation in SGOT and SGPT levels in the paracetamol control group (Group 1) indicates extensive hepatocellular damage." These transaminases are sensitive indicators of hepatic membrane integrity, and their elevation correlate with increased permeability and enzymes leakage due to cellular necrosis. Treatment with *Shlesahmatakadhya Agad* (Group 2) significant reduced both SGOT and SGPT level, indicating its role in membrane stabilization and hepatocellular repair. The effect was more pronounced in the Mucinac treated group 3, which demonstrated even lower transaminase, aligning with its known mechanism of action as a glutathione precursor and free radical scavenger.

The marked elevation in serum ALP levels in the paracetamol-treated group (Group 1) is indicative of cholestatic injury or biliary obstruction. ALP is a sensitive marker of bile duct injury, and its normalization in the test and standard treatment groups suggests effective protection and functional recovery of the biliary system. The reduction in ALP levels following administration of *Shleshmatakadhya Agad* (Group 2) and Mucinac (Group 3) supports the hepatoprotective and choleretic properties of these agents.

Similarly, the elevated protein and albumin levels in Group 1 may reflect compensatory hepatic stress or systemic inflammation. While the liver is the principal site for plasma protein synthesis, paracetamol-induced injury may lead to altered regulation of protein metabolism. Treatment with *Shleshmatakadhya Agad* significantly restored these parameters toward normal levels, suggesting improved hepatic synthetic capacity and homeostatic regulation. The effect was slightly more pronounced with Mucinac, reflecting its well-established efficacy in hepatic detoxification.

Direct bilirubin levels were also significantly elevated in the paracetamol control group, consistent with impaired conjugation and excretion functions of the liver. The reduction in bilirubin levels following treatment with *Shleshmatakadhya Agad* indicates restoration of hepatic excretory function and improved bile flow.

Thus, the *Shleshmatakadhya Agad* formulation demonstrates multi-targeted hepatoprotective action, not only through contemporary pharmacological activity but also through its correlation with classical Ayurvedic roles in neutralizing *Dushi Visha*, promoting *Dhatu Samya* (tissue equilibrium), and supporting long-term hepatic resilience.

CONCLUSION

Shleshmatakadhya Agad demonstrated significant hepatoprotective effects against paracetamol-induced liver injury in Wistar rats. The formulation effectively normalized liver enzyme levels and preserved hepatic architecture, comparable to the standard drug, N-acetylcysteine. All these findings conclude that *Shleshmatakadhya Agad* can potentially serve as an alternative or adjunctive hepatoprotective agent in cases of drug-induced liver injury or toxicity.

REFERENCES

1. Gautam R, Chandrasekar B, Deobagkar-Lele M, Rakshit S, Kumar BN, Umapathy S, et al. Identification of early biomarkers during acetaminophen-induced hepatotoxicity by fourier transform infrared microspectroscopy. PLoS One., 2012; 7: e45521.
2. Duseja A. Nonalcoholic fatty liver disease in India – A lot done, yet more required! Indian J Gastroenterol., 2010; 29: 217–25.
3. Michael J. Hodgman, Alexander R. Garrard. A Review of Acetaminophen Poisoning. Crit Care Clin., 2012; 28: 499-516. http://dx.doi.org/10.1016/j.ccc.2012.07.006
4. Acetaminophen poisoning now most common cause of acute liver failure in the USA (cited on http://www.medicalnewstoday.com/releases/34287.php
5. Hurkadale PJ, Shelar PA, Palled SG, Mandavkar YD and Khedkar AS. Hepatoprotective activity of Amorphophallus paeoniifolius tubers against paracetamol-induced liver damage in rats. Asian Pacific Journal of Tropical Biomedicine 2012; S238-S242. http://dx.doi.org/10.1016/S2221-1691(12)60167-1
6. Naughton, C., 2008. Drug-Induced Nephrotoxicity. PharmD, BCPS Am Fam Physician., 78(6): 743-750.

7. Shastri P., Pandeya D., Charak Samhita of Agnivesha, Chikitsasthana, Varanasi, Chaukhambha Sanskrit Sanstana, 2012; chapter no-23, verse no-6, page no-550.
8. Shastri, K., Sushruta samhita, Kalpasthana. 14th ed. Varanasi: Chaukamba Sanskrit Sansthan, 2003; chapter no-2, verse no-3, page no-15.
9. Garde, D., Ashtanghridaya of Vagbhat, Uttarsthan,. Pune: Anmol Prakashan, 2006, Chapter no- 35, verse no- 5 & 6, page no- 458.
10. Yoga Ratnakar, commentary by Vaidya Sri Laxmi Pati Shastri, Vishaadhikar Chikitsa, Shastri SB, editor, Varanasi, Chaukhamba Sanskrit Prakashan-2009.
11. Krishna Mohan G et al, 2007.
12. Ja Wani et al, 2011.
13. Tv etrichelva net al, 2003.
14. P Siddhuraju et al, 2002; Noorhajati Het al, 2012.
15. Prof. K R Srikanta Murthy, Sharangadhara Samhitha, Chowkamba Orientalia, Varnasi, edition 2012, Pur vakhanda, 1/48, Pg. 8.
16. Sarngadhar Samhita by Prof. K. R srikantha Murthy, Chaukhambha Orientalia Varanasi Part 2 chapter 6 slok 1.